THURSDAY, JULY 1, 1897.

LAKES RUDOLF AND STEFANIE.

Through Unknown African Countries. The First Expedition from Somaliland to Lake Lamu. By A. Donaldson Smith, M.D., F.R.G.S., Hon. Member of Acad. Nat. Sci., Phil. Pp. xvi + 471, with illustrations and five-sheet map. (London: E. Arnold, 1897.)

THE region of Africa to the south of Eastern Abyssinia has been long regarded as of exceptional interest, both by the naturalist and the novelist. So early as 1847, when most geographers still believed that the snows of Kilima Njaro were a traveller's tale, and before Kenya had been seen by a European, Captain Short returned from the Juba, and asserted the existence of snow clad mountains away to the westward. According to the statements of some native traders to the court of Abyssinia, the bamboo forests of the same region were inhabited by tribes of dwarfs; and these reports were published by Captain Harris in 1844, long before the measurements by Schweinfurth, the skeletons sent home by Emin, and the discoveries of Stanley had called prominent attention to the pigmy races of Equatorial Africa. At a subsequent period, the late M. Abbadie placed a great mountain in the same unvisited district, exaggerating its height, as he recently naïvely remarked, in the hope of calling attention to it. Suahili traders also reported the existence in this region of two great lakes, of which the larger was sometimes called Samburu, and at others was confused with Baringo; it was the hope of reaching this lake region that led to the expedition of Burton and Speke, which came to such a disastrous end at the landing-place near Berbera. The excitability of the Somali, and the fascination of the discoveries made in East Africa south of the equator, subsequently diverted attention from this region, and it was not until 1888 that the first Europeans reached it. Teleki and Höhnel then entered from the south, and found, as reported, that there were two great lakes: the larger was named by its discoverer Lake Rudolf, apparently on the principle of Oliver St. John's dedication of his memoirs to Cromwell, who, by persuading him to travel, had given him the leisure in which to write them. After Teleki's return, several attempts were made to reach the twin lakes from the north, along Burton's projected route. But it was not until 1895 that success was gained by the expedition described in this volume.

The author, Arthur Donaldson Smith, is a young American doctor who prefers sport to surgery. He made a preliminary excursion in Somaliland in 1893, in order to gain experience of the people and the conditions of travel. Having further prepared himself by a course of training in geographical surveying, under Mr. Coles, he returned to Berbera in June 1894. He was accompanied by two English companions—a young sportsman, Mr. F. Gillett, and an experienced taxidermist and collector, Mr. Dodson; both of them gave him most loyal assistance. A force of 82 Somali were enlisted, and 84 camels purchased. The expedition started from Berbera on July 15; Dr. Smith had the advantage of the help of the most famous of African caravan headmen, the late Dualla Idris, who is, however, referred to as Haji Idris. The expedition crossed Somaliland to Milmil, and thence struck westward, and somewhat southward, in the hope of traversing the countries of the Arussa and Janjam to Lake Rudolf. The Webi Shebeli was crossed on September 1, and its course followed to a Galla settlement round the remarkable tomb of Sheik Hussein (the Scech Uscen of Bottego). The native tradition as to the origin of this building is clearly a legend, and more information about it would have been welcome. While staying here, Dr. Smith heard that the Abyssinians were in force at Ginea, a town a little distance to the south Mr. Gillett went to ask the chief for permission to proceed; but after considerable negotiations, during which the Abyssinians were friendly, the permission was refused, and the expedition had to return to the Shebeli. It descended this river to Bari, the village reached by the brothers James and Lort-Phillips in the first crossing of Somaliland. Thence the persevering explorer again turned westward, crossed the Juba, and marched over the Borana Galla country to Lake Stefanie. After exploring this lake, and the district to the north, the expedition continued westward to Lake Rudolf. Dr. Smith followed the course of the river that flows into the northern end of the lake for 75 miles. The river was apparently about to turn to the north-east, but he could follow it no further; and thus it is still uncertain whether the Nianam is the lower part of the Omo. From Lake Rudolf the expedition marched southward, across the waterless wastes of the Rendile country to the Nyiro, and descended the valley of the Tana to the coast.

The narrative of the journey is of great interest throughout. It abounds in sporting adventures, which are tersely and vividly told. The author had narrow escapes from elephants, rhinoceros, and lions. He came into conflict with hostile tribes on one or two occasions; but it was apparently not his fault. African natives are often fools, and it is impossible to read the narrative without feeling that there was nothing the author wanted more than peace. He had diplomatic intercourse with many "kings" and one "emperor," and throughout all his varied experiences he showed himself a man of resource, of courage, and of indomitable perseverance.

The scientific results of the expedition were very important. The five-sheet map, based on an extensive series of astronomical observations, is very valuable. The zoological collections were rich, especially in vertebrates; they are described in a series of appendices by Dr. Günther, Mr. R. I. Pocock, Prof. Jordan, and others, whose names might well have been given in the list of contents as well as the titles of their contributions. The collection of birds was, however, the most important, though there is no report upon it, and there is no complete reference to Dr. Sharpe's paper in which it was described. The general value of the zoological collection lies in the fact that it comes from the unexplored area between southern Somaliland and northern British East Africa. Many of the separate observations are also of interest. The author describes an attack made on a lion by some hyenas; he notes the existence of a large rhinoceros differing from the common species in the shape of the front part of the head. This animal has been recorded twice previously, but it is apparently still represented in Europe by a single horn.

The principal geological problem, which it was hoped the expedition would settle, was whether the Omo Valley is a continuation of the great East African Rift Valley, in which Lake Rudolf lies. Unfortunately the circumstances which prevented Dr. Smith tracking the Nianam further towards its source are responsible for this question being left open. Dr. Smith, however, believes that the Omo is one of the head streams of the Juba, and does not flow into Lake Rudolf, as is generally believed from Borelli's work. If the altitudes given us are correct, the new view is impossible. Borelli descended the Omo to the level of 3450 feet: Bottego ascended the Juba to a height of over 4500 feet: the Omo cannot flow 1000 feet up hill into the Juba. Another alternative was once possible. We have previously suggested, from Dr. Smith's preliminary map, that "it is just possible that the Omo reaches this lake [Abaya] instead of Basso Narok [*i.e.*, Lake Rudolf]" [Gregory, "Great Rift Valley," p. 258]; but now Dr. Smith fixes the height of Lake Abaya as 3460 feet, so that the Omo is excluded from that goal. Hence, we are driven to the conclusion that the Omo must continue as the Nianam, and flow into Lake Rudolf, as Borelli believed; this conclusion is in agreement with the altitudes and with the trend of the country as shown by Dr. Smith's map.

Another point of interest to geologists is the evidence as to the existence of volcanic activity in this region; for Dr. Smith tells us that the Teleki volcano at the southern end of Lake Rudolf, in August 1895 "sent up clouds of smoke, and at night a great stream of glowing lava could be seen pouring from one of the craters" (p. 333). This information is especially interesting, as Mr. Neumann found no signs of activity there, and as the oft-asserted "Volcano Doenyo Ngai" now turns out not to be a true volcano.

In one respect Dr. Smith's information is strikingly different from that of Teleki and Höhnel. These explorers found the water of Lake Rudolf so brackish that they could hardly drink it, while that of Lake Stefanie was so salt that it was quite useless, and they could only stay on its shore owing to the existence of pools of rain-water. This was in 1888. But in 1895 Dr. Smith found the water of both lakes was quite fresh, in which he is confirmed by a very accurate observer, Mr. A. H. Neumann, for the northern end of Lake Rudolf. There can be no doubt that a remarkable change in the salinity of these lakes has taken place in only seven years; and the possibility of such changes must be borne in mind in considering the origin and relations of the African lake faunas. For example, it has been urged that the marine origin of the Tanganyika fauna is impossible, since there is no trace of marine influence in that of Lake Nyasa, through which the former, on the usual theory, must have passed. But Lake Stefanie reminds us that either a too rapid freshening of a lake, or a period of intense salinity, may obliterate the original fauna. Hence the complete absence of any marine types from the fauna of Nyasa is no proof that that of Tanganyika had not a marine origin. It should, however, be remarked that we are not expressing any acceptance of the view that the fauna of Tanganyika has any marine characters; but only that one of the arguments against that view is invalid.

The part of the book most open to criticism is that dealing with ethnography; but the facts mentioned show that the country traversed is of extreme interest. The author found some dwarf people about five feet high, and gives us a list of their words, although a few phrases would have been more useful; he describes some wells, which he attributes to the ancient Egyptians: and he met with Midgans, Tomal and "half-caste Boran," respecting each of which more detailed information is desirable. One quaint slip in this department is speaking of a "tamasho (*sic*) or equestrian exhibition" as though it were a Somali word instead of Hindustani for a "function." But one man cannot do everything; and now that the author has shown the way, we hope that other travellers will follow and collect further information regarding the many questions which the volume raises. For it is a great testimony to the interest of the country that Dr. Donaldson Smith's valuable book suggests as many problems as it solves.

J. W. G.

EXERCISES IN PHYSICS.

Problems and Questions in Physics. By C. P. Matthews and J. Shearer. Pp. vii+247. (London: Macmillan and Co., Ltd., 1897.)

THIS useful book contains more than thirteen hundred problems in the various branches of physics, and, from the point of view of degree work, covers the ground required for the London Matriculation and Intermediate Science Examinations, as well as part of that for the Final B.Sc. It is, however, intended for all students of elementary physics, including, therefore, students of engineering, and the peculiar needs of the latter have also been provided for.

The authors begin with an introduction, which, as they explain, is intended not only to be read, but continually referred to, and contains short sections on physical measurement in general, units, vectors, the expression of physical relations by curves, averages, and approximations. A few examples are added on graphic methods, as well as a list of units and physical constants for use in the problems. Next follow the problems themselves; and the book ends with a set of four-figure mathematical tables, the solutions to the problems, and a rather meagre index.

In a work designed for students of both engineering and physics, one naturally looks first to see what is said on the vexed question of the unit of force. We congratulate the authors on the line they have here taken. As they explain in their preface,

> "Many of the students who will use these problems are pursuing engineering courses. In such case, they must of necessity use engineering units. The aim has been not so much to train them in the use of these units—an abundance of this training comes to them during their course—but to bring out the relation of the so-called practical and gravitational units to the C.G.S. units of physics."

The C.G.S. and foot-pound-second systems are first defined, and the superfluous character of the latter tacitly assumed. This is shown by the fact that, after its definition has been given, the word poundal does not again occur. The authors then explain that pound and kilogramme are used by engineers as names for units of force, and the two corresponding gravitational systems are well illustrated by problems introduced, throughout the mechanics section, among those on C.G.S. measurements.

This takes us as far as is at present, perhaps, possible in the direction of a compromise to which many teachers of physics are now looking forward—the recognition, namely, of two distinct systems of measurements only; one the C.G.S. with its derived practical system, for scientific and electrical purposes, the other the system used by engineers, and based on the units of length, time, and *force*.

Among other noteworthy features is a good set of problems on dynamos and alternating currents, another on wave and harmonic motions in connection with sound, and a third on gravitational potential in the section on work and energy. Less commendable, however, is the reference to water-levels in connection with electrical potentials. The most perfect "water analogy," and the one which, in our experience, appeals most directly to students, is that in which conductors are represented by water-filled cavities in a large block of india-rubber; it affords, indeed, almost the only means of enabling the average beginner to realise how the potential of a body or of a point in space may be altered by altering the charge on another body at a distance.

It is a pity that those problems which admit of solutions are not all supplied with them. Many are of the nature of examination questions, requiring long answers in words, and to these, naturally, no answers are given; but of the rest, not more than about three-fourths are solved.

We have noticed the following slips. The answers to Nos. 251, 759, 775, 776, 837 are either wholly or partially wrong; in No. 607 the water-worth of the dish should be given; and the headings to pp. 204 and 221 want altering. These are, however, small blemishes on an otherwise very useful work. A. P. C.

COSMIC ETHICS.

Cosmic Ethics; or, the Mathematical Theory of Evolution. By W. Cave Thomas. Pp. xxii + 296. (London: Smith, Elder, and Co., 1896.)

IN styling his book "Cosmic Ethics," Mr. Cave Thomas means to imply that not only in morals as a department of "the wider hygiene," but throughout the universe, there is but one law of rightness, that of balance, proportion, or the mean. By "mathematical evolution" he desires to signify that evolution is "the becoming of the proportioned," its goal being "the at-mean-ment of nature."

Starting from the admitted applicability of the idea of quantity throughout the concrete world, and from the progress which the sciences undoubtedly make when measurement or quantitative formulæ can be used in them, Mr. Thomas advances to an apotheosis of the average, and offers principia of the science of proportion and applications of quantification throughout the whole range of human knowledge. By somewhat elementary numerical formulæ we can determine the beau-idéal in the arts, attain to a quantitative ethic, discover that a man ought to drink neither too much nor too little, that his morning tub should not vary much in temperature from that of the human body, that the combination of great athletic and great intellectual effort leads to a break-down, and that technical and specialist education is inferior to general education.

Of the principia we may quote as an instance: "*The mean of fraction* is $\frac{1}{2}$; it is the fraction which is equally indifferent to the two extreme fractional limits of $\frac{1}{1}$ and $\frac{1}{0}$." (!) Of the exemplifications of the formulæ, we may point out that they are purely arbitrary. We ought to aim, we are told, at not diverging from the average, which is the ideal, to any extent which carries us beyond the middle third of our scale. Why not the middle fifth or seventh? There is no attempt to point out how the qualitative kind to which any particular scale is applicable is determined, and this despite of the fact that in a quotation which he makes from Reynolds—one of a constantly recurring set of quotations—that point is definitely raised.

Mr. Thomas accepts the Darwinian theory, though how the importance which that theory ascribes to "accidental variations" from type, can be reconciled with his own views as they stand, it is difficult to see. In fact, as they are here put before the reader, Mr. Thomas's doctrines will not allow of being harmonised into an intelligible system. This is the more to be regretted, as there is no doubt that an adequate elucidation of the theory of quantity, number, and measurement, would be of very great service to applied science. Nay, it is perhaps not too much to say that from the Galton system of composite photography, and from the statistical results of anthropometry, to which the author refers, conclusions of considerable value for art may be drawn. But they are not those drawn by Mr. Cave Thomas, nor to be drawn by his methods; though his considerable judgment in art and his grasp of the distinction between the organic fitness of an object for its purpose and its appositeness to human taste, make this department of his investigations the least unpromising.

His quotation of the headings of the chapters in Aristotle suggests the suspicion that Mr. Thomas has not studied that author in the Greek. Otherwise the attribution to him of a system of quantitative ethics would be, despite of the great authorities for that view, less pardonable than it is. Yet to the Greeks Mr. Thomas has chosen to go in his quasi-Pythagorean glorification of quantity. H. W. B.

OUR BOOK SHELF.

The Flora of the Alps. By Alfred W. Bennett, M.A., B.Sc., F.L.S. 2 vols., with 120 coloured plates. Pp. xxii + 165; vi + 223. (London: J. C. Nimmo, 1896.)

THE Alpine wanderer will not be very grateful to Mr. Bennett and his publishers for this new "Flora of the Alps." The net is spread widely; for, in addition to the whole Swiss flora, there are included here plants from adjacent mountain districts, and also the Pyrenees. The result is a rather cumbrous affair, and yet unsatisfying in detail. The species of each genus are enumerated with very short and sometimes rather inadequate characters, so that the identifying of specimens is not always as easy as it might be. That the book is arranged according to the system of Bentham and Hooker we may regard as a welcome innovation in Alpine floras, which have been too long wedded to the irritating Linnæan system. The paper and printing are in their way admirable, but the thickness of the former does not make for portability. The custom of arranging Latin and English names under separate indices should be prohibited. It is a time-honoured survival in some Floras, but a constant source of annoyance to their users. Whether the 120 coloured plates of Alpine plants scattered through these pages will prove acceptable to purchasers of the work, we cannot say. A very large number of them are to be found in Wooster's "Alpine Plants," published a quarter of a century ago, though we have searched in vain for any indication of this fact. Then, too, some trouble was taken in the printing, and the result was not unpleasing. In Mr. Bennett's "Flora," these old plates have been mutilated, as will be obvious to any one who cares to compare the two works. In these days of modern methods and high-priced books we expect an advance, not a retrogression. We have said sufficient to show that the ideal Alpine Flora still remains to be produced. Our own view is that it should be somewhat on the lines of Hooker's "Student's Flora of the British Islands," with a separate volume of woodcuts similar to those of the well-known "Companion" to Bentham's "Handbook." If coloured plates are wanted, a draftsman of high artistic capacity and requisite botanical knowledge must be employed, whilst the printing must be of the very best. Nor would the public which travels in the Alps, and collects and examines the flowers growing there, be backward in its recognition of such a work.

First Stage Mechanics of Fluids. (The Organised Science Series.) By Prof. G. H. Bryan, Sc.D., F.R.S., and F. Rosenberg, M.A. Pp. vi + 208. (London: W. B. Clive, 1897.)

IN the pages of this book the authors have brought material together to cover that part of the subject of mechanics which is required by the Science and Art Department in the elementary examination. There are also chapters devoted to that portion of dynamics which is required by the corresponding syllabus in the mechanics of solids. The twenty-three chapters which fulfil the above-mentioned requirements are so arranged as to form an excellent elementary treatise, and also a good introduction to those who wish to make a further study of the subject. The style of treatment is similar to that adopted in other books of this series. The authors advocate strongly the importance of each student working out examples by himself, and with this idea have inserted numerous solved and unsolved problems. They have also kept down the number of formulæ, in order that the reader shall attack problems from first principles, and not trust to his memory; for those formulæ which have been inserted, proofs have been added. Numerous typical illustrations and figures are inserted in the text, thus rendering it still more serviceable to the young beginner.

Illustrative Cloud Forms. By C. D. Sigsbee. (Washington: U.S. Hydrographic Office, 1897.)

IN this book we have a collection of coloured plates, sixteen in number, illustrative of the different typical forms which clouds assume under various conditions. The classification, nomenclature, and descriptive text are derived from the "International Cloud Atlas" (Paris, 1896), but the plates are from the original paintings made for the Hydrographic Office by Mr. Rudolf Cronau. In addition to the ten standard types which are included in the classification, six further plates are devoted to illustrating certain modifications of these, such as fracto-stratus, fracto-cumulus, mamato-cumulus, &c. Each plate embraces the horizon and sufficient extension of view, so that the observer can obtain a good idea of cloud perspective. The paintings themselves have been made as accurately and as true to nature as possible, and photographs, printed exemplars, together with the artist's personal observations and knowledge of clouds, have all been brought to bear on them. Great pains have been taken by the Hydrographic Office to ensure a faithful reproduction of the originals, and we can safely say that the observer has here before him a most excellent guide for the classification of clouds, which branch of meteorology is becoming every year of more importance as a means of forecasting the weather.

Among British Birds in their Nesting Haunts, illustrated by the Camera. By Oswin A. J. Lee. Part iv. (Edinburgh: David Douglas.)

THE first three parts of this work were noticed in these pages a few weeks ago (May 13, p. 26); the photographic reproductions in the present part are as attractive as those which preceded them, and will interest every student of bird life. There are ten large plates showing the nests of the Woodcock, Oyster-catcher (two plates), Tree Pipit, Reed Bunting, Ringed Plover (two plates), Little Tern (two plates), and Jackdaw. Brief notes upon the birds and their nesting haunts accompany each plate.

More brilliant photographic pictures of the nests of birds have never been published than those which now bear testimony to Mr. Lee's skill with the camera. The work in which the pictures appear is already known to most ornithologists, and it will long receive a full measure of admiration.

The Indigenous Drugs of India; Short Descriptive Notices of the Principal Medicinal Products met with in British India. By Kanny Lall Dey, Rai Bahadur, C.I.E. Second edition. Pp. 387. (Calcutta: Thacker, Spink, and Co.)

A WORK like the present, which is intended to promote the extension of our knowledge of Indian drugs, is much to be welcomed. Indian Materia Medica presents a wide field of research for the botanist, chemist, and pharmacologist. Dr. Lall Dey's book is a useful epitome of the characters and uses of Indian indigenous drugs, and contains a great deal of valuable information. It will form an excellent introduction to larger works on the subject, such as Dymock's "Pharmacographia Indica," and Watt's well-known Dictionary.

LETTERS TO THE EDITOR.

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

The Storm in Essex on June 24.

I AM doubtful if an English thunderstorm has ever assumed the proportions that one reached here on Thursday last. Although there is nothing new under the sun, yet there is a good deal new to each individual, and the following facts were not looked on as possibilities by me before I witnessed them on that day.

The 24th was an intensely hot day, and after much distant thunder the storm broke on us about 2.45 p.m. (while haymaking was in full swing) from the north-west. After about ten minutes of the heaviest rain, hail began to fall, and soon a terrific hurricane, accompanied by hailstones larger than hens' eggs (mixed in with others of all sizes downwards), came on and lasted for five minutes, during which most of the damage was done. After this the storm gradually abated, and in something over half-an-hour had passed away. The scene was quite unique and winter-like. The ground was quite white, and in many places the hail had drifted to a foot deep, and every ditch and depression in the ground was full of water and hail. Every window on the north-west sides of the houses and cottages was destitute of glass—not merely broken, but the whole driven through. Two greenhouses were completely smashed, only one pane in some miraculous way having escaped on the windward side. A bird-cage hanging in a window was demolished, and the bird found in a chair on its back under a bit of glass. Rooks and pigeons were lying about the fields dead and dying, and one of my men secured enough for a rook pie next day. Also we picked up next day some half-dozen small birds while turning over about eight acres of hay.

A stable roof covered by pantiles half-an-inch thick had half the tiles broken into quite small pieces, and has the appearance of having been shot at by rifles. Several chimney stacks had been blown on to the roofs, and in one case close by, through the house to the ground. All the farm buildings and cottages were unroofed more or less.

Trees had fallen in quantity, either torn up by the roots or broken off in the middle. Branches had been twisted off everywhere and hardly a leaf remained; the neighbouring common was beaten down as if an army had stampeded over it.

The crops presented a curious and melancholy sight. The grass intended for hay looked as if a steam-roller had been over it. The oats had also been not only beaten flat, but broken off short, and reduced to a sort of long chaff; in some cases the ends of a piece of stem stuck up, while the middle had been driven into the ground by a hailstone.

The mown ground and the lawn were indented to the depth of from one to two inches all over, much as if a flock of sheep had passed over them. This was, of course, also seen on the flower-beds and mangold-fields. This last crop has also been destroyed to the extent of two-thirds, every leaf broken off, and often the root in two pieces.

A hedge at right angles to the storm and some wall fruit were completely stripped of leaves and twigs, and left with "bare poles" nearly half denuded of bark; not a vegetable remains in the garden. Luckily the area of greatest severity was very small and not in the centre of the storm. The advancing front of the worst part seems to have been only about a mile in width, and to have spent its greatest energy after advancing a like distance.

The hailstones were in appearance a conglomerate of smaller ones cemented together with ice, and generally the centre stone was bigger than the others. They were much collected together in corners, and one was measured, twenty-four hours after the storm, four and a half inches round. SHEFFIELD NEAVE.

Ingatestone, June 28.

On Mimicry.

DR. JORDAN's suggestion (p. 153) that the result of a one-sided selection involves a physiological one-sidedness unfitting a mimetic species in other respects for the struggle for existence, can hold good only if the selective change in external imaginal characters be correlated with an unfavourable modification of other characters, perhaps in another stage of the insect's life; inasmuch as destruction can modify a species solely in respect to the constants for which it is selective.

Unless such correlation can be shown to exist, the physiological one-sidedness postulated by Dr. Jordan remains as hypothetical as are still many of the axioms on which the existing theories of mimicry are supported.

His objection is precisely analogous with another which is sometimes advanced: that the process of selection towards mimetic resemblance of the imago is rendered nugatory by means of the enormous destruction of individuals in the early stages, and the consequent survival of a very small percentage to hand on the greatly diluted effects of selection. But if the imagos of a mimetic species are distributed about a mean in respect of the degrees of likeness to a model, it is clear that no amount of unselective destruction, *i.e.* one which reduces the numbers uniformly on each side of the mean, can modify the curve of distribution.

That is, no loss of larvæ or pupæ can lessen the force of imaginal selection, unless there be correlation of characters.

Dr. Jordan's suggestion, however, is complementary to one at which I have arrived, but which I have hitherto put forward only privately. Even if there be no correlation of characters, as he assumes, a limitation upon the numbers of a mimetic species may yet be due to interrelation between its abundance and the natural checks upon its multiplication.

If a species, hitherto non-mimetic and persisting in small but constant numbers, come under the influence of a "protected" model, and the distribution of mimetic forms shows that such a phenomenon has probably been common, it must escape destruction in the imago stage in proportion to the degree of resemblance thereby acquired.

If the natural checks on its earlier stages remain constant in ratio, the mimic must become increasingly numerous concomitantly with increase of likeness to the model, the effect on which, though important, need not now be discussed.

But it is possible that, apart from any physiological modifications, the greater abundance of the imago is counteracted by increased destruction in other stages. While the effect of climate, for example, is presumably constant in ratio whether the species be few or numerous in examples, it is almost certain that within limits such important checks as animal parasites (Ichneumonidæ, &c.) become actually more efficient with multiplication of the host. In other words the number, say, of larvæ which can exist in a given area may be limited by such outside causes; so that no amount of lessened destruction of the imago can cause the species to become more numerous, because it is counterbalanced by greater larval destruction. And if the species has a greater chance of survival in the imago stage, it may actually become rarer therein as a result of the necessity that the number of larvæ shall remain constant.

If this be the case, mimicry may indeed be the outcome of natural selection; but, as Dr. Jordan suggests, it may have nothing to do with utility or the survival of the species.

And this leads to a further generalisation: it is conceivable, and indeed probable, that many species can exist indefinitely in small but constant numbers, as rarities, that is, which are unable by the assumption of any favourable modifications to become permanently common, owing to the interrelation of the factors which impose a limit on their multiplication.

June 19. WALTER F. H. BLANDFORD.

A Bacterium living in Strong Spirit.

IT is well known that the shipments of rum from Demerara, especially during the past year, have been "faulty," and very great pecuniary loss has resulted to the colony. Through the kindness of a friend and the courtesy of the Excise authorities, we received certain samples direct from a bonded warehouse; we were informed that the spirit had been returned at 42 per cent over proof, equivalent to 74·6 per cent. alcohol by weight; our determinations showed the assessment to be correct. On microscopical examination of a sediment at the bottom of the samples, using a magnification of 1200 diameters, we found chains of small cocci; after the spirit had been kept for some days the cocci were seen to be surrounded with a gelatinous envelope, and after a further interval of time the cocci were found disseminated throughout the liquid, and were rapidly developing and multiplying. The micro-organism, adopting the classification of Zopf, belongs to the group Coccaceæ, and for the present, from our study of cultivations, we are inclined to regard it as a new species; we have already obtained several stages of its life-history, and hope shortly to be in a position to publish a fuller account of its development and the chemical changes which it produces. Meanwhile, the observation of the existence and multiplication of any micro-organism in a spirit of such alcoholic strength appears to be of so much scientific interest, and the problem of its presence of such technical importance, that we send this note as a preliminary communication.

Oxford, June 23. V. H. VELEY.
LILIAN J. VELEY.

A Well-known Text-Book of Chemistry.

YOU have thought proper to admit to your columns a long and rambling notice of my "Manual of Chemistry," by Mr. M. M. Pattison Muir. It is difficult to make out from this what, definitely, is the charge which the writer brings against the book, but the article winds up with the statement that in his opinion "this book is not a success." I have the satisfaction of believing that chemists will derive little except amusement from this expression of Mr. Muir's opinion; but, as presumably NATURE is read by a portion of the general public and by some scientific persons who may not be acquainted with Mr. Muir's chemical idiosyncrasy, I desire to say, more in the interests of my publishers than of myself, that this opinion of his is not shared by the writer of any one, so far as I have seen, of the notices which have appeared in other papers.

William A. Tilden.

Royal College of Science, London, June 19.

The Gravitation Constant.

I beg to point out that at the end of the article on pp. 127–128 of Nature, relating to my researches on the gravitation constant, there is a misprint. The "oscillation" result for 1892 should be 5·523 instead of 5·520.

The error is not great, but by correcting it a much better concordance appears between the four principal values.

Charles Braun.

Mariaschein in Bohemia, June 21.

THE AMERICAN EXCAVATIONS IN SOUTHERN BABYLONIA.

For the last fifteen or sixteen years we have been glad to watch the endeavours of the Americans to carry out systematic excavations in Southern Babylonia, and we feel sure that all will rejoice with them now that they are able to report a very considerable success. It will be remembered that the first American to visit that country with a view of acquiring antiquities was Mr. Hayes Ward, who went out there early in the "eighties"; and the report which he gave on the matter probably helped forward the later expeditions of Dr. Peters and Mr. Haynes. Dr. Peters and a small party of promising young men went to Baghdad in 1890, and set out from that city for the ruins of Niffer, which are situated a few days' journey to the south-west, where they began to dig. For various reasons, however, Dr. Peters withdrew from the work soon afterwards, and the Committee of Excavations of Pennsylvania University determined to place the undertaking in the hands of Mr. Haynes, then the American Consul at Baghdad. Mr. Haynes took over the work, and for some years past he has devoted all his time to it, through the heats of summer when the land is burnt as hard as a brick, and through the rains of winter and early spring when the plains become seas of mud, has he lived at Niffer, patiently digging through the ruins of the temple, and tower, and ramparts, and court-yard, and hidden chambers of that ancient city. No other excavator has done his work so thoroughly, or so well in consequence, for he never left his post whilst diggings were going on; and though the cuneiform scholar sitting in a comfortable chair at home reading the descriptions of the work by Dr. Hilprecht[1] may think lightly of such devotion to science, it by no means diminishes its value. Moreover, the Arab of the neighbourhood of Niffer is not the gentlest of men; on the contrary, when he is displeased with the "Frangi" excavator, he will break his water-jars, or slit his water-skins as they are passing on donkeys to the river, or try to burn down his tents, or even to kill him, as he has done to more than one excavator.

In the limited space at our disposal we do not intend to describe the details of Mr. Haynes' excavations, but only to call attention to the general results of his work and their bearings upon the early history of civilisation in the East. Like all the cities which lie between the Tigris and Euphrates below Hillah and Baghdad, the mounds of Niffer contain the ruins of a temple of considerable size and of a tower; both rested upon a solid clay platform, the intention of the architect being to lift the buildings which were to be set upon it out of the reach of floods and overflows of the river. Round these ran a wall more than fifty feet in thickness, the object of which was, naturally, to keep out foes from the temple buildings and tower. The ruins which Mr. Haynes found on the platform belong to the temple and tower which a king called Ur-gur built about 2600 B.C.; but below this, Mr. Haynes found another platform which Sargon I. had built some twelve hundred years earlier, for all the bricks bore the name of this king and of his son Naram-Sin. Digging down deeper, Mr. Haynes found the ruins of one or more temples, but there are no inscriptions or marks upon any object which will help us to date them. Elsewhere in the outlying buildings in the mound small but strongly built chambers were found, and it is thought that these were employed for the safe keeping of records, tablets, and the like. Thus it seems that the oldest inscribed object discovered at Niffer belongs to the reign of Sargon I., who, according to the information given on the famous Cylinder of Nabonidus, reigned 3200 years before that king's time. The question which will naturally be asked next is, "To what period do the temples, the ruins of which were found beneath Sargon's platform, belong? and who built them?" At present it is impossible to give a satisfactory answer. Those who would reckon years by the depth of deposits say these temple-ruins are about 2000 years older than Sargon's platform; but this is, after all, only a guess, and if probabilities are taken into consideration we might as well date them at 10,000 B.C. as 6000 B.C., and we deprecate the use of exact figures in such matters. What is to be considered is the fact that about 3800 B.C. Sargon was able to build such a strong fortress, and that all the faculties of civilisation which such a power implied existed at that remote date. As to the earlier buildings which he found there and the platform on which they rested, they probably only stood upon the ruins of earlier buildings and of an earlier platform, and the site of Niffer being favourable for a city, it is more than likely that one stood there from time immemorial. To attempt to limit a civilisation of such antiquity as that of Southern Babylonia by thousands of years is, in our opinion, futile; though figures are useful at times to convey to the non-expert a general idea of antiquity. Mr. Haynes has proved that Niffer, in common with Tell-Lo, was one of a number of large and important cities which flourished in Southern Babylonia between 4000 B.C. and 2500 B.C., and the materials which he has obtained will enable us to describe the knowledge and religion, and manners and customs of its people with a fulness and minuteness hitherto impossible. We trust that he will soon give us his own account of the work which he has carried out, and meanwhile accord him our thanks for what he has already done, and congratulations upon the great success which he has achieved.

[1] "The Babylonian Expedition of the University of Pennsylvania," vol. i., 1893; vol. ii., 1896. (Philadelphia: Reprinted from *Trans. Amer. Philos. Soc.*, N.S., vol. xviii., Nos. 1 and 3.)

THE FRESH-WATER FAUNA OF LAKE TANGANYIKA.

The aquatic faunas of the great lakes of Central Africa, although like so many other features of the dark continent still largely unexplored, have attracted a good deal of attention during the last few years. It has been ascertained that some of these great sheets of water, although physiographically apparently so similar, are absolutely unlike each other in respect to the aquatic animals they contain. Thus the fishes and molluscs of Nyasa, which have been up to the present time by far the most completely known, show no forms which have deviated widely from easily recognisable fresh-water stocks, or that suggest that Nyasa has at any past time been more directly connected with the sea. On the other hand, one of the first items of zoological information which reached Europe concerning Tanganyika, was the discovery of a Craspidote medusa by Boehm in 1893. The mere existence of fresh-water medusæ is such a rare and remarkable occurrence, that scientific interest became at once turned towards the Tanganyika fauna as a whole, and a re-examination of the shells of the molluscs of the lake, which had been brought home by various travellers, showed that the medusa was only one member of a remarkable fauna, many of the forms of which were as singular and marine-looking as the jelly-fish itself. Up to the present time, however, the real nature of this remarkable assemblage of lake animals has of necessity remained entirely problematical, since, without more material, it was impossible to attempt to determine whether the close similarity, which some of the gastropod shells exhibit to species living elsewhere in the ocean, was due to actual affinity, or was brought about by a convergence of variations induced somehow in an originally fresh-water stock. To obtain the material sufficient to throw light on these forms, by a determination of their actual affinities, was the object of an expedition to Tanganyika, which, through the generosity of the Royal Society and British Association, I was able to undertake nearly two years ago.

The only practical route at present open to the Lake lies up the great Zambesi water-way, which, but for the Murchison Cataracts, extends from the coast to the north end of Lake Nyasa. From this point it is necessary to march across the elevated forest land, and mountain ranges which constitute the interior plateau.

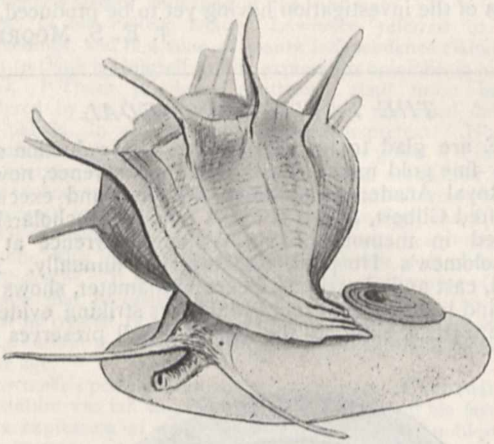

FIG. 1.—Living *Typhobia Horei*.

Approached in this direction the lake becomes first visible from the heights above Kituta, where a strip of bright green marsh-land skirts its southern coast. Descending from these heights the damp oppressive heat of Tanganyika is felt at once, and long before reaching the water's edge the forest is filled with the sickly scent which characterises the whole lake, and reminds one strongly of that of a weedy tidal beach. The lake has fallen considerably of late, and much of the coast-line is now obliterated by dense papyrus swamps, reeds, and partially submerged mimosa scrub, so that its actual shore is often very difficult to approach. In the deep water of this southern arm there are vast drift collections of empty Neothauma shells, which act as growing points for sponges, and constitute the feeding-ground of innumerable small active and entirely aquatic crabs. The living Neothaumas are found in shoaler water, generally on the flat sandy deposits which characterise the coast-line of other portions of the lake. Above the water's edge this sand has been thrown up by the wind and surf into low dunes, which are now covered with mimosa scrub and wild cotton, and beyond these, again, there is generally a strip of swamp swarming with Dactylethera, Ampularia shells, and frogs.

In many places, however, the mountains are not fringed by these lacustrine flats, and where the great western escarpments of the rift valley in which Tanganyika lies, rise perpendicularly from the water's edge, the submerged stones are covered with a bright growth of green algæ, and studded with numbers of the so-called Paramelania, a marine-looking gastropod, the affinities of which are not yet known. The great range of variation which these shells exhibit is most remarkable, and their differentation seems to be a simple function of the depth at which the shells exist, those with the most prominent processes being the lowest.

The different kinds of coast-line, which I have just described, are more or less characteristic of the whole lake, and each has a fauna peculiar to itself; but, on the flat sandy beaches, all sorts of shells, fish-bones, and the like are thrown up together by the waves, so that it is some time before one ascertains the habitat of each. Thus I observed the exquisite spined Typhobia shells two months before I found a specimen alive, owing to the fact that Typhobia, together with some curious associated forms, inhabit the profound depths of the lake, and are only to be obtained by dredging with lines of from five to seven hundred feet.

Like Neothauma and Paramelania, these deep-water gastropods are all viviparous; but while the first deposits

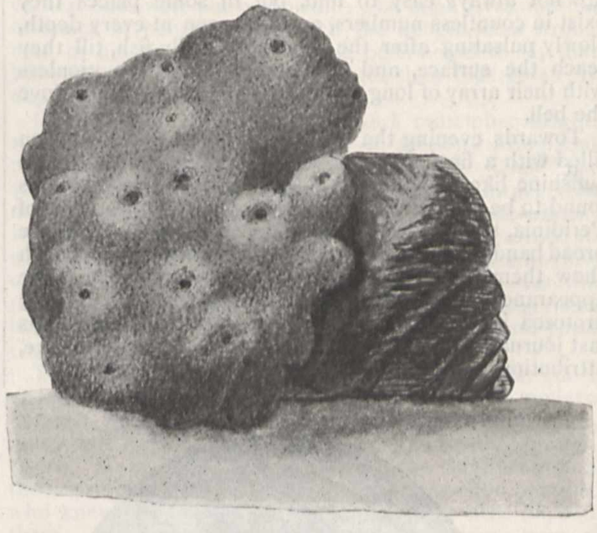

FIG. 2.—Sponge growing on dead shell of Neothauma.

only two or three large embryos at once, Typhobia produces a great number of bright green young. In this form all stages of development are present in the same animal, and we have, therefore, embryological material which may throw much light on the affinities of an aberrant group. It would be unprofitable for me, as yet, to enter into any discussion of the comparative morphology of these forms; but it may be interesting to note that, while the radula formula of Neothauma approximates in character to that of Paludina, that of Typhobia and its associates is almost unique, and although the Paramelanias show some similarity, in this respect, to the forms with which they have been provisionally associated, the radula of the so-called Lythoglythus of Tanganyika is absolutely unlike those of the forms to which it has been thought to belong.

Typhobia and its allies inhabit the flat mud bottom of the lake, and the mud itself contains numerous spiculæ, which, on treatment with nitric acid, are seen to be siliceous, many of them being indistinguishable from those of the sponge Potamolepis, found as an encrusting species in the Congo, but which I have not seen living in Tanganyika.

In many places the precipitous coast-line of the lake has been cañoned out by waves and storm-torrents into a succession of superb rocky headlands, and in the still waters of the recesses, which they partially enclose, there are innumerable swarms of prawns, some of which are certainly Palœmon-like in structure; but I am not yet sure of the affinities of them all. Like those of the Lago di Garda in Italy, lake prawns are generally supposed to have migrated up the rivers from the sea; but it is curious that they should have found their way 2700 feet up into Tanganyika, and yet not have reached Nyasa, which is so much nearer the coast.

It would be impossible within the limits of this article to give any account of the widely different forms of Tanganyika fish; but there is a curious and, I believe, quite new example of protective mimicry exhibited by a small chromis, which, in order to escape from the swarms of kingfishers along the shore, has simulated the bands of colour, size, and mode of swimming of a leech.

There appears to be only one species of medusa in Tanganyika; but this species, like so many of the lake animals, is subject to wide variation, and if the intermediate forms could not have been obtained, the extremes would certainly have been regarded as distinct species. They are rather local in their distribution, and are not always easy to find, but in some places they exist in countless numbers, and are seen at every depth, slowly pulsating after the manner of jelly-fish, till they reach the surface, and then sinking again motionless with their array of long tentacles standing stiffly up above the bell.

Towards evening the deep water of the lake is often filled with a finely-divided substance, that glitters in the sunshine like precipitated gold, and this appearance is found to be caused by the sculptured shells of swarms of Peridinia, together with a number of large infusoria, the broad bands of cilia and undulating membranes of which show them to be related to the Condylostomas. The appearance produced by this assemblage of pelagic protozoa is probably what Livingstone described in his last journal as a yellow scum on the surface of the lake, attributing it to some vegetable form.

The assemblage of animals which I have just described appears to be almost entirely restricted to the confines of the lake, and it is this geographical isolation to which at present I would draw attention, as it is, without doubt, among the most remarkable characteristics which the fauna possesses. In fact, the presence of such an assemblage of animal forms in an inland and greatly elevated lake is only intelligible by supposing either that the lake itself was at one time connected with the sea, and that its fauna is a collection of types which have persisted as survivals of an oceanic series that has elsewhere passed away, or that its marine characters are due to parallel development, produced in a fresh-water stock by the action of some conditions obtaining in an immense inland lake. I would at present offer no opinion as to which of these surmises is likely to prove correct; but whatever supposition may be entertained, it becomes obvious that the fauna of Tanganyika is comparatively old, for it is unlike anything now inhabiting the sea, and if it is derived from a previous fresh-water stock, much time would be required for the evolution of its widely-divergent present forms. This conclusion as to the comparative antiquity of the Tanganyika fauna is, in my opinion, the most important which can be drawn with certainty from a cursory survey of the facts; and, without attempting to push comparisons at present, the remarkable similarity between several varieties of Paramelania and those of the equally variable Jurassic genus Purpurina, between other varieties of Paramelania and the American and Southern European Pirguliferas, should be fully borne in mind. The determination of the actual affinities of the Tanganyika forms, which are often exclusively related to the lake, can only be made by a prolonged comparative study of the morphology of each, and it would be at present useless to speculate on the result. I have here only indicated some of the peculiarities of the fauna of the lake as they present themselves to a naturalist on the spot, the actual results of the investigation having yet to be produced.

J. E. S. MOORE.

THE LAWRENCE MEDAL.

WE are glad to be able to give a reproduction of a fine gold medal of Sir William Lawrence, now in the Royal Academy Exhibition, designed and executed by Alfred Gilbert, R.A. It forms part of a scholarship, founded in memory of Sir William Lawrence at St. Bartholomew's Hospital, and is given annually. The medal, cast and chased, $2\frac{1}{4}$ inches in diameter, shows the face and head in high relief, and gives striking evidence of the artist's skill, as the likeness well preserves the

dignity and intellectual power of the original. The view is nearly full face, not the usual profile, a treatment of which there are but few examples, either ancient or modern, and of difficult execution. The reverse has an allegorical subject suited to the aim of the scholarship, and instinct with the grace and fancy of which Mr. Gilbert is master. A youth, full of confidence, presses through the shield dividing him from life, whilst wisdom and science on either hand whisper counsel as they point to the motto on the shield, part of the line from Homer, "αἰὲν ἀριστεύειν καὶ ὑπείροχον ἔμμεναι ἄλλων," often cited by the original of the medal.

A few notes follow, on a less well-known side of Sir William Lawrence's early work, from the pen of a distinguished pupil.

IN MEMORY OF LAWRENCE.

In the domain of surgery the name of Lawrence is held in high honour as that of a practitioner and observer of the utmost skill and originality. As a teacher at St. Bartholomew's Hospital and in the theatre of the College of Surgeons his services to the profession which he had adopted are recognised as having been invaluable. It is, however, not perhaps so well known that he was also a pioneer in those branches of research which more recently, under the direction of Darwin and Wallace, have effected such a revolution in our conceptions of the great scheme of zoological development. Not that it can be claimed for Sir William Lawrence that he anticipated the modern creed as to the descent of man, for he expressly repudiated the tenet of a common line of ancestry for man and brutes. Still, however, his lectures on the "Natural History of Man," delivered as professor to the Royal College of Surgeons, were far in advance of the opinions of the day, and were full of new thought and suggestion. They were published in 1816, and went through at least eight editions. Although now superseded by other works, they are still a mine of carefully collated facts to which the student refers with pleasure and profit. As is well known, they brought upon their author a storm of persecuting zeal, at the head of which was Abernethy, Lawrence's senior colleague at the hospital! In a second course of his college lectures Lawrence referred to these proceedings, and in a tone of manly independence claimed the right to think for himself and to express his opinions in his own terms. "These privileges, gentlemen, shall never be surrendered by me; I will not be set down nor cried down by any person, in any place, or under any pretext. However flattering it may be to my vanity to wear this gown, if it involves any sacrifice of independence, the smallest dereliction of the right to examine freely the subjects on which I address you, and to express fearlessly the result of my investigations, I would strip it off instantly." This was bold language in a young man, and one who in his profession was of course a candidate for public favour. It was indeed by this high endowment of moral courage that Lawrence was enabled to approach the topics which he treated of in a manner which was so far in advance of the current modes of thought, and so eminently advantageous to the age.

Lawrence's personal bearing was an index of his character. His stature was tall and his manner dignified, and his face was, in its expression of intellectual calm, one of the noblest ever worn by man. JONATHAN HUTCHINSON.

JULIUS SACHS.

JULIUS SACHS[1] was born at Breslau October 2, 1832, and died at Würzburg on May 29, 1897. Although his health had been seriously impaired for years, his last illness was not of long duration. He was regularly at work in his laboratory during the Easter vacation, and only took to his bed about the middle of April. A few days before the end came, he sank into coma and died without pain. Of his early career I have not been able to learn anything: I remember to have heard him say that his first teacher was Purkinje, under whom he published two or three zoological and geological papers. His first official post was that of Privat-Docent at Prague. In 1858–59 he was at Tharandt, in 1860 at Chemnitz. In 1861–62 he was appointed Professor in the Landwirthschaftliche Institut at Poppelsdorf, near Bonn. In 1867 he was called to the chair of Botany in Freiburg, and in 1867 he obtained the professorship at Würzburg, which he held up to the time of his death.[2]

It is not easy for a botanist of these days to estimate the debt of gratitude that he owes to Sachs. We have grown up in the modern school, and we mistake for our natural environment a state of things which his labour of forty years painfully built up for us. There is a natural blindness of the child to the parent, or the apprentice to his master, and this we can only partially overcome.

The place of Sachs in the history of Botany is, I am inclined to think, even higher as a teacher than as a discoverer. He will be more permanently known for his "Experimental Physiologie" (1866), by his "Lehrbuch" (first edition, 1868),[1] his "Geschichte der Botanik" (1875),[2] and his "Vorlesungen" (1882),[3] than by his "Collected Papers" (1892–93). The earliest of these volumes, the "Experimental Physiologie," seems to me in some respects the best. If we compare it with previous books on the physiology of plants we feel an enormous advance, not only in the fire and vigour with which it is written, but especially in the absence of compilation; it reads like an original paper rather than a treatise, and it was in fact largely founded on the activity of twelve of the best years of his life. Between 1853, when his first paper appeared in the Czechish journal *Ziva*, until 1865, just before the publication of the "Experimental Physiologie," he published (according to the Royal Society's Catalogue) sixty-eight papers, of which, however, the two or three earliest ones were not botanical. The book gives internal evidence of being written with the delight of a strong man in his work, and Sachs has been heard to say that he wrote it with a pleasure greater than that given by any of his later books.

On the other hand he spoke, if I remember aright, somewhat wearily of the years of section-cutting and microscopy needed for his "Text-Book." This may serve to remind us of what we are apt to forget—the mass of original matter hidden in this admirable book. In his last book, the "Lectures" of 1882, he returned to what best suited his turn of mind—a broad, general view of physiology. At the same time he handed over the re-editing of the histology, the detailed morphology and classification in the "Text-Book," to his friend and pupil Goebel.[4]

The "Text-Book" has no doubt had a greater effect on botany than any one of his other books. The modern botanist is sometimes assumed to be ignorant of taxonomy, but a man who has worked practically through Sachs' "Text-Book" knows more of the classification of the vegetable kingdom as a whole, than the older botanist who knew the phanerogams minutely, but little beyond them. As a single proof of the fruits arising from a proper understanding of the taxonomy of plants, it may be pointed out that palæobotany has only been rendered possible as a science by the sort of knowledge inculcated by Sachs. Witness the work of Solms Laubach and Nathorst and others on the continent, and of Scott and Seward in this country, as compared with the efforts of earlier workers. The effect of Sachs' "Text-Book" in England was intensified by the great revival of scientific teaching instituted by Huxley, in which the all-importance of practical work was insisted on. And thus the learner of those days had the good luck to be supplied with Sachs' "Text-Book" just when he was spurred on by his teacher and by the spirit of the times to examine the histology and physiology of plants for himself.

As a teacher in the laboratory Sachs' position was equally great. He was most generous in receiving pupils, and those of us who had the good fortune to be of that number must always remember with gratitude his genial welcome and the pains he took with us over our work. To some it was a first introduction to a research laboratory, to a region where, if examination is not quite

[1] I believe that Sachs never made use of the title of *von*, which was conferred upon him.
[2] For the above facts I am indebted to the kindness of Prof. Kunkel of Würzburg, and Prof. Marshall Ward.

[1] The English translation of a later edition appeared in 1874, under the name of "Text-Book."
[2] English translation, 1890. [3] English translation, 1887.
[4] English translation, under the title of "Outlines of Classification, &c.," 1887.

banished, it is so much in the background as to be forgotten. It was extraordinarily invigorating to fall into the midst of a group of young men each engaged in his problem, and ruled over by a kindly despot full of resource and enthusiasm, and both willing and able to give us questions to solve. His tendency was to do things in a broad, handsome manner. He liked to have a flush of material, and he sacrificed it royally; for instance, in his work on roots he used 3000 beans. He insisted on things being done in a sound, cleanly manner, and especially inculcated the proper cultivation of experimental material, often reproving his pupils if they did not give light enough to their plants. He liked the practical details of cultivation, and would take pleasure, for instance, in showing his pupils the proper way of moistening earth for germinating beans; with the remark that this ought not to be done by a gardener, and adding "Das macht mir Spass" as a further reason for doing it himself. He preferred simple methods and broad results, and was essentially a man of round numbers. He did not deal in elaborate apparatus, and had indeed a somewhat unreasonable dislike for "Sogenannte Genauigkeit." But this was rather the dislike of unnecessary exactness, or of exactness misplaced—a valuable point of view in an experimentalist. He had, however, a liking for mechanism, as his invention of the recording auxanometer and of the klinostat shows.

As a lecturer he was admirable, and illustrated his words on the blackboard with evident pleasure and in the most life-like of sketches.

His papers have been collected in two volumes, published in 1892-3, many of the researches having appeared in his celebrated "Arbeiten," three well-known volumes, in which it was the highest ambition of his pupils to obtain a place.

The main point that strikes one about his work is that his was pure rather than applied physiology; he cared for the behaviour of a plant as he cared for a machine, not in relation to its environment. He was essentially not a biologist in the modern sense, though, as a matter of fact, he was an evolutionist.

His work may be divided, as he has himself classified it, into the physiology of nutrition and that of movement. In both these departments he laboured incessantly, and made numerous important discoveries; yet, in spite of what he added by his admirable researches, it seems to me that he was even more remarkable for his power of strengthening and marshalling a subject, and of placing it before the world with a vigour and clearness that ensured its acceptance.

Thus, in regard to nutrition, he established, by the most brilliant of his researches, the connection between carbon-assimilation and the existence of starch in the chloroplasts; yet his fame seems to me to rest with even greater certainty on the fact that he saw more clearly than any modern botanist the overwhelming importance of a just view of assimilation, and that he had the intellectual force needed to drive it into the minds of a generation of botanists.

In the same way he marshalled, remodelled and largely added to our knowledge of growth and growth-curvatures, and set forth his results with a style and force that were irresistible. But the conception of stimulus and reaction, now the central principle of plant—as of animal—physiology, only came to him imperfectly, as it seems to me. His use of the word *anisotropic* for organs behaving differently in relation to the same cause, implies a certain want of perception of the heart of the matter. The word is not really wanted, since the conception of irritability postulates what he called anisotropy. The stimulus is but a sign-post; the needs of the plant in relation to its environment necessitate that different organs shall be guided by the stimulus in opposite directions.

In spite of the strength and clearness of his way of thinking, there was in him a vein of something like mysticism, as, for instance, in his conception of a radial organ as corresponding to a dorsiventral organ rolled up like a scroll; or in his assumption of an invisible dorsiventrality in certain plagiotropic organs.

Again, there is in his views what strikes some of us as almost mediæval. For instance, his idea of the root-forming and shoot-forming material flowing in opposite directions, and thus accounting for the behaviour of cuttings. The same may be said of his views on etiolation, although in these days of the thyroid treatment of myxœdema it is rash to deny the feasibility of any explanation founded on the special nutrient value of definite substances. But it is juster to put aside these considerations, and in a broader spirit to remember only the masterly way in which, in his "Lectures" (1882), he developed the classification of organs into "root" and "shoot" into a system of physiological morphology, *i.e.* into a morphology which goes beyond phylogeny into the region of adaptation.

I have thought it right to speak plainly about Sachs' work, for I am assured that it contains so much of enduring value that it deserves the truth; and I willingly allow that in the points in which my estimate of this great man is less favourable than some of my contemporaries, I may be misled by that blindness of which I have already spoken.

In his later years his life was overshadowed by broken health, and his nature—sensitive and self-centred—was never compatible with a serene or happy life. Those who came under his influence must be glad to forget the less happy side of the picture, and remember with gratitude how much they owe to Sachs.

FRANCIS DARWIN.

PROFESSOR R. FRESENIUS.

CARL REMIGIUS FRESENIUS, whose death occurred last week, was born at Frankfurt-on-Main on December 28, 1818. After a preliminary training at a pharmacy in that town, he devoted himself to the study of natural science, more especially of chemistry and botany. In 1840 he entered the University of Bonn, but a year later went to Giessen, where Liebig chose him as assistant in his laboratory. He graduated at Giessen in 1843. In 1845 he was called to the professorship of chemistry, physics, and technology at the Agricultural Institute at Wiesbaden, with which he has since been identified. The chemical laboratory at Wiesbaden, founded, owing to his exertions, in 1848 by the Government of the Duchy of Nassau, has since been much enlarged, a school of pharmacy being added in 1862, and a research laboratory for agricultural chemistry in 1868. The direction of the latter was taken over by his son, Dr. Henry Fresenius, in 1881. Fresenius received the title of Geheim Rath of the Duchy of Nassau in 1855. His best-known works are his "Qualitative Analysis" (first published in 1841) and his "Quantitative Analysis" (published in 1846); both have passed through very numerous editions, and have been translated into almost every European language. His numerous original memoirs (there are 162 titles in the Royal Society's Catalogue between the years 1842 and 1883) deal almost exclusively with analytical chemistry. One of his earliest papers (1843) deals with the composition of a mineral water from Java, and this was a subject to which he frequently returned. A series of papers on the mineral waters of Nassau (1864-68) are well known. Many of his later papers are published in the *Zeitschrift für Analytische Chemie*, which he founded in 1862, and which he continued to edit until his death. T. E.

NOTES.

M. HATT has been elected a member of the Section de Géographie et Navigation of the Paris Academy of Sciences, in succession to the late M. d'Abbadie; and Prof. de Lapparent, professor of mineralogy, geology, and physical geography in the Paris École libre des hautes études, has been elected a member of the Academy, in succession to the late M. des Cloizeaux.

WE regret to announce the death, at sixty-seven years of age, of Prof. P. Schützenberger, professor of chemistry at the Collège de France, and member of the Paris Academy of Sciences.

M. MAURICE LÉVY AND M. LÉAUTE will represent the Paris Academy of Sciences at the inauguration of the statue of Perronet at Neuilly, on Sunday next, July 4.

THE eightieth annual meeting of the Société helvétique des sciences naturelles (the Swiss Association of Naturalists) will be held at Engelberg, in the pretty Alpine village of Engelberg (Obwalden), on September 12–15. The Committee has issued a very cordial letter of invitation, in which it is pointed out that though Engelberg does not offer the resources and pleasures of a large town, or exhibit such a solid testimony to scientific movement as is seen at Zürich, where the Association met last year, nevertheless the little village at the foot of snow-capped Titlis has attractions of its own, and the welcome which will be extended to the members will be a very hearty one. The meeting will open with a reception at five o'clock in the evening of Sunday, September 12. On the following day there will be a general meeting, after which an excursion and a banquet will be the order of the day. On September 14 the sections will meet in the morning, but the afternoon and evening will be devoted to lighter pleasures. The second general meeting will take place on September 15, and the session will be closed on the same day. The railway and steamboat companies offer special facilities to members of the Association, and the charges at hotels will be reduced. The hearty invitation of the Committee, and the place of meeting (in one of the most beautiful valleys of the Alps), will doubtless attract many men of science to go with friends or families to Engelberg next September. It is hoped that those who propose to attend the meeting will notify their intention before the end of July. Letters should be addressed to the President of the Annual Committee, Herr E. Etlin, Arzt, Sarnen, Obwalden.

THE Albert Medal for the present year has been awarded, with the approval of H.R.H. the Prince of Wales, the President of the Society of Arts, to Mr. G. J. Symons, F.R.S., "for the services he has rendered to the United Kingdom by affording to engineers engaged in the water supply and the sewage of towns a trustworthy basis for their work, by establishing and carrying on, during nearly forty years, systematic observations (now at over 3000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself."

THE annual meeting of the American Microscopical Society will be held at Toledo, Ohio, on August 5–7, under the presidency of Prof. E. W. Claypole.

IN the House of Lords on Tuesday, Lord Hobhouse moved the second reading of the Sunday Bill. The object of the Bill was to amend the Lord's Day Act of 1781, which is now being vexatiously used to repress attempts to improve the rational use of Sunday by means of lectures and musical performances. After discussion, the second reading was rejected by 50 votes to 33.

A PUBLIC meeting will be held in the Botanical Theatre of University College, Gower Street, to-morrow at 4 p.m., to inaugurate the personal memorial to the late Sir John Pender. Mr. Onslow Ford's bust of Sir John Pender will be on view, and a cheque for 5000*l.*, to endow the electrical laboratory of University College, will be handed over to the Trustees. The gift will be acknowledged by Lord Reay on behalf of the College. The Marquis of Tweeddale will preside, and Lord Kelvin is expected to be present and speak.

A COMMISSION, consisting of Prof. D. T. McDougal, of the State University of Minnesota, and Prof. Campbell, has lately visited Jamaica and other of the West Indian Islands, to select a site for an international botanical laboratory in the tropics. American botanists have long been considering the advisability and expediency of the establishment of such an institution, which, if it is founded, will be of great value as a permanent research laboratory.

THE New York Zoological Society is making special efforts to increase its membership and obtain subscriptions and endowments for the Zoological Gardens, to be established in South Bronx Park (see vol. lv. p. 613). The Society requires 250,000 dollars for the erection of animal buildings, aviaries, and other enclosures, and for the purchase of a series of mammals, birds, and reptiles with which to fill them. The sum of 100,000 dollars is urgently required, and should be obtained before August 1, as that amount must be pledged before any work on the proposed Zoological Park can begin. There ought not to be any difficulty in obtaining this amount if the rich citizens of the largest and wealthiest city in America have any public spirit.

AT Shoreditch, on Monday, Lord Kelvin opened a central electric station, in which the motive power is steam produced by a destructor which is to be fed with household refuse as fuel. From the *Times* we learn that there are twelve destructor cells, each having a grate area of twenty-five square feet, and heating six water-tube boilers working at a pressure of 200 pounds to the square inch. The chimney is 150 feet high and 7 feet in internal diameter at the top, and, in addition, there are three electrically-driven fans, which each deliver 8000 cubic feet of air a minute with a maximum ash-pit pressure of three inches of water. An interesting feature is the employment of Mr. Druitt Halpin's system of feed thermal storage. As it is necessary to keep the destructors burning continuously, steam is generated during all the twenty-four hours. But as power is required on a large scale during only a portion of that time, in order to reduce waste a plan of heat storage has been introduced, by which, during the day, steam is mixed in a vessel with cold water in such proportions that at evening the cylinder is full of water at the temperature and pressure of the steam required by the engines. The boilers are fed with this heated water, and are said to be enabled in consequence to produce one-third more steam than they would if working with water direct from the mains. As to the amount of refuse consumed, it is expected that the most efficient rate will be between eight and twelve tons a day. The electrical plant at present consists of three generators working at 1100 volts, and three low-tension dynamos at 165 volts. All are driven by Willans' three-crank engines, coupled direct. Orders have already been received to nearly the full capacity of the present plant. In declaring the undertaking ready for public use, Lord Kelvin said that it was worthy of the Victorian era as an example of the combination of scientific forethought, mechanical skill, and courage, which had nothing of gambling in it, but simply brought into practice recognised engineering possibilities. Dust destructors have been tried for some years in order to get quit of refuse at a lower cost than is required for spreading it on the ground or carrying it out to sea, but little has been done in the way of using the heat of these dust-crematories for raising steam. Shoreditch is the pioneer vestry in this respect. But what has been done is only the small beginning of what will be a much greater thing, for all dust refuse will soon be used in the same way.

THE firing at Portsmouth on Saturday, on the occasion of the naval review, was distinctly heard at Hungerford, Wilts, a distance of forty-five miles, as the crow flies, and also at Great Malvern. It would be interesting to know whether the salutes were heard at greater distances than these.

IN accordance with the will of the late Prof. E. D. Cope, his collection of fossils is to be sold, and the proceeds devoted to establishing a chair of Palæontology in the Philadelphia Academy of Sciences, with which his name was so closely connected. The appointment to the chair must be approved by the National Academy, the duty being chiefly that of original research.

IT may interest some of our readers to know that the following are among the portraits recently acquired by the Trustees of the National Portrait Gallery:—Sir Francis Ronalds (1788–1873), inventor of the first working electric telegraph. A small plaster bust of Richard Jefferies (1848–1887), naturalist and author. A painting of Constantine Phipps, Lord Mulgrave, R.N. (1744–1792), represented in the Arctic regions while commander of H.M.S. *Racehorse* in 1773 on a voyage to the North Pole. Sir Joseph Williamson, P.R.S. (1630–1701), Secretary of State in 1674, and second President of the Royal Society.

A THUNDER-STORM of extraordinary violence passed over London on Thursday last, and did an immense amount of damage in Essex, every kind of crop over an area of about a hundred square miles being ruined. A description of the storm will be found in our correspondence columns. Hailstones of unusually large size fell during the thunder-storm. Mr. F. E. Allhusen, writing from Harrow-on-the-Hill, sends us a description of hailstones which fell there at about 1.50 p.m. The hail continued for about twenty minutes, and was followed by heavy rain. Referring to a number of hailstones picked up and examined within five minutes of their fall, Mr. Allhusen says:—"The majority were roughly spherical in shape, and had an opaque nucleus about the size of a pea. Round this there was a layer of clear ice, in several distinct concentric layers. The ice was honeycombed with small air-bubbles, arranged radially; many of these air-bubbles were much elongated. The general appearance of the hailstones was rough, and somewhat similar to that of the edible part of a walnut. . . . Twelve fairly large stones were weighed; they turned the scale at two ounces."

MR. J. A. MCMICHAEL, Head-master of the Technical Day School, Chester, informs us that on Sunday evening, June 20, at 7.45, he saw a distinct solar halo. The angle subtended by its radius was roughly estimated at 25°. No second halo was visible. The colours were easily seen, the red being inside. Mr. McMichael thinks the appearance of such a phenomenon four days before Midsummer Day is very remarkable, and would like to know if any of our readers could give similar instances.

IT is stated in *Science* that a Bill has been introduced in the Minnesota Legislature providing for the appointment of expert witnesses, and that a similar Bill has been prepared to be presented to the New York Legislature. The object of the Bill is to provide a list of experts from whom witnesses are to be selected by the Court and paid by the State. The following remark of our Transatlantic contemporary will find many supporters:—"The employment of expert witnesses by the counsel for the prosecution or defence has been unfortunate both for the Courts and for science. It would certainly be desirable to devise a plan by which the expert witness should be in the position of a judge rather than that of a paid attorney."

THE number and variety of scientific exploring expeditions in America this summer is surprising. The latest announcement is that Prof. Wm. Libbey, jun., of Princeton University, will in a few days lead a party of six explorers to Albuquerque, New Mexico, to explore a mesa or sandstone tableland near there. The outcroppings of red sandstone project from the face of the walls, rendering it almost inaccessible. Cliff dwellings have been seen along the edges, and fragments of pottery at the base indicate occupancy by a pre-historic race; but the tableland has never been scaled in historic times, so far as known. Prof. Libbey intends to throw a line over this tableland, which is several acres in extent on top, by means of tandem kites; or, in case the wind should be too light, by means of a mortar which will fire a life line across the top. Larger lines will be drawn over, and the ascent made in a boatswain's chair.—Mr. Jesse D. Grant, son of General Grant, is sending an expedition to explore the islands in the Gulf of California, north of 29°, which parallel intersects Tiburon Island, inhabited by the fierce and little-known cannibal Ceris Indians.

TWO exploring expeditions are now on their way to Mount St. Elias—one from the United States, the other from Italy. The object of the American expedition is to make a survey of the region, and settle the boundary dispute with Great Britain. The 141st meridian of west longitude is the boundary line, and the summit of the mountain was found by the commission appointed in 1891 to be approximately 60° 17′ 51″ N. and 140° 55′ 30″ W. It is said to be thirty-three miles inland, whereas the jurisdiction of the United States extends ten marine leagues or 34½ miles; thus, it would seem, taking in the summit. Mr. E. B. Tatham, of the United States Coast Survey, will conduct this work. The party will be led by Mr. Henry G. Bryant, of Philadelphia, who explored the great falls of Labrador in 1891, and was leader of the Peary Auxiliary Expedition in 1894. Mr. Samuel J. Enterkin, who goes with the party, was with the Peary party on its journey to the ice cap in March 1894.

THE Italian expedition to Mount St. Elias is led by Prince Luigi Amadio of Savoy, who is accompanied by four aides, Chevaliers M. Cagni, Francesco Gonella, Vittoria Sella, and Dr. Filippo De Filippi. After the ascent, this party will attempt to climb Logan's Peak. Mount St. Elias is over 18,000 feet high, and was for a long time considered the highest mountain on the American continent. The summit has never been reached, though several attempts have been made, notably in 1891, when the surveying party reached the height of 14,500 feet. The reason of the failure of former parties is said to be that the approach was made on the south side, where there is a heavy fall of snow and tremendous avalanches, glaciers, precipices, and chasms. The northerly side, from which the ascent will now be attempted, is more approachable, owing to a long ridge of mountains.

WE learn with regret that Mr. W. J. C. Millar has been compelled by ill-health to resign the post of mathematical editor of the *Educational Times*, which he has held for the past forty years. Mr. Millar's labours have been purely honorary, and his collections of problems and mathematical riddles have inspired and directed the early efforts of many mathematicians of the highest eminence, including such names as Clifford, Cockle, Cayley, and Sylvester. It is now proposed to present Mr. Millar with a testimonial in recognition of his services, and towards this purpose 40*l*. has been already received. The Rev. Robert Harley, F.R.S., of "Rosslyn," Westbourne Road, Forest Hill, S.E., has kindly undertaken to receive contributions, which it is hoped will be "*numerous* rather than *large*," the object being to show Mr. Millar how widely his work has been appreciated.

IT is somewhat remarkable that, although the conception of the centre of gravity was evidently known to Archimedes, those of his writings which have been handed down to us nowhere contain either a definition or a proof of the existence of that point. This gap has been attributed to his having treated the subject in a lost work on balances, quoted by Pappus. An important contribution to our historical information has now been made by Dr. Giovanni Vailati (*Atti della R. Accademia delle Scienze di Torino*, xxxii.), who has found fresh material in an Arabic translation of an unknown work by Hero, of Alexandria, in the library of Leyden. This work was brought over in the seventeenth century by Golius, then Professor of Mathematics and of Oriental Languages in the University of Leyden, and attention has recently been directed to it by Carra de Vaux. In it Hero makes numerous references to Archimedes' lost manuscript, from which Dr. Vailati has been enabled to build up, with a fair degree of certainty, the arguments by which Archimedes proved the existence of the centre of gravity.

DR. F. CAMPANILE and Dr. E. Stromei (*Rendiconti dell'Accademia delle Scienze di Napoli*, iii. 4) describe some further experiments on the phenomena of phosphorescence observed by them in Crookes and Geissler tubes. This phenomenon consists in the production of phosphorescence and Röntgen rays on the walls of a Geissler tube opposite two plates of tinfoil which were attached to a Ruhmkorff coil or to an electrostatic machine, connected with a spinterometer.—A somewhat different line of investigation has been taken up by Prof. Battelli (*Nuovo Cimento*, v., March 1897), who has studied the variations in the photographic action both inside and outside a vacuum tube, and their dependency on the form and dimensions of the tube, the form of the electrodes, the intensity of the current, and the degree of rarefaction.—In a subsequent number of the *Nuovo Cimento*, Signor P. G. Melani discusses the influence of magnetism on discharges in vacuum tubes, and describes a number of experiments carried out in Prof. Battelli's laboratory at Pisa.

ALONG with a fine series of reptiles lately presented to the Zoological Society's collections, Mr. F. W. Urich has sent from Trinidad a nest of the "Sauba" or Parasol Ant, *Œcodoma cephalotes*, the extraordinary habits of which are well known to naturalists. The colony has been placed in a glass case in the Zoological Society's Insect House, where the workers may be seen every day cutting out bits of leaves from a plant that has been provided for their use, and conveying them into their subterranean dwellings.

A NEW Tortoise House, placed near the Reptile House, has just been completed in the Zoological Society's Gardens, and the various specimens of the *Testudinata* will shortly be removed there from their present quarters on the further side of the canal, so that the whole of the reptile collection will be together. The most remarkable of the tortoises are two fine adult specimens of the Giant Tortoise of the Aldabra Islands in the Indian Ocean, which were presented to the Society by Rear-Admiral Kennedy in 1894. There are also three other examples of the same, or of a nearly-allied species, which have been recently received "on deposit" from the Hon. Walter Rothschild.

AUTHORITIES on Indian birds seem to be unanimous in the opinion that the common little Cotton-Teal or Goose-Teal, *Nettopus coromandelianus*, is unable to stand and walk like other ducks, but invariably flutters along in a strange scuffling manner, like a wounded bird. At a recent meeting of the Asiatic Society of Bengal, Mr. F. Finn gave reasons for doubting the accuracy of this statement. He has had many opportunities of observing Cotton-Teal in confinement, and after watching the gait and movements of numerous specimens, he asserts that the inability to walk, attributed to the species by many observers, is not in reality natural to it, but merely the result of fright, weakness, or injury.

Science Gossip for June reproduces from the *Journal of Malacology* some very interesting sciagraphs of shells by Mr. W. M. Webb, which seem to show that the Röntgen rays are of practical value for studying their interior structure. In a paper read before the Natural History Society of Buda-Pesth, Dr. J. Istvánffy states that, in the case of living plants, the Röntgen rays penetrate only the woody tissue. In a leaf of *Camellia* exposed to them, the veins appeared white. All other tissues, whether containing chlorophyll or not, are impenetrable to them.

WE are glad to see that the *Gleaner*, of Kingston, Jamaica, is urging the appointment of a geologist to examine the new sections which will be exposed during the construction of a new road now being made over the mountains. The palæontology of Jamaica has been very little studied. There is a very poor collection of fossils in the local museum. It is a little better with mineralogy, but so slight has been the interest taken in all branches of geological science that there are both fossils and minerals from local sources in the museum, about which there is absolutely nothing known; all trace of their origin and other circumstances having been lost. What is really wanted is a Government geologist, to devote himself exclusively to geological observations; and if the appointment of such an officer cannot be entertained at present, the least that should be done is to commission a geologist to map the sections which the road-builders will expose, and save whatever vestiges of vanished ages may be obtained. The facts thus accumulated would be of the greatest value when a survey of the country comes to be made.

MESSRS. GINN AND CO. will shortly publish the first number of the *Zoological Bulletin*, a companion serial to the *Journal of Morphology*, and designed for shorter contributions in animal morphology and general biology. The *Bulletin* will differ from its German prototypes chiefly in excluding, at least for the present, bibliographical lists. Its contents will consist wholly of scientific communications. The editorial work will be directed by Profs. C. O. Whitman and W. M. Wheeler.

IN connection with the excursion of the Geologists' Association to Edinburgh, from Monday, July 26, to Saturday, July 31, the four following papers will be read at a meeting of the Association at University College, London, to-morrow, July 2, at 8 o'clock:—"Outline of the Geological History of the Rocks around Edinburgh," by Mr. J. G. Goodchild; "Excursions from Bathgate to Linlithgow, and from St. Monans to Elie," by Prof. James Geikie, F.R.S.; "Fish Remains in the Abden Bone-bed," by Dr. R. H. Traquair, F.R.S.; "The Stirling District," by Mr. H. W. Monckton.

THE Report of the Government Observatory, Colába, Bombay, for the year ended March 31 last, presents two special points of interest: (1) The introduction of a Dines' pressure tube anemometer, the vane of which is erected about 3 feet above the cups of the Robinson anemometer, and about 6 feet from it. A comparison of the results of the two instruments during the short period of the erection of the new anemometer shows that the average velocity recorded by the old instrument is 42 per cent. more than the average velocity given by the

Dines' anemometer, confirming the results of other observers that the factor 3 (the ratio of the speed of the wind to that of the cups) is too great. (2) The Director is able to report a clean bill of health in his little colony (numbering altogether about 100 persons, including servants and their families) during the plague epidemic. This satisfactory state is attributed to additional ventilation, by removal of tiles, &c., to fumigation twice a week by carbolic acid, to inoculation of every man, woman, and child with Dr. Haffkine's prophylactic serum, and to the daily inspection of the quarters and inmates.

The additions to the Zoological Society's Gardens during the past week include a Servaline Cat (*Felis servalina*) from East Africa, presented by the Rev. Ernest Millar; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. M. A. Murray; a Common Squirrel (*Sciurus vulgaris*), British, presented by Lady Acland Hood; two Bateleur Eagles (*Helotarsus ecaudatus*), two Common Herons (*Ardea cinerea*) from East Africa, presented by Mr. Chas. Palmer; a Red-crested Cardinal (*Paroaria cucullata*) from South America, presented by Miss Edith M. Kenyon Welch; a Grey Monitor (*Varanus griseus*) from Egypt, presented by Dixon Bey; two Natal Pythons (*Python sebæ*, var.) from Natal, presented by the Hon. R. Carnegie; an Orang-outang (*Simia satyrus*, ♂) from Sumatra, deposited; two King Penguins (*Aptenodytes pennanti*) from the Antarctic Seas, purchased; a Burchell's Zebra (*Equus burchelli*, ♀), a Japanese Deer (*Cervus sika*, ♀), two Glossy Ibises (*Plegadis falcinellus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

Personal Equations in Transit Observations.—In the reduction of transit observations the question of personal equation is an important factor in the accuracy of the final star places, and it is on this account that investigations are always being pursued to determine the values of these equations for each meridian observer. A communication of importance in this respect appears in the *Monthly Notices* for May, by Prof. Truman Safford, who treats of the various forms of personal equation in transit observations which arise from the non-observance of the exact time of transit due to personality, magnitude of the star observed, and the apparent velocity and direction of movement. In his investigation Prof. Safford concludes that since the year 1795 most eye and ear observers anticipate the true time of transits, taking the average observed as a standard. At Greenwich, since 1885, the great majority of observers by the eye and ear method anticipate the time of their own chronographic transits, while the average chronographic observer registers transits after the time of their occurrence by an amount not greatly different from that which is required to register an impression on the senses. The personal error arising from the rate of movement of the star, or as it is termed the polar equation, amounts sometimes to a very considerable quantity, and several values are given in the paper showing the importance of a strict elimination of this variable. Dealing with faint stars an observer using the chronographic method registers its time of transit later than that when a more bright one is taken, while with the eye and ear method the time of transit is generally somewhat earlier. The change in direction of motion of stars due to their being observed sometimes north and sometimes south of the zenith, gives rise to a further personal equation discovered by Dr. Gill, but which is found generally very small. The investigation shows that the general theory thrown out by Bessel is thus confirmed, and Prof. Safford points out that the same is true with regard to Wundt's explanation of the eye and ear process from a psychological point of view.

Paris Observatory Report.—In his annual report for the year 1896, M. Lœwy, after a brief reference to the loss the observatory sustained in the death of M. Tisserand, sums up the work of the past twelve months. Among some of the chief points to which reference is made, may be mentioned the two astronomical congresses that have been held at the Observatory, and the work connected with the great enterprise of the photographic chart of the heavens. Many of the difficulties connected with the latter have for the great part been overcome, but there still remain one or two important questions which have been left over for another meeting. M. Bigourdan's work on the determination of the accurate position of the nebulæ between declination 90° and −30° has made great progress, and it is expected that it will take him three years more to complete the whole region under survey. The work on the photographic atlas on the moon has been successfully continued, and besides the issue of the first portion of the atlas during the past year, a second one will be published in the present one. The report further gives a brief account of M. Deslandres' work on the motions of stars in the line of sight, and the results of the expedition to Japan to observe the solar eclipse of August last. The work done in other departments of the observatory during last year, such as the Bureau des Calculs, Service Meridien, &c., is also briefly described.

Belgian Time-Reckoning.—Since the beginning of May, the hours in Belgium have been reckoned from 0 to 24, noon being represented by 12, and midnight by 0 or 24, according to circumstances. In the case of a train starting exactly at midnight, it is said to leave at 0 hour; and one arriving exactly at midnight is considered due at 24 hours, or, as we should say, at 24 o'clock. We learn from the *Journal* of the Society of Arts that on the time-tables the times between midnight and 1 a.m. are indicated by a zero, followed by a point and the letter H, the latter followed in turn by the number of minutes. The dials of existing clocks at railway stations are completed by the figures 13, 14, 15, &c., to 24, added below the existing figures of 1, 2, 3, &c., to 12. This change, which should have come into force with the new year, was deferred for three months, on account of the administrative difficulties which it involved, and also in the hope that the Greenwich meridian, now adopted in Belgium, might also be accepted by France at the same time, urgency having been voted for a measure to that effect by the Chamber of Deputies.

A NEW CLASSIFICATION OF STELLAR SPECTRA.[1]

Many of the recent advances in our knowledge of the constitution of the stars are traceable to Prof. Pickering's revival of Fraunhofer's mode of investigating stellar spectra. The endowment of this research by Mrs. Draper as a memorial to her husband, Dr. Henry Draper, has enabled Prof. Pickering to apply this method in two principal directions. First, a series of photographs was taken on a small scale to indicate the chief characteristics of the spectra of a very great number of stars; second, in the case of the brighter stars, another series was taken with greater dispersion with the view of facilitating an inquiry into the more minute features of each type of spectrum. The results of the first investigation are comprised in the well-known "Draper Catalogue," giving particulars of the spectra of over 10,000 stars (Nature, vol. xlv. p. 427), and the research has now been advanced another stage by the publication of the results obtained along the second line of inquiry.

The new series of photographs has been taken with one to four objective prisms of 15° each in conjunction with the 11-inch Draper telescope of 153 inches focal length.

When four prisms were employed, the spectra were 8 centimetres long from H_β to H_ϵ, and with one prism 2 centimetres. Since only the brighter spectra could be photographed with the highest dispersion, some of the more typical of these were also photographed with one and two prisms in order to give a proper term of comparison with the spectra of the fainter stars. In all, 4800 photographs of the spectra of 681 of the brighter stars north of declination −30° are included in the present discussion. By the use of plates stained with erythrosin the spectra of several stars have been photographed in the green and yellow.

As in all previous work involving considerable numbers of stellar spectra, it has been found that the spectra can be classified in large groups, between which there are intermediate varieties. "Large numbers of almost identical spectra are found, even when several hundred lines appear in each." The description of the spectra accordingly takes the form of an account of typical stars in the scheme of classification adopted, accompanied by tables of the lines which characterise the larger groups. No

[1] Spectra of bright stars, photographed with the 11-inch Draper telescope as a part of the Henry Draper Memorial, and discussed by Antonia C. Maury, under the direction of Edward C. Pickering. (*Annals of Harvard College Observatory*, vol. xxviii. part 1, 1897.)

attempt has apparently been made to assign chemical origins to the various lines, so that the endeavour to arrive at a natural and satisfactory system of classification may be regarded as the most important part of the discussion.

The classification of stars has another object besides that of the mere grouping together of those which have similar spectra. It is generally believed that the various types of spectra represent different stages of stellar evolution, but there are divergences of opinion as to the exact order in which the various types should follow each other. Dr. Vogel still holds, with some slight modifications, to the classification which he suggested in 1874, and believes that all the stars can be arranged along a descending line of temperature. Sir Norman Lockyer, who has adopted the same method of work as Prof. Pickering, and has also obtained large-scale photographs of stellar spectra, finds evidence that there are some stars which are getting hotter while others are becoming cooler, so that two series of spectra can be recognised.

For the Draper Catalogue a somewhat arbitrary and provisional classification was adopted, but this has not been found sufficient to meet the requirements of the more detailed results which are now available.

Among the stars with line spectra, as previous researches have shown, there are a few sets of lines which occur with various relative intensities in different stars, each set in some degree varying bodily, and the new classification is based chiefly upon the distribution of these sets. As will appear later, the classification adopted by Miss Maury also takes account of the appearance, as well as of the positions of spectral lines, and every care has been taken to eliminate instrumental sources of error.

Four distinct sets of lines are distinguished. The first includes the lines of hydrogen and calcium, and the remainder are thus described :—

"Another class of lines frequently mentioned comprises those which are characteristic of the solar spectrum, excluding the lines of hydrogen and calcium. They are called 'solar' lines, except when referring to lines not contained in the solar spectrum, in which case they are called metallic lines."

"A third class of lines includes those known as 'Orion lines,' from the fact that they are conspicuous in the spectra of many stars belonging to the constellation Orion. . . .

"Certain stars, such as α Cygni and δ Canis Majoris, have spectra in which the majority of the lines, though probably identical in position with lines belonging to the solar spectrum, differ greatly in intensity, while others apparently are not represented in the solar spectrum. The characteristic lines of such stars should perhaps be regarded as forming a class distinct from those already described."

Bearing in mind these different classes of lines, the new system of classification can readily be understood. Excluding "composite" spectra and bright line stars, "the stars were arranged in an apparently progressive series, which in the present case was made to include twenty-two groups. . . . But it also appeared that a single series was inadequate to represent the peculiarities which presented themselves in certain cases, and that it would be more satisfactory to assume the existence of collateral series."

Three lines of progression are recognised in the earlier stages, and are called "divisions." Stars of division *a* are characterised by lines having the appearance with which we are familiar in the solar spectrum ; that is, they are fine and sharp, if hydrogen and calcium be excluded. Those of division *b* are uniformly hazy, as in α Aquilæ, but otherwise present no notable differences in relative intensity from corresponding lines which are sharp in division *a*, so that "there appears to be no decided difference in the constitution of the stars belonging respectively to the two divisions." In division *c* the hydrogen lines are narrow and sharp and less intense than in the other divisions, while several lines, some of which do not correspond with solar lines, are of unusually great intensity; these are especially marked in α Cygni.

Groups and divisions alike proceed by very gradual stages in some parts of the series, and it has frequently been found difficult to assign some of the stars their proper places.

In consequence of the adoption of the term "group," which has been in use for the last ten years in connection with Sir Norman Lockyer's classification, some confusion may possibly occur, as similarly numbered groups include different stars. To avoid ambiguity, it will therefore be necessary, in the case of the first seven groups at least, to specify the system of classification in question. In what follows, the Draper groups will be distinguished by the addition of the letter D to the number where necessary.

Of the twenty-two groups, the first five include stars in which the Orion lines are especially marked ; the sixth contains stars intermediate between this type and the first type of Secchi, to which belong the stars in the seventh to the eleventh groups inclusive. The twelfth group is intermediate between Secchi's first and second types, and the stars included in groups thirteen to sixteen are of Secchi's second type. Groups seventeen to twenty inclusive correspond to Secchi's third type, and groups twenty-one and twenty-two to the fourth and fifth types respectively. Besides these, two unnumbered groups are recognised, one containing composite spectra, apparently resolvable into two or more, and the other including stars of the Orion type which also show bright lines. Nebulæ find no place among the numbered groups, but reference is made to a former paper (*Ast. Nach.*, vol. 127, p. 1), in which it was suggested that the Wolf Rayet stars probably form a connecting link between the spectra of nebulæ and those of the Orion type.

It is not possible within the limits of this notice to indicate the full details of the twenty-two groups with their sub-divisions, but the general course of development which is suggested may be briefly stated.

In Group I. D, of which ι Orionis is a type, the hydrogen lines are comparatively faint, while the Orion lines are strong, and "solar" lines are absent. Passing to Secchi's first type, through Groups II. D to V. D, the Orion lines become fainter and less numerous until in the spectrum of Sirius (Group VII. D) all but two or three are wanting. Meanwhile solar lines have become numerous, and the hydrogen lines reach their maximum intensity. The transition to succeeding groups is very gradual, hydrogen lines thinning out and solar lines becoming stronger. Arriving at stars like Capella and the sun (Group XIV. D), the intensity of the hydrogen lines is little more than a tenth of that shown in Sirius, and they afterwards continue to decrease, but less rapidly, down to the third type stars (Groups XVII. D to XX. D), where they are inconspicuous. In the third-type stars banded absorption appears, and becomes more marked in each succeeding group, while the majority of the lines fade out in the later groups. An important feature of the series is the manifestation of extensive absorption in the later groups of second type stars and in those of the third type.

For the present, the series is regarded as ending with the spectra of the third type, stars following the twentieth group not being considered as having a place in the series exhibiting the gradual development of stellar spectra.

Spectra of division *c* are not found after the thirteenth group, and those of division *b* disappear still earlier, "so that the series tends to become more uniform as it progresses."

In connection with the new classification, it is remarked (p. 11) that "while it will be generally admitted that the series represents successive stages in stellar evolution, it may still be doubted whether the arrangement beginning with the Orion type, and here adopted, is in fact the natural order. It is strongly indicated, however, by the gradual falling off of the more refrangible rays in the successive groups, by the corresponding increase in the less refrangible rays, and by the occurrence of marked absorption at the close of the series. The comparative simplicity of the Orion spectra and the increasing complexity shown throughout the series, lends additional weight to the argument. Finally, the prevalence of the Orion type in great nebulous regions, as in Orion and the Pleiades, indicates very emphatically that stars of this type are in an early stage of development."

It will be seen that the supposed evolutionary series has been arrived at without reference to temperature considerations. Nevertheless, a gradual reduction of temperature as the series progresses is suggested by the diminishing intensity of the more refrangible rays, so that, in the main series at least, the order is in all probability one of gradually reducing temperature.

As already remarked, the stars of Secchi's fourth type have been omitted from the supposed evolutionary series of spectra, for the reason that the few lines photographed "have not yet been identified with those of other classes of stars, owing to the total dissimilarity of the spectra." This dissimilarity is stated to extend to the yellow part of the spectrum, and is difficult to comprehend in the light of the more recent results obtained by Dr. McClean, who has shown that the spectrum of 152 Schj. contains many lines which are apparently identical with lines in the spectrum of α Orionis (*Monthly Notices*, vol. lvii. p. 8). The existence of carbon absorption in the solar spectrum, however, is of itself, as Lockyer long ago insisted, a sufficient connecting link between stars resembling the sun and stars in which carbon absorption is predominant. A classification which excludes these stars from the evolutionary series cannot, therefore, be regarded as final.

It is perhaps unfortunate that the new classification was adopted prior to the discovery of terrestrial sources of helium. Many of the "Orion" lines are now known to be due to this gas, but not all of them, so that these lines may be sub-divided into groups. In the preface to the volume Prof. Pickering remarks: "As the investigations were made several years ago, they could not take account of the recent discoveries respecting the spectrum of helium, which, if known at the time, might have had an important influence upon some of the conclusions. Such modifications could not now be introduced without practically rewriting the treatise, which is therefore published without change. A discussion of the relation of the spectra of stars of the Orion type to that of helium has, however, been made, and is contained in the supplementary notes."

The question of classification, however, is not the sole feature of interest possessed by the spectroscopic work at Harvard. Besides this, there are several tables which give the wavelengths of the lines depicted on the photographs, a general catalogue of the spectra, and copious remarks on the spectra of individual stars. In the case of the composite spectra it has been noted that in all but one, o Andromedæ, the spectrum of the earlier type was the fainter. The peculiarities of the spectrum of γ Cassiopeiæ, already recorded by Lockyer (NATURE, vol. li. p. 425), have been fully confirmed, and the additional fact observed that the entire region of the spectrum from λ 4154·7 to 3927·1 appears brighter than the rest of the spectrum, although the brightening is not homogeneous. The possible importance of this feature is suggested by its occurrence also in stars of the first two groups of the new classification.

The complex phenomena in the variable spectrum of β Lyræ are fully detailed, and the composite character of the dark line spectrum detected at Kensington by Sir Norman Lockyer receives independent confirmation. It is concluded that "the bright bands accompany a spectrum approximately of Group IV. D (*e.g.* γ Orionis), which oscillates periodically over one of Group VII. D, division *c*" (*e.g.* η Leonis), a result which agrees very closely with Lockyer's conclusion that the two dark line stars were not very unlike γ Orionis and β Orionis. It is pointed out that the supposition of a system of three bodies explains most of the spectral phenomena of β Lyræ, but not all of them, and the rapid and complex transformations require to be continuously followed before a complete explanation can be given.

While fully aware of the difficulty attending the satisfactory reproduction of stellar spectra, we think the value of the volume would have been greatly increased by some attempt to give copies of photographs of as many as possible of the typical stars. Without such reproductions the classification can scarcely be adopted by others taking up the work unless photographs of all the typical stars are first obtained. In spite of this drawback, the volume is a magnificent contribution to celestial spectroscopy, and will be of the greatest value to those pursuing similar investigations. Prof. Pickering and his assistants are to be congratulated upon the excellence of this additional contribution to the Henry Draper Memorial. A. FOWLER.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MOST of the arrangements for the approaching meeting of the American Association for the Advancement of Science have now been made, and are announced in the preliminary circular of the local committee. The meeting will be held at Detroit, Michigan, August 9–14. All the meetings, both general and sectional, will be held in the Detroit Central High School.

The chairman of the local committee is General Russell A. Alger, Secretary of War of the United States. The committee contains a great number of distinguished names, including seven or eight presidents of colleges, and several governors, senators, and foreign ministers.

The first session of the American Association, on Monday morning, August 9, will be opened by Prof. Theodore Gill, senior vice-president, owing to the death of President Edward D. Cope. The President-elect, Prof. Wolcott Gibbs, will be introduced, and addresses of welcome will be made by Mayor Maybury and by the ex-Minister to Spain, Mr. Thomas W. Palmer, after which the sections will meet. The addresses by the several vice-presidents of the sections will be as follows:—Prof. Carl Barus, to the section of physics, on long range temperature and pressure variables in physics; by Prof. Wm. J. McGee, to the section of anthropology, on the science of humanity; and by Prof J. C. White, to the section of geology and geography, on the Pittsburg coal bed (the latter to be read in his absence at the Geological Congress at St. Petersburg); Prof. W. W. Beman, to the section of astronomy and mathematics, on a chapter in the history of mathematics; by Mr. Richard T. Colburn, to the section of social and economic science, on improvident civilisation; and by Prof. L. O. Howard (nominated to succeed the late Prof. G. Brown Goode), to the section of zoology, on a subject to be hereafter announced; Prof. W. P. Mason, to the section of chemistry, on sanitary chemistry; by Prof. George F. Atkinson, to the section of botany, on experimental morphology; and by Prof. John Galbraith, to the section of mechanical science and engineering, on applied mechanics.

A general session will be held on the evening of the opening day, and Prof. Theodore Gill will deliver, as the presidential address, a memorial of the life and work of the late president, Prof. Edward D. Cope, after which will follow a reception by the citizens of Detroit.

August 10–13 will be occupied as usual by section meetings, and to some extent by excursions of the sections. A new arrangement has been made by which the affiliated societies will occupy a portion of the time heretofore allotted to the sections; and these meetings will be open to members of the Association, as those of the several sections are to members of the affiliated societies. Only three societies meet this year in connection with the Association, namely, the Geological Society of America, the American Chemical Society, and the Society for the Promotion of Agricultural Science. These several societies meet on August 9–11. The Association of Economic Entomologists anticipates the others, holding its meetings on August 6 and 7. Of the other Societies usually affiliated with the Association, the American Mathematical Society will meet at Toronto on August 17–18; and the Society for the Promotion of Engineering Education on August 16–18.

The closing meeting of the Association will be held on the evening of August 13, followed by a reception.

There will be a general excursion by steamer to St. Claire Flats on August 14, the contemplated trip to Buffalo and Niagara Falls having been abandoned.

Attention is again called to the fact that members of foreign scientific associations of a national character are admitted without fee to the meetings of the American Association.

Matters relating to local arrangements, transportation, &c., are in the hands of the local secretary, Mr. John A. Russell, No. 401 Chamber of Commerce, Detroit, Mich. Hotel and boarding-house accommodation is arranged by Mr. Edward W. Pendleton, of the same address. Nominations to membership and letters relating to the general business of the Association should be sent to Miss C. A. Watson, assistant secretary, Salem, Mass., until August 3; after that date to the American Association, Detroit, Mich.

The circular repeats the announcement that after the close of the meeting it is expected that members of the American Association will go in a body to Toronto to join in welcoming the British Association to America. Special rates of fare will probably be secured for this purpose.

The several sections will issue preliminary circulars. The first to appear is that of the anthropological section, which states that Tuesday, August 10, will be devoted to folklore, to which the American Folklore Society has been invited. On Wednesday the report of the committee on the ethnography of the white race in America will be presented in the morning, to be followed by discussion; the subject of psychology will occupy the afternoon. Thursday forenoon will be devoted to the archæology and ethnology of Mexico and Central America; afternoon, to the United States. On Friday morning the report of the committee on anthropologic teaching will be received; and in the afternoon the subject for consideration will be somatology.

THE ANALYSIS OF PHONOGRAPH RECORDS.[1]

AFTER describing the general characters of waves, as regards pitch, amplitude, and form, Dr. McKendrick said:—

Thus we can now understand what is meant by a compound wave, and you will appreciate the statement that compound waves may be very complex in character. If you look at the curves showing the resultant waves, you will see that they represent, in a way, the character of the variations of pressure made on the drum-head. With simple pendular waves, the drum-head moves out and in with perfect regularity, like the movements of a pendulum. The physiological effect of such simple pendular vibrations is a sensation of a pure tone, such as you hear when I bow this tuning-fork. But if a compound wave falls on the drum-head, it is not so easy to follow with the imagination the variations of pressure. While these variations occur in regularly recurring intervals of time so as to give the sensation of the pitch of the fundamental tone, the movement may not be uniform on each side of the median line, indicating the position of repose of the drum-head, like the swing of a pendulum. Thus the drum-head may move in, owing to the increase of pressure, faster than it moves out, or the reverse; or it may move in a little distance, then return again to the starting-point and again move in, and it may return to the position of rest after one or more to-and-fro movements Again, it may be pushed in to the maximum distance, and remain in that position for a short time, and then return to the original place of repose. Thus the characters of the variations of pressure may vary to a remarkable degree—to a degree, with a very complex sound, that is to us almost inconceivable; but we may be sure that these variations of pressure will be faithfully followed by the drum-head, and communicated by it to the deeper ear. When a compound wave thus falls on the ear, the result is a sensation of sound of a certain quality, or timbre, or clang, and we say that we hear the sound of various musical instruments, as in a brass band or an orchestra, or the sound of a particular instrument, a trombone, a flute, a harp, a clarionet, or the sound of a well-known voice that we can distinguish from all others.

He then described the attempts to record graphically the vibrations of bodies emitting sound from the time of Thomas Young down to 1874–75, when the phonograph was invented. In 1878, Fleeming Jenkin and Ewing succeeded in obtaining tracings of the records of vowel sounds on the tinfoil phonograph, and the curves were submitted to harmonic analysis. Since that time, the marks on the tinfoil of the first phonograph have been scrutinised by Grutzner, Mayer, Graham Bell, Preece, and Lahr. The imperfections of the tinfoil phonograph made progress impossible for ten years (from 1878 to 1888), during which time, however, Edison, Graham Bell, and others were engaged in working out the mechanical details of the wax-cylinder phonograph. The subject was then taken up by Hermann, and he succeeded in obtaining photographs of the vibrations of the vowel sounds, a beam of light reflected from a small mirror attached to the vibrating disc of the phonograph being allowed to fall on a sensitive plate while the phonograph was slowly travelling. The curves thus obtained were very beautiful. In 1891, Boeke, in a laborious microscopical research, measured the transverse diameters of the depressions on the wax cylinder at different depths, and from these measurements calculated the depths of the curves. He then reconstructed the curves on a large scale, and he also has been busily engaged in the analysis of vowel curves.

Recently also Pipping has traced and analysed the curves obtained by a kind of phonautograph constructed on the type of the drum-head of the ear, and R. J. Lloyd has written two valuable papers on the interpretation of the tracings obtained by Pipping and by Hermann.

Dr. McKendrick exhibited one of the first phonographs made in this country. It was constructed by the late Prof. Fleeming Jenkin in 1876. It represents the instrument in its simplest form. You observe how the drum travels from side to side as in the phonautograph. The drum has a deep spiral groove, the thread of which corresponds to that of the spindle on which the drum rotates, and it is covered with thin, soft tinfoil. The membrane has fixed firmly to its centre a stout little marker having a chisel-shaped edge. When sound waves fall on the membrane it vibrates, and as the drum is rotated, the edge of the needle pushes in the tinfoil into the spiral groove, and it makes a series of indentations corresponding to the variations of pressures produced by the sound waves. When the sound is reproduced, we run the point of the needle over these indentations by turning the drum, and the varying pressures on the needle point caused by the indentations act on the membrane, and reproduce the sound. Thus this simple mechanism records the *number* of vibrations, corresponding to pitch, the relative *amplitude* of the vibrations, corresponding to intensity or loudness, and the *form* of the vibrations which has reference to the quality of the sound.

Since this remarkable invention first appeared, the phonograph has been improved so as to make it now a valuable scientific instrument. Many are too apt to think of it as an amusing toy, or as an apparatus that will serve the practical purpose of a shorthand writer. It is both amusing and practical, but it is much more. It is now a scientific instrument worthy of a place in physical and physiological laboratories beside other instruments of scientific research, and those employed for demonstration in teaching. It merits this position because it makes it possible to study some of the phenomena of sound in a manner otherwise unattainable.

Since 1877 the phonograph has been immensely improved, and we now have it in the form that you see before you. The machine used in this country is so geared that the wax cylinder, 6⅞ inches in circumference, makes two revolutions in one second, while the spiral grooves described on the cylinder are 1/200 inch apart. A spiral line about 136 yards in length may be described on the cylinder, and the recording or reproducing point travels over this distance in about six minutes.

I have also used the American model, now also before you, which resembles in all essential particulars the one I have just described, except that the grooves are 1/100 inch apart, instead of 1/200 inch.

The mechanism by which the glass disc or diaphragm communicates its movement is shown by means of the large model now before you. When sound waves fall on the glass disc, the latter is subjected to variations of pressure, as I have already explained. From the centre of the glass disc there comes a rod which passes to the end of a lever, and to this lever a counterpoise is attached. The end of the lever carries a sapphire point which, like a gouge, cuts a spiral groove on the surface of the wax cylinder. When there is increased pressure on the disc, the inclination of the edge of the gouge is directed downwards at such an angle with the surface of the wax cylinder as to cut a groove of a certain depth; but when the pressure becomes less, the angle is changed, the gouge cuts more in a horizontal direction, and the groove ploughed out is not so deep. Consequently as with each vibration of sound we have, as I have already explained, increased pressure and diminished pressure, a series of marks of an oblong form are made in the bottom of the groove, each little mark corresponding to a vibration. The number of such marks, therefore, in a given distance—which, when the velocity of the movement is taken into account, represents a certain interval of time, say the one-fiftieth of a second—corresponds to the pitch of the note; the depth of the marks corresponds to the intensity of the vibration; and the form of the marks to the form of the vibration. Again, suppose a note is sung *diminuendo* to *crescendo*, and again to *diminuendo*, the depth of the groove will vary according to the intensity, at first shallow, gradually becoming deeper till the maximum depth has been reached, and again becoming more and more shallow. These marks, therefore, on the wax cylinder are the representations of the mechanical effects of the vibrations in all respects—number (pitch), depth (intensity or loudness), form (quality). It will be evident, therefore, that if we run over these marks again with the reproducing point, the glass disc will again vibrate to the impulses received by the ups and downs on the cylinder as to reproduce faithfully, but with diminished intensity, the original sound. It is, therefore, an investigation of great interest to study these marks, to reproduce them on such a scale as to enable us to study their form, and to let us see the ups and downs as we would do, suppose we could make a longitudinal section along the bottom of the groove, and looked at the marks sideways.

Before we set ourselves to the study of these marks, let me bring under your notice certain other branches of the investigation. In the first place, we may, to a wonderful extent, increase the volume of tone or loudness of the phonograph by the use of

[1] Abstract of the Science Lecture for 1896, delivered to the Philosophical Society of Glasgow on December 16, 1896, by John G. McKendrick, M.D., F.R.S., Professor of Physiology, University of Glasgow.

resonators. No doubt the *quality* of the tones is best appreciated by carrying the vibrations directly to the vicinity of the drum-head of the ear, as is usually done, by fine tubes; but this method is not always agreeable, and the pleasurable effect is sadly marred by the friction noises. Still the fact that tones are heard best in this way, *as regards their quality*, proves to my mind that the marks on the wax cylinder are accurate representations of the varying intensities of the pressures caused by the sound waves. Resonators, such as the large one you now see, increase the volume of tone, and you will notice how accurately the tones are reproduced.

Now, let us see what we can make of the marks. I have endeavoured to study the marks on the wax cylinder in three different ways—by casts, by photographs, and by mechanical devices.

As regards the first method—taking casts, which was also attempted by Hermann and Boeke—the results were not satisfactory. The most efficient method followed by me was to paint in the cylinder, with a camel-hair brush, a layer of celloidin dissolved in ether. This soon hardened, and the film could then be peeled off. The thin film thus obtained was then inverted on the stage of a microscope, and the marks were seen in relief. A photograph of the marks thus obtained is now on the screen (Fig. 1).

The depressions are well seen, and their differences as regards length are obvious. The method has the disadvantage of flattening out the marks.

I took numerous photographs, with the aid of the microscope and camera, of portions of the surface of the cylinder on which

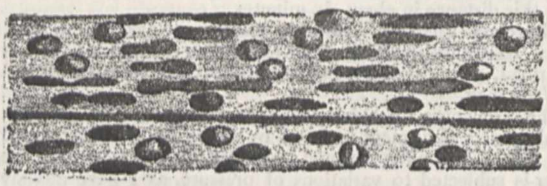

Fig. 1.—Celloidin cast (magnified) of marks on wax cylinder. Portion of record of a military band.

were records of many instruments and of the voice. I now show you on the screen examples of such records (Fig. 2).

Each figure, from above downwards, represents the $\frac{1}{8}$th of an inch on the surface of the wax magnified fourteen diameters. The grooves seen in each figure are, on the wax cylinder, $\frac{1}{200}$th inch apart, and the length of the groove, from above downwards, represents in time the $\frac{1}{64}$th second—that is to say, when each tracing was recorded, the sapphire point of the recorder travelled over the distance represented in magnified proportions in the $\frac{1}{64}$th part of a second. By counting the number of indentations or marks, which in a photograph have a curious appearance of being in relief, one can at once determine approximately the pitch of the tone, the vibrations of which make the impression. The tones highest in pitch were obtained from the piccolo and the xylophone. Here the pitch was about 1920 vibrations per second. In Fig. *A* we have a picture of the vibrations produced by the tones of the violin, and it will be seen that they vary in character. Sometimes the marks are a little apart, and at other times they blend into each other, the mark widening out as the receding point cut into the wax and then contracting as it receded. It is to be borne in mind that even when the glass disc is not vibrating, the recorder ploughs a groove on the cylinder, and when the glass disc vibrates each vibration cuts deeper into the groove. The figure of the vibration of the tones of a flute (*B*) shows moniliform markings, indicating that the disc may not, in some instances, return to its position of rest for a short time. Sometimes the intensity of the tone is so great as to cause, after each deeply ploughed groove (as will be seen in the figure of the vibrations of the tones of an organ, *D*), a rebound lifting the recorder up to the surface of the cylinder, or even off the surface altogether. This is the explanation of the smooth spaces between the ends of the individual marks.

To obtain a mechanical representation of the curves is a very difficult matter. The difficulties were so far overcome by the device of Jenkin and Ewing with the tinfoil phonograph. The method followed by these observers, which was entirely mechanical, was to cause the disc of the phonograph to record its movements on a drum moved at the same rate as that of the cylinder. As I have already mentioned, Hermann photographed the oscillations of a beam of light reflected from a small mirror connected with the disc of the phonograph, the whole apparatus moving slowly. My method consists in the adaptation of a light lever to the phonograph itself, and so arranged that it (the point of the marker) would travel over all the ups and downs of the phonographic curve on the wax cylinder at an extremely slow rate. The obvious objection to any method of directly recording the ups and downs of the lever is that the inertia of the lever

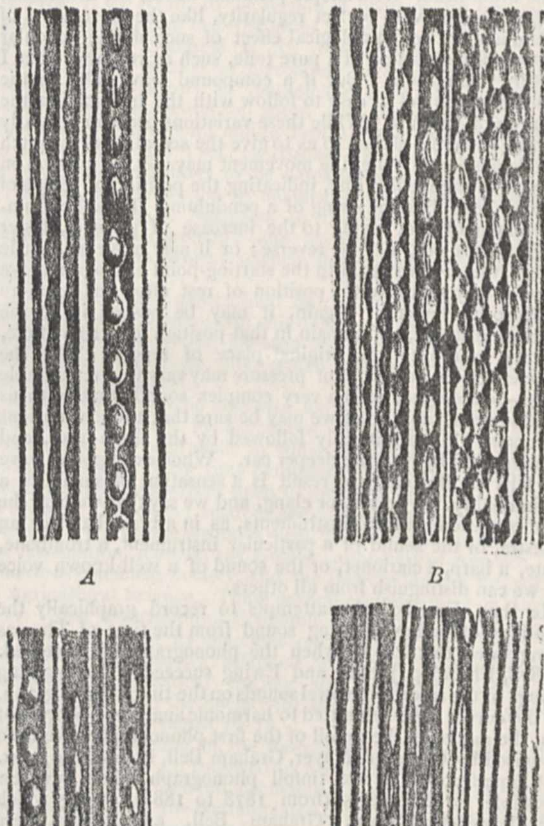

Fig. 2.—From photographs of portions of the surface of the wax cylinder. *A*, violin. *B*, flute. *C*, vowel *o*. *D*, full organ.

might cause extraneous vibrations, while, at the same time, the smaller marks on the wax cylinder might be missed. These objections, however, were removed by reducing the friction to minimum, and by moving the phonograph cylinder so slowly as to make the movement almost invisible to the naked eye. In this way inertia ceases to give trouble. The first arrangement gave curves of very small amplitude, a specimen of which I now show you.

Various mechanical arrangements were employed, some of which I described to the Royal Society of Edinburgh in February last.

My attention has since been directed to perfecting a mechanism for obtaining a record of the vibrations.

The instrument now before you, which I shall call a *phonograph-recorder*, traces out, on a large scale, the curves of the indentations on the wax cylinder corresponding to each vibration of sound, and it does so in a way that seems to be highly satisfactory.[1]

Since the apparatus was brought to its present condition, I have been able to record the vibrations of the tones of several instruments, and also the tones of the human voice, both in singing and in speech. Illustrations of these I now show you (Fig. 3).

First, with reference to speech, I wish to point out that when the record of a *word* is examined it is found to consist of a long series of waves, the number of which depends (1) on the pitch of the vowel constituents in the word, and (2) on the duration of the whole word or of its syllables individually. There is not for each word a definite wave form, but a vast series of waves, and, even although the greatest care be taken, it is impossible to obtain two records for the same word precisely the same in character. A word is built up of a succession of sounds, all usually of a musical character. Each of these sounds, if taken individually, is represented on the phonograph-record by a greater or less number of waves or vibrations, according to the pitch of the sound and its duration. The pitch, of course, will depend on the number of vibrations per second, or per hundredth of a second, according to the standard we take, but the number of the waves counted depends on the duration of the sound. As it is almost impossible to utter the same sound twice over in exactly the same fraction of a second, or in the same interval of time, the number of waves counted varies much in different records. The rate per unit of time determines the pitch, the number the duration of the sound. In a *word*, these successive sounds blend into each other, and, in many records, the passage from one pitch to another can be distinctly seen. The speech sounds of a man vary in pitch from 100 to 150 vibrations per second, and the song sounds of a man from 80 to 400 vibrations per second. The sounds that build up a word are chiefly those of the vowels. These give a series of waves representing a variation in pitch according to the character of the vowel sound. In the record of a spoken word the pitch is constantly moving up and down, so the waves are seen in the record to change in length. It is also very difficult to notice where one series of waves ends and where another begins. For example, in the word *Con-stan-ti-nople*, the predominant sounds are those of *o-a-i-o-ill*, and the variation in pitch is observable to the ear if, in *speaking* the word, we allow the sound of the syllables to be prolonged. If we look at the record of the word, we find these variations in pitch indicated by the rate of the waves, or, as the eye may catch this more easily, by the greater or less length of wave, according to the pitch of the sound. The consonantal sounds of the word are breaks, as it were, in the stream of air issuing from the oral cavity, and these breaks (I am not discussing the mechanism at present) produce sounds that have also often the character of vowel sounds. Thus, at the beginning of "Constantinople," we have, as will be observed on pronouncing the syllables very slowly, the sound *ŭkkō*. This sound is represented in the record by a series of waves. Then follow the waves of the vowel *o*. Next we have the sound *nn* (sound through the nose), also represented by a series of waves. Next the hissing sound *ss*, which has first something in it of the vowel *e* or *i*, and then the *iss-s*. This sound also is shown by a series of waves. Then there is *ta*, which has a double series of waves—(1) those for *it* or *t*, and the next for *a*. This passes into the prolonged vowel *a*, this into *in*, this followed by *ti* passing into the vowel *i*, then another *in*, then a long *o*, then a sound like *op*, and, lastly, the sound *ill*, a sort of double-vowel sound. As so many of these sounds have the character of vowels, it is impossible, by an inspection of the record, to say where one set of waves begins and another ends. There are no such breaks corresponding to the consonants; the vibrations of the consonants glide on as smoothly as those of the vowels. The *number* of waves producing a word is sometimes enormous. In "Constantinople" there may be 500, or 600, or 800 vibrations. A record of the words "Royal Society of Edinburgh," spoken with the slowness of ordinary speech, showed over 3000 vibrations, and I am not sure if they were all counted. This brief illustration gives one an insight into nature's method of producing speech sounds, and it shows clearly that we can never hope to reach such records in the sense of identifying the curve by an inspection of the vibrations. The details are too minute to be of service to us, and we must again fall back on the power the ear possesses of identifying the sounds, and on the use of conventional signs or symbols, such as letters of the alphabet, vowel symbols, consonant symbols, or the symbols of Chinese, which are monosyllabic roots often meaning very different things, according to the inflection of tone, the variations in pitch being used in that language to convey shades of meaning.

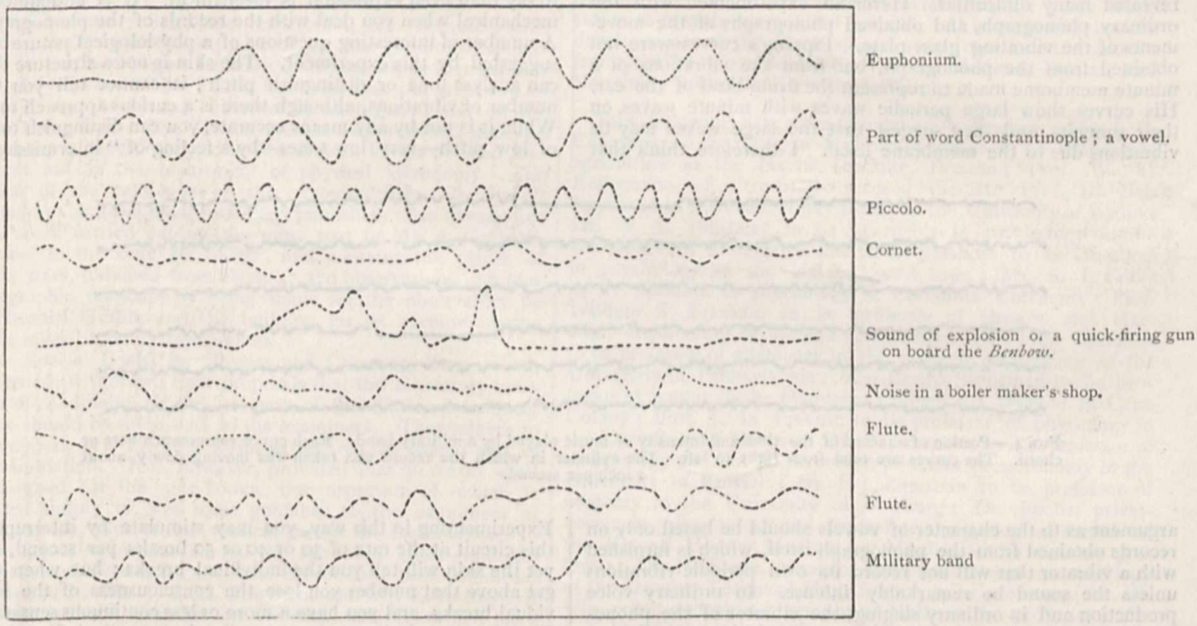

FIG. 3.—Specimens of curves obtained by phonograph recorder. Four inches = 1/120th sec. The curves read from left to right. The lower curve of the flute is continuous with the upper one, to show change of pitch. These curves are given to show the great variety of wave form. They are not sufficiently accurate for analysis. To obtain curves suitable for analysis, the greatest care must be taken.

[1] For a diagram of the apparatus, see *Proc. Roy. Soc. Ed.*, December 7, 1896.

When human voice sounds are produced in singing, especially when an open vowel sound is sung on a note of definite pitch, the record is much more easily understood. Then we have the waves following each other with great regularity, and the pitch can easily be made out. Still, as has been well pointed out by Dr. R. J. Lloyd, of Liverpool, a gentleman who has devoted much time and learning to this subject, it is impossible by a visual inspection of the vowel curve to recognise its elements. Thus two curves, very similar, possibly identical to the eye, may give different sounds to the ear—that is to say, the ear, or ear and brain together, have analytical powers of the finest delicacy. No doubt, by the application of the Fourierian analysis, we may split up the periodic wave into a fundamental of the same period, and a series of waves of varying strength vibrating 2, 3, 4, 5, &c., times faster than the fundamental, and the relative amplitude of each of these may be determined. If all these waves of given amplitude and given phase acted simultaneously on a given particle, the particle would describe the vibration as seen in the original curve. Dr. Lloyd, however, is of opinion that even a Fourierian analysis may not exhaust the contents of a vowel, as it does not take account of inharmonic constituents which may possibly exist. Hermann and Pipping have also been investigating the analysis of vowel tones, and their investigations have revealed many difficulties. Hermann experimented with the ordinary phonograph, and obtained photographs of the movements of the vibrating glass plate. Pipping's curves were not obtained from the phonograph, but from the vibrations of a minute membrane made to represent the drum-head of the ear. His curves show large periodic waves with minute waves on their summits, and they suggest that the large waves may be vibrations due to the membrane itself. I therefore think that experiment suggested another of a different kind. Suppose I send the current not only through the variable resistance apparatus above the disc of the phonograph, but also through the primary coil of an induction machine. The wires from the secondary coil pass to two platinum plates dipped in weak salt solution. I now set the phonograph going; and when I put my fingers into the beakers containing salt solution, I *feel* the intensity of every note. The variation of intensity, the time, the rhythm, and even the expression of music, are all felt. I shall now place on the mandril of the phonograph a cylinder on which has been recorded another piece of music, with a faster *tempo*. I now feel a series of electrical thrills corresponding to every variation of intensity of sound coming from the phonograph. That method shows that the nerves of the skin can be stimulated by irritations coming to it at the rate of the notes and chords of rapid music. Some of the notes produced by the phonograph do not last longer than the five-hundredth or six-hundredth part of a second, but they are quite sufficient to stimulate the nerves of the skin, and, as I have pointed out, you can appreciate the variations of intensity. You can *feel* the long drawn-out notes from the saxhorn or trombone. You feel the *crescendo* and *diminuendo* of rhythmic movement, and you can estimate the duration of the note and chord. You feel even something of the expression of the music. It is rather a pity to say than even expression is mechanical. It is undoubtedly mechanical when you deal with the records of the phonograph. A number of interesting questions of a physiological nature are suggested by this experiment. The skin is not a structure that can analyse tone or distinguish pitch; it cannot tell you the number of vibrations, although there is a curious approach to it. While it is not by any means accurate, you can distinguish tones of low pitch—very low tones—by a feeling of "intermission."

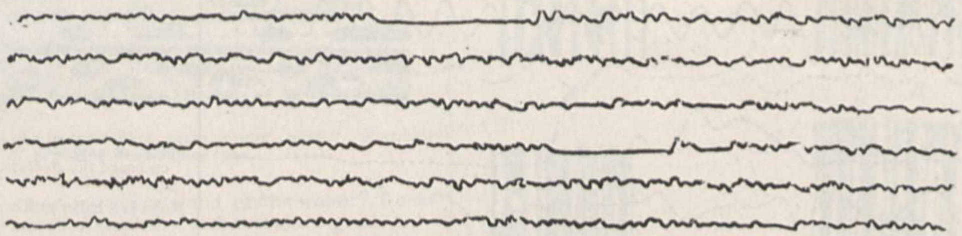

FIG. 4.—Portion of a record of the time and intensity of music played by a military band. Each curve represents a note or chord. The curves are read from right to left. The cylinder in which the record was taken was moving slowly, about 1 inch per second.

argument as to the character of vowels should be based only on records obtained from the phonograph itself, which is furnished with a vibrator that will not record its own periodic vibrations unless the sound be remarkably intense. In ordinary voice production and in ordinary singing, the vibrator of the phonograph faithfully records only the pressures falling upon it—no more and no less.

I shall now show you another method of recording, not the individual vibrations of the phonograph, but the variations in intensity of the sounds of the phonograph—the intensities of individual notes and chords. I was led to use this method by becoming acquainted with an instrument devised by Prof. Heurthle, of Breslau. He has succeeded in recording the vibrations of the sounds of the heart. I saw that his instrument was very useful, and I adapted it to the particular purpose in hand. Heurthle's instrument is an electro-magnet acting on a metal plate connected with the elastic membrane of a tambour. Another drum is connected with the first by an india-rubber tube. The metal plate of the first tambour is pulled down by the electro-magnet; thus the air is rarefied in the tube and in both tambours, and the lever of the second tambour moves. The next instant the lever flies back. We shall now connect Graham's variable resistance apparatus with the phonograph. As sound waves fall on it, a change is produced in the current passing through the electro-magnet; the latter acts on its tambour; a variable pressure is communicated to the other tambour; and if the lever of the latter is brought against a revolving drum, a tracing is obtained. I show you a little bit of such a tracing (Fig. 4).

Each note and each chord is recorded, so that you get a mechanical tracing of the variations of intensity. Now this Experimenting in this way, you may stimulate by interrupting this circuit at the rate of 30 or 40 or 50 breaks per second, and yet the skin will tell you the individual breaks; but when you get above that number you lose the consciousness of the individual breaks, and you have a more or less continuous sensation. The phonograph does not necessarily give you 50 or 60 *stimuli* to produce a sensation of a tone; you do not require that number. I found that 8 or 10 per second may give you the sensation for a tone of any pitch. In the same way you may be able to notice a slight difference up to perhaps 50 or 60, but above that the sensation seems continuous. It is not the number of *stimuli* that determine pitch, but the rate at which the *stimuli* affect the sense organ, whether it be ear or skin. Then the question arises, What is it in the skin that is irritated? It is not the corpuscles. They have to do with pressure. There is no organ for the sense of temperature. You may say that the feeling is muscular. Possibly it may be so; but the effect is most marked when the current is so weak as to make it unlikely that it passes so deep as to reach the muscles.

This experiment suggests the possibility of being able to communicate to those who are stone deaf the feeling, or, at all events, the rhythm of music. It is not music, of course, but, if you like to call it so, it is music *on one plane and without colour*. There is no appreciation of pitch or colour or of quality, and there is no effort at analysis, an effort which, I believe, has a great deal to do with the pleasurable sensation we derive from music. In this experiment you have the rhythm which enters largely into musical feeling. Recently, through the kindness of Dr. J. Kerr Love, I had the opportunity of experimenting with four patients from the Deaf and Dumb Institution, one of whom had her hearing till she was eleven years of age, and then she became stone deaf. This girl had undoubtedly a recollection of music,although she does not now hear any sound. She wrote me a little letter, in which she declared that *what she felt was music*, and that it awakened in her mind a conscious something that recalled what music was The others had no conception of music, but they were able to appreciate the rhythm, and it was interesting to notice how they all, without exception, caught up the rhythm, and bobbed their heads up and down, keeping time with the electrical thrills in their finger-tips.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE —The establishment of a University Lectureship in Experimental Psychology was opposed in the Senate, but it has now been carried by a very large majority.

Thirty-three men and three women have obtained a first-class in the Natural Sciences Tripos, Part I. In Part II. the first-class includes eleven names.

Prof. Allbutt, F.R.S., has been appointed to represent the University at the International Medical Congress to be held at Moscow in August.

The Harkness Scholarship in Geology and Palæontology has been awarded to Mr. R. H. Kitson, of Trinity College.

The Observatory Syndicate report that, Mr. Newall's term of office as Observer having expired, he has generously undertaken to continue to give his services without stipend for another term of five years. They think, however, that the provision of a stipend for the Newall Observer is an urgent claim on the funds of the University. In its present impoverished state the University is much indebted to Mr. Newall for his devoted and efficient aid in the department of physical astronomy. The portion of the catalogue of the *Astronomische Gesellschaft* allotted to Cambridge has now been published, after twenty-five years' work carried out for the most part by Mr. A. Graham. It refers to the zone 25° to 30°, and contains the places of 14,464 stars, obtained from about 47,570 observations. A new photographic telescope is being made for the observatory by Sir Howard Grubb, and the building for its accommodation will be taken in hand this summer.

The Special Board for Physics and Chemistry have, as was anticipated, withdrawn their proposals that the laboratory note-books of candidates for the first part of the National Sciences Tripos should be submitted to the examiners. They adhere to the proposal, in a modified form, as regards the second part of the examination. It is, however, provided that no marks shall be assigned for the note-books, the inspection of which is intended simply to give some guidance to the examiners in estimating the value of the practical part of the examination.

The first dissertations offered by advanced (post-graduate) students as candidates for the B.A. degree have been submitted and approved. Mr. J. S. E. Townsend and Mr. E. Rutherford have each offered memoirs on electrical subjects which have been honoured by publication in the *Phil. Trans.* of the Royal Society, and the Degree Committee record their opinion that the work submitted "is of distinction as a record of original research." These gentlemen have accordingly received the University Certificate of Research, and the degree of Bachelor of Arts, under the new regulations for graduates of other Universities.

The Hutchinson Studentship has been awarded to Mr. V. H. Blackman, of St. John's College, for botanical researches on Algæ. The Hockin Prize for Electricity has been awarded to Mr. W. A. D. Rudge, of the same college, a student in his first year.

THE University of Dublin has conferred the honorary degree of Doctor of Science upon Dr. Wilhelm His, Professor of Anatomy in Leipzig University, and Prof. Ramsay.

THE will of the late Mr. J. H. R. Molson has been admitted to probate at Montreal. It assigns 100,000 dollars to McGill University, 30,000 dollars to the Frazer Institute, and 10,000 dollars to Bishop's College School at Lennoxville.

ON Thursday last a farewell address was presented to Prof. Sollas, F.R.S., by past and present students of geology in Trinity College, Dublin. Prof. Sollas is leaving Dublin for Oxford, where he succeeds the late Prof. Green as professor of geology.

ENDOWMENTS recently received by Rutgers College increase the fund nearly 50,000 dollars, and include 5000 dollars from the Vice-President of the United States; 10,000 from Mrs. Winants, of Brooklyn; 5000 each from Mr. Frederick Frelinghuysen, of Newark, and Mr. Samuel Sloan and Mr. Richard Schlett, of New York, with the promise of 10,000 more from the latter; and 3234 from the Alumni Association.

IN order to obtain an accurate conception of the growth of Harvard University, Prof. C. S. Minot has compiled a table showing the gifts of money to Harvard College from 1868 to 1896, and he makes it the subject of a contribution to the Harvard *Graduate's Magazine* for June. It appears from this article that Harvard University has received annually during the past twenty-eight years in round numbers 330,000 dollars. The educational efficiency of the University has increased even faster than its endowment. It is held that seven scientific departments, in which the Medical, Dental, and Veterinary Schools have a common interest, need immediate endowment. The departments are: (1) anatomy (human and comparative); (2) physiology; (3) histology and embryology; (4) pathology; (5) bacteriology; (6) pharmacology; (7) hygiene. Each of the seven departments needs to be organised on the minimum basis of 300,000 dollars, making in all an endowment of 2,100,000 dollars. If the gifts continue as heretofore, six years would suffice to furnish the required amount. It is suggested that the development of the seven departments mentioned would be facilitated by the consolidation of the Medical, Dental, and Veterinary Schools under a single Faculty.

THE following are among recent appointments:—Mr. J. R. Campbell, of the Glasgow Technical College, to be lecturer in agriculture at the Harris Institute, Preston; Prof. W. T. Engelmann, of Utrecht, to succeed the late Prof. Du Bois Reymond in the chair of physiology in the University of Berlin; Dr. W. B. Pillsbury to be instructor in psychology in the University of Michigan; Dr. C. E. Seashore to be assistant in psychology in the University of Iowa; Mr. S. I. Franz to be assistant in psychology in Columbia University; Prof. William S. Franklin to be professor of physics and electrical engineering at Lehigh University; Dr. John Marshall to be professor of chemistry in the medical department of the University of Pennsylvania; Miss Bertha Stoneman to be professor of botany in the Huguenot College for Women in Cape Colony; Prof. J. L. Prevost to be professor of physiology in the University of Geneva; Dr. P. Francotte to be professor of embryology and Dr. P. Stroobant professor of astronomy in the University of Brussels; Dr. J. J. Zumstein to be professor of anatomy in the University of Marburg; Dr. Fuchs, privat-docent in palæontology and director of the geological section of the Natural History Museum at Munich, to be assistant professor; Dr. H. Baum, prosector and privat-docent in osteology at the Dresden Technical High School, to be professor; Dr. W. Ule, privat-docent in geography at Halle, to be professor; Dr. J. J. Ptaschicky to be professor of geometry at St. Petersburg; Dr. A. O. Kihlman to be assistant professor of botany at Helsingfors; Dr. Heim to be assistant professor of hygiene at Erlangen; Dr. Alex. Bittner to be chief geologist of the K. K. geologischen Reichsanstalt at Vienna; also, at the same institution, G. Geyer to be geologist, G. v. Bukowski and August Rosiwal to be adjunkten, and Dr. J. Dreger, F. Eichleiter, Dr. F. v. Kerner, and Dr. J. J. Jahn to be assistants.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, June 25.—Mr. Shelford Bidwell, President, in the chair.—A paper by Mr. Sutherland, on a new theory of the earth's magnetism, was taken as read.—Dr. Kuenen described some experiments on critical phenomena, made in continuation of a research on the condensation and critical phenomena of mixtures of ethane and nitrous oxide, the results of which were published last year. The author now investigates mixtures of ethane and acetylene, and mixtures of ethane and carbonic acid, and finds for them similar properties to those of the mixtures of ethane and nitrous oxide. The first part of the paper refers to the preparation of ethane, and the effect of impurities on its vapour-pressure, and critical constants.

Ethane from ethyl iodide is not very pure, it has generally several per cent. of an admixture of a substance of higher critical temperature and higher density than ethane; this substance is probably butane. Ethane from sodic acetate, by electrolysis, is nearly pure; the method of preparation is described by the author. The pressure and corresponding volumes during condensation are given for this substance at various temperatures. In the former paper, above referred to, instances are mentioned of mixtures having critical temperatures *below* those of the component substances. The only instance of critical temperatures *above* those of the components, seem to be those relating to mixtures of carbonic acid and acetylene. According to an experiment of Dewar's, however, a mixture of $\frac{1}{2}CO_2$ and $\frac{1}{2}C_2H_2$ has a critical temperature of 41° C., those for carbonic acid and acetylene being 31° and 37° respectively. The present investigation contradicts this result. Dewar may not have taken sufficient precaution in avoiding errors of retardation. Mixtures of carbonic acid and acetylene have critical temperatures between those of the component pure gases. The diagram connecting temperature and volume shows that the plait-point curve is a line with small curvature; the border-curve is relatively narrow. An instance of a critical temperature above those of the components, for this mixture, has not yet been proved. Theory indicates that this phenomenon probably occurs for mixtures having a minimum vapour-pressure at low temperature. Critical temperatures below those of components, seem to occur for mixtures having a maximum vapour-pressure; as for nitrous oxide and ethane. The law connecting the two phenomena is deduced from van der Waal's theory. As a further application of this theory, it is shown that in consequence of certain coincidences between the real border-curve and the hypothethical border-curve, the critical point of the maximum mixture may be determined in exactly the same way as for a single substance. A remark is added with regard to the condensation of such substances as exhibit changes of molecular systems. If an association takes place of molecules to more complicated systems, van der Waal's formula does not apply. Dr. S. P. Thompson asked whether diagrams characteristic of cyanogen had been obtained. Its remarkable polymerism suggested an interesting case for critical phenomena. Dr. Kuenen thought such a substance might be worth investigation.—A paper by Dr. Barton, on the attenuation of electric waves in wires, was taken as read.—Mr. G. F. C. Searle read a paper on the steady motion of an electrified ellipsoid. The first part of the investigation is printed in the *Phil. Trans. Roy. Soc.*; it contains the principles required in the solution of problems with respect to moving electrical charges. The second part, now presented to the Physical Society, deals with the motion of a charged ellipsoid; the treatment is entirely mathematical. When any system of electric charges moves with uniform velocity through the æther, the electro-magnetic field, referred to axes moving forward with the charges, can be completely defined by means of a quantity of which the electric force and the magnetic force are simple functions. Another vector concerned in the problem is the mechanical force experienced by a unit charge moving with the rest of the system. A distribution of electricity on the surface of a charged body such as to give zero distribution at all points inside the surface is an equilibrium distribution. Since the mechanical force vanishes inside the surface, it is shown that on the outside of the surface the mechanical force is perpendicular to the surface, and the above-mentioned function is constant over the surface, and the distribution on an ellipsoid is the same for motion as for rest. When a charged sphere is at rest it produces the same effect as a point-charge at its centre. If the sphere is in motion it produces the same effect as a uniformly-charged line whose length bears to the diameter of the sphere the same ratio as the velocity of the sphere bears to the velocity of light. When the sphere moves with the velocity of light, the line becomes the diameter of the sphere; the same is true for an ellipsoid. At the velocity of light, the charge on any surface is in equilibrium, whatever the distribution. The force between two charges moving with the speed of light, is zero. The lines of electric force for a charged sphere in motion are not radial; they form a series of hyperbolas. The author proceeds to calculate the total energy possessed by an ellipsoid when in motion along its axis of figure. Expressions are given (1) for the energy of a Heaviside ellipsoid; (2) for a sphere; and (3) for a very slender ellipsoid. In all cases the energy becomes infinite when the charges move at the velocity of light. It would seem impossible to make a charged body move at a greater speed than that of light. Prof. Perry said the paper would help to solve many problems connected with the effect of the rotation of the earth upon electrical surface charges. An expression might be found for the mechanical and magnetic forces due to the motion of a charge at any point of the earth's surface. At the equator a point moves at different velocity at midday to its midnight velocity; it may now be possible to determine the magnetic and mechanical effects due to electrical charges at equatorial points. Mr. Blakesley asked whether, in calculating the mutual action of two charged particles, proceeding at the velocity of light, it was assumed that the lines of motion were parallel. Mr. Searle said he had always considered parallel lines of motion; he could not say whether the force would be zero in any other case. The results arrived at in the paper could be applied to problems connected with distributions of terrestrial charges.—The President proposed votes of thanks to the authors; the meeting then adjourned until November.

Chemical Society, June 3.—Prof. Dewar, President, in the chair.—The following papers were read:—On the thermal phenomena attending the change of rotatory power of freshly-prepared solutions of certain carbohydrates; with some remarks on the cause of multirotation, by H. T. Brown and S. Pickering. Freshly prepared solutions of dextrose, lævulose, and milk-sugar contain the sugar as an unstable α-modification, which gradually changes into a stable β-modification; this change is made apparent by a change of specific rotation, and, as the authors show, is accompanied by evolution of heat, the quantity of which has been measured.—On the thermo-chemistry of carbohydrate-hydrolysis: (1) The hydrolysis of starch by vegetable and animal diastase; (2) the hydrolysis of cane-sugar by invertase, by H. T. Brown and S. Pickering. The authors have determined by direct measurement the heat evolved in the hydrolysis of starch by malt-diastase, pancreatic-diastase, Taka-diastase and saliva, and in the hydrolysis of cane-sugar by invertase.—Optical inversion of camphor, by F. S. Kipping and W. J. Pope. It is shown that during the sulphonation of *d*-camphor, part of it is converted into *l*-camphor.—Derivatives of camphoric acid. Part ii. Optically-inactive derivatives, by F. S. Kipping and W. J. Pope.—Racemism and pseudoracemism, by F. S. Kipping and W. J. Pope. The authors show that a number of apparently racemic compounds really consist of intercalations of crystals of the two enantiomorphously related components; the term pseudoracemic is applied to such substances of which several are described in detail.—Note on some new gold salts of the Solanaceous alkaloids, by H. A. D. Jowett. Hyoscine hydrobromide combines with auric chloride and bromide, giving salts of the composition X, HBr, $AuCl_3$ and X, HBr, $AuBr_3$.—Production of camphenol from camphor, by J. E. Marsh and J. A. Gardner. Camphenol, an isomeride of camphor, is obtained by the action of strong sulphuric acid on chlorocamphene, camphene dichloride, and turpentine dihydrochloride.—Preliminary note on the oxidation of fenchene, by J. A. Gardner and G. B. Cockburn. Cis-camphopyric acid is produced on oxidising fenchene with dilute nitric acid.—Apiin and apigenin, by A. G. Perkin. The author produces experimental evidence which renders it probable that apigenin is a hydroxy-derivative of chrysin, the colouring matter of poplar buds.—Rhamnazin, by A. G. Perkin and H. W. Martin.—Experimental verification of van 't Hoff's constant in very dilute solution, by M. Wildermann.—The isomeric dibromoethylenes, by T. Gray. The author has been unsuccessful in his attempts to prepare a stereo-isomeride of ordinary symmetrical dibromoethylene; he considers the latter to be the trans-compound.

Entomological Society, June 2.—Mr. R. Trimen, F.R.S., President, in the chair.—The President referred to the great loss which the Society had sustained by the death of Dr. Fritz Müller, one of its Honorary Fellows, and to his distinguished services in the cause of entomological science, and especially in forwarding the theory of the origin of species.—Dr. Chapman exhibited the larva of *Eriocephala allionella*.—Mr. Jacoby exhibited a fine example of the large Hepialid, *Leto venus*, from Plettenberg Bay, South Africa. The President said that the insect afforded an interesting case of localised distribution, being confined to an area of about fifty by fourteen miles, whereas the larva fed in the wood of *Virgilia capensis*, a common and widely-distributed leguminous tree. The insect was very conspicuous, and could not have been overlooked in other localities.—Mr. Burr showed a pair of gynandromorphous earwigs, *Chelisoches* *morio*, Fabr., from Java, with ordinary males and females for comparison. In both specimens the right branch of the forceps was of the male, and the left branch of the female form.—The Hon. Walter Rothschild exhibited a series of specimens of *Eudæmonia brachyura*, Drury, and *E. argiphontes*, Kirby, to show the differences between these two West African Saturniid moths. The distinctness of the latter species had been doubted, as until recently it was only known by the unique examples in the Dublin Museum, and the three published figures of these were materially different from each other. A comparison of the series exhibited showed the two species to be abundantly distinct.—Mr. Kirkaldy exhibited fifty specimens of *Notonecta glauca*, Linn., to show the extreme range in size and colour of this widely-distributed species.—The discussion on mimicry and homœochromatism in butterflies was then resumed by Dr. Dixey, who replied to the comments of Prof. Poulton and Mr. Blandford on his paper. He did not regard the phenomenon of reciprocal convergence as necessarily a demonstrable feature in Müllerian mimicry; it was merely potential. With respect to mimetic Pierinæ, he did not consider that they were invariably protected, but that, in certain cases, they were shown to be so by the indications of convergence exhibited by the models. Mr. Elwes thought, from his personal experience as a collector, that there was too much assumption about both the Batesian and Müllerian theories. In many supposed cases he doubted whether the so-called models were protected by taste or smell. He had previously referred to the extraordinary superficial resemblance between two Pieridæ found in the high Andes of Bolivia, and two others found at similar elevations in Ladak, and was inclined to think that similar conditions of environment produced similar effects. Mr. J. J. Walker, Sir George Hampson, and Colonel Yerbury gave evidence, from personal experience in the Tropics, as to the extreme rarity of butterfly-destruction by birds. The President admitted its rarity in Africa, but stated that he had seen birds, especially the Drongo shrike, chasing butterflies. Mr. Blandford called attention to a recent paper by M. Piepers, who, as the result of twenty-eight years' observation in the Malay region, had seen four instances only of butterflies, two of which belonged to the "protected" genus *Euplœa*, being attacked by birds, and had been driven to the conclusion that the phenomena of mimicry had nothing to do with natural selection.—Papers were communicated by the Rev. F. D. Morice, on new or little-known Sphegidæ from Egypt, and by Prof. J. R. Grote, on changes in the structure of the wing of butterflies.

Geological Society, June 9.—Dr. Henry Hicks, F.R.S., President, in the chair.—The Cretaceous strata of County Antrim, by Dr. W. Fraser Hume. The paper, which dealt with the Irish Cretaceous strata, was divided into four parts, viz.: I. A detailed account of the principal subdivisions, their local distribution, and characteristic fossils. The area occupied by these rocks is separated into five divisions, each marked by special lithological and palæontological features. The main lithological features are displayed in sections between Lisburn and Belfast; they are (1) glauconitic sands (a blue-green rock rich in glauconite); (2) glauconitic marls; (3) yellow sandstones (a light calcareous sandstone); (4) chloritic sands and sandstones of the *Exogyra columba*-zone (yellow-green sands and sandstones); and (5) white limestone. II. Chemical and micromineralogical examination of the lithological types. The glauconitic sands are characterised by the abundance of glauconite (23 per cent. $CaCO_3$), showing evidence of having been formed in the interior of foraminiferal shells; the glauconitic marls by an abundance of spheres and rods of pyrites; the yellow sandstones by a series of heavy minerals, notably rutile, zircon, tourmaline, kyanite, and perfectly-formed crystals of garnet; the *Inoceramus*-zone contains delicate glauconitic mesh-works of hexactinellid sponges and silicified portions of *Inoceramus* and brachiopoda, besides an abundant series of heavy minerals: in the chloritic chalk above the glauconitic sponge-casts become very abundant, associated with delicate casts of foraminifera; the white limestone itself has scarcely any residue. The analyses show that the percentage of carbonate of lime increases steadily from base to summit, the glauconitic marls alone being an exception. III. This section dealt with the stratigraphical conclusions. IV. General questions.—An account of the Portraine inlier, by C. I. Gardiner and S. H. Reynolds.—Some igneous rocks in North Pembrokeshire, by J. Parkinson.

Zoological Society, June 15.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—Dr. Arthur Keith exhibited a series of lantern-slides showing the arrangement of the hair and some other points of interest in the Orang-Outang (*Simia satyrus*) that had lately died in the Society's Gardens.—Mr. Oldfield Thomas read an account of the mammals obtained by Mr. John Whitehead during the last three years in the Philippine Islands. During this expedition the peculiar mammal-fauna of the mountains of northern Luzon had been discovered, and Mr. Thomas had already described no less than five new genera and eight new species belonging to it. The paper read contained a detailed account of the whole of Mr. Whitehead's collection.—A communication was read from Prof. T. W. Bridge, on the presence of ribs in *Polyodon* (*Spatularia*) *folium*.—Mr. R. I. Pocock read a paper on the spiders of the suborder *Mygalomorphæ* from the Ethiopian region contained in the collection of the British Museum. Many new genera and species were described, the most interesting being the new genus *Cyclotrematus*, containing two new species collected in Mashonaland by Mr. J. ffolliott Darling, *Stasniopus oculatus*, sp. nov., from Bloemfontein, and *Moggridgea whytei*, sp. nov., obtained by Mr. A. Whyte on the Nyika Plateau. The discovery of new stridulating organs, consisting of modified setæ, lying between the mandible and the maxilla in *Harpactina*, was also alluded to.—A communication was read from Miss Emily M. Sharpe on the butterflies collected in the neigbourhood of Suakim by Mr. Alfred J. Cholmley. Thirty species were enumerated, and the localities where the specimens were collected and the dates of their capture were recorded.—A communication was read from Mr. Walter E. Collinge, describing two new slugs of the genus *Parmarion* from Borneo, viz. *P. everetti* and *P. intermedium*.—A communication was read from Dr. Alphonse Dubois, containing notes on certain specimens of birds in the Brussels Museum, and describing a supposed new species of woodpecker from Borneo, proposed to be called *Tiga borneonensis*.—A communication from Mr. D. J. Scourfield contained some preliminary notes and a report on the Protozoa, Tardigrada, Acarina, and Entomostraca collected by Dr. J. W. Gregory during his expedition to Spitzbergen in 1896.—A communication from Mr. David Bryce contained a report on the Rotifera collected by Dr. Gregory's expedition in Spitzbergen.—Mr. G. A. Boulenger, F.R.S., gave a list of the reptiles and batrachians collected in Northern Nyasaland by Mr. Alex. Whyte, and presented to the British Museum by Sir Harry Johnston, K.C.B. Thirty-six species of reptiles and fifteen species of batrachians were enumerated, of which the following were described as new:—*Lygosoma johnstoni*, *Glypholycus whytii*, *Anthroleptis whytii* and *Hylambates johnstoni*.—Dr. Fowler communicated a paper on the later development of *Arachnactis albida* (M. Sars) and on *A. boweni*, sp. nov., being the third instalment of the "Contributions to our Knowledge of the Plankton of the Faeroe Channel."

Royal Meteorological Society, June 16.—Mr. E. Mawley, President, in the chair.—A paper, by Mr. R. C. Mossman, on the non-instrumental meteorology of London, 1713–1896, was read by the Secretary. The author has gone through the principal meteorological registers and weather records kept in the metropolis, and in this paper discusses for a period of 167 years the notices of thunderstorms, lightning without thunder, fog, snow, hail and gales. The average number of thunderstorms is 9·7 per annum, the maximum occurring in July, and the minimum in February. The average number of fogs is 24·4, and of "dense" fogs 5·8 per annum. The decadal means show that there has been a steady and uninterrupted increase of fog since 1841. The average number of days with snow is 13·6 per annum. The snowiest winter was that of 1887–8, with forty-three days, while in the winter of 1862–3 there is not a single instance of a snowfall. The mean date of first snowfall is November 9, and of last snowfall March 30. Hail is essentially a spring phenomenon, reaching a maximum in March and April; the minimum is in July and August. The average number of days with hail is 5·9 per annum.—Mr. C. Harding gave an account of the hailstorm which occurred in the south-west of London on April 27. This accompanied a thunderstorm, in which the lightning was very vivid. The hail lasted only about twenty minutes, from 6.30 to 6.50 p.m., and in that short space of time the melted hail and rain amounted to about an inch of water. The districts affected by the hail were Tooting, Balham, Streatham, Tulse Hill, and Brixton. The ground was quite white with the hailstones, which in some places remained unmelted the whole of the next day. Much damage was done to fruit-trees and shrubs.

PARIS.

Academy of Sciences, June 21.—M. A. Chatin in the chair.—On the Abelian functions, by M. H. Poincaré.—Expression of the small transverse components of velocity in the gradually varied outflow of liquids, by M. Boussinesq.—Note on the seventh volume of the "Annales de l'observatoire de Bordeaux," by M. Lœwy.—Examination of some spectra, by M. Lecoq de Boisbaudran. A discussion of some points raised by MM. Eder and Valenta on the spectrum of gold.—Note by M. Pomel accompanying the presentation of his work on the "Mammifères quaternaires fossiles algériens, monographie des Porcins."—M. Hatt was nominated a member in the Section of Geography and Navigation, in the place of the late M. d'Abbadie.—On the universal deluge, by M. F. E. Paumier.—On the movement of the perihelia of Mercury and Mars, and of the node of Venus, by M. Simonin.—On the surfaces which can, in several different movements, develop a family of Lamé, by M. Eugène Cosserat.—Observations by M. Darboux on the preceding communication.—On a class of hyperabelian functions, by M. H. Bourget.—On certain equations analogous to differential equations, by M. C. Bourlet.—Observations on the preceding communication, by M. Appell.—On a class of ds^2 of three variables, by M. Levi-Civita.—Application of photography to the measurement of indices of refraction, by MM. Auguste and Louis Lumière. The plate, the refractive index of which is to be measured, is coated very thinly with the sensitive emulsion. It is then faintly illuminated by rays from a point (a minute hole in a sheet of metal). Under these circumstances a halo is produced, arising from reflexion at the back of the plate, the edges of which are quite sharp, and whose diameter determines the refractive index. To apply this method to the measurement of the refractive index of liquids, the back of the plate is wetted with the liquid, and backed with a piece of black velvet soaked in the same. Data are given for water and glycerine.—On a new self-registering apparatus for submarine cables, by M. Ader. The improvements consist of devices for reducing the inertia of the moving parts. The wire carrying the cable current forms part of a minute dynamometer, placed in a powerful magnetic field formed by a permanent magnet. The oscillations are recorded photographically; a practical trial over the Brest-St. Pierre and Marseilles-Algiers cables showed that the number of signals transmitted per minute was from 1·5 to 2·7 times that of the maximum obtainable by the Kelvin recorder.—On a new electrolytic condenser of large capacity and on an electrolytic current rectifier, by M. Ch. Pollak. By passing firstly an alternating current and then a continuous current between aluminium electrodes in an alkaline solution, the plates become coated with an extremely thin crystalline deposit of oxide, which is practically non-conducting. A condenser is thus obtained in which the oxide film acts as the dielectric, and the extreme thinness of this film is the cause of its very high capacity.—Double and triple lines in spectra produced under the influence of an external magnetic field, by M. Zeeman.—On the sulpho-antimonites of potassium, by M. Pouget.—On the fluidity of fused nickel, by M. Jules Garnier.—Combinations of tellurium iodide and bromide with the corresponding hydracids, by M. R. Metzner.—The electrolytic analysis of brass and bronze, by M. Hollard.—The reaction between formaldehyde and potash, by M. Delépine. A thermo-chemical study.—Destruction of organic matter in toxicological researches, by M. A. Villiers. The use of manganese salts with a mixture of hydrochloric and nitric acids is recommended.—On caffotannic acid, by MM. P. Cazeneuve and Haddon.—Coleopterine, a red pigment in the wing shells of some Coleoptera, by M. A. B. Griffiths.—On the decolorisation of wine; new interpretation based upon the function of iron salts, by M. H. Lagatu.—On the subrenal capsules, the renal organs, and lymphoidal tissue of lophobranchial fishes, by M. E. Huot.—On a new Copepod, by M. Émile Brumpt. The new species is found as a parasite of *Polycirrus aurontiacus* (Grube), and is named *Saccopsis Alleni*.—Action of mineral salts upon the development and structure of some gramineæ, by M. Ch. Dassonville. The graminaceæ studied, when they were cultivated in pure water, showed a more feeble development in all the tissues, but a much greater lignification.—On the propagation of *Pseudocommis vitis* (Debray), by M. E. Roze.—On the discovery of new strata containing fossils of mammals in the Island of Corsica, by M. Charles Depéret.—On some localisations of morphine in the organism, by MM. A. Antheaume and A. Mouneyrat.—New experiments on nerve irritation by electric rays, by M. B. Danilewsky.—The diurnal oscillatory movement of the atmosphere, by M. Dechevrens.—On the tornado of June 18, at Asnières, and the storm phenomena observed on the same day, by M. Joseph Jaubert.—On the tornado of June 18, by M. Léon Teisserenc de Bort.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Yew Trees of Great Britain and Ireland: Dr. J. Lowe (Macmillan).—Elektrische Ströme: Prof. E. Cohn (Leipzig, Hirzel).—The New Africa: Dr. A. Schulz and A. Hammar (Heinemann).—The Life-Histories of the British Marine Food-Fishes: Prof. McIntosh and A. T. Masterman (C. J. Clay).—Lectures on the Action of Medicines: Dr. T. Lauder Brunton (Macmillan).—Botanische Wanderungen in Brasilien: Dr. W. Detmer (Leipzig, Veit).—Ostwald's Klassiker der Exakten Wissenschaften, Nr. 86, 87 (Leipzig, Engelmann).—Monthly Current Charts of the Atlantic Ocean (London).—Die Mechanik in Ihrer Enwickelung: Dr. E. Mach (Leipzig, Brockhaus).—L'Année Biologique, Première Année 1895 (Paris, Schleicher).—Macmillan's Geography Readers, Book 4 (Macmillan).—Thirty Years of Teaching: Prof. L. C. Miall (Macmillan).

PAMPHLETS.—Die Gesetze der Rotationselemente der Himmelskörper: C. A. Lilje (Stockholm).—The Extinction of War, Poverty and Infectious Diseases (Truelove).—The Science of Speech: A. M. Bell (Washington).

SERIALS.—Engineering Magazine, June (Tucker).—Botanische Jahrbücher, Dreiundzwanzigster Band, 4 Heft (Leipzig, Engelmann).—Journal of the Institution of Electrical Engineers, June (Spon).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1897, Part 1 (Philadelphia).—Sitzungsberichte der K. B. Gesellschaft der Wissenschaften, Math. Naturw. Classe, 1896, i. and ii. (Prag)—Twentieth Annual Report of the Connecticut Agricultural Exploration Station (New Haven)—Archives of Skiagraphy, No. 4 (Rebman).—Good Words, July (Isbister).—Sunday Magazine, July (Isbister).—Longman's Magazine, July (Longmans).—Humanitarian, July (Hutchinson).—Aus dem Archiv der Deutschen Seewarte, xix. Jahrgang, 1896 (Hamburg).—Séances de la Société Française de Physique, 1895, 4e Fasc. (Paris).—Transactions of the Leicester Literary and Philosophical Society, Vol. iv. Part 8 (Leicester).—Manchester Microscopical Society, Transactions and Annual Report, 1896 (Manchester).—Reliquary and Illustrated Archæologist, July (Bemrose).—Contemporary Review, July (Isbister).

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