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

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

THURSDAY, MAY 3, 1894.

'HE MODERN INCANDESCENT ELECTRIC LAMP.

'he Incandescent Lamp and its Manufacture. By Gilbert S. Ram. (London: *The Electrician* Printing and Publishing Company, Limited.)

NOW the Swan-Edison monopoly is a thing of the past, the manufacture of incandescent lamps ; assuming considerable proportions; consumers are lready deluged with applications for orders by con-nental firms, and it is to be hoped that we shall not ›ng be obliged to send abroad for what can so easily be ıade in our own country. The information in this book ; of a unique and valuable nature, and the author seems › have a thoroughly practical acquaintance with the ıbject, and goes into minute details when dealing with ll the different branches of the manufacture. Indeed trade secretism" seems to have been abolished in these ages, and the wealth of technical information here met ·ith will go far towards the production of a more efficient ımp than those at present in use.

Chapter i. treats of the filament, and after briefly touch-ıg on the early efforts to produce lamps with incandescent latinum, and the possibilities of making use of some of ıe metallic oxides, the author passes to the consideration f carbon filaments now used. It is here noted that great improvements may yet be looked for in the carbon self." This is a matter of supreme importance, for the ıcandescent lamp is as yet in such an early stage of volution as to make it more than probable that the ·idening of the sphere of manufacture will soon bring bout an advance upon its present excellence; and lthough, as the author points out, the volatilisation of arbon in vacuo will prevent us from attaining to the rightness of the crater of an arc lamp, still there is onsiderable room for improvement. The "electrical olatilisation" or dissociation of particles of carbon from ıe filament is noted, and the conclusion is drawn that the best carbon is one which at the highest possible emperature disintegrates at the slowest rate."

The value of a lamp from the consumer's point of view must now be modified, since, by the lowering of the price to 1s., the filament can be run at a much higher temperature; for although the life will be thus reduced, this will be more than compensated by the smaller quantity of current used.

The materials at present used for the production of carbon filaments—silk, hair, wood fibre, cellulose—are described, and then chapter ii. begins with the practical preparation of filaments. Swan's process for the parchmentising of cotton thread is taken first, and a good working sketch is given of an apparatus for producing the thread, together with full instructions for the manipulation and drying. Details are also given of the jewelled draw-plates used for bringing down the dried thread to a uniform diameter. This process is the one to which the author devotes most attention. Other processes, such as those in which zinc chloride, furfurol, cuprammonia, pyroxyline and bamboo are used, are mentioned with more brevity.

Carbonisation is very fully treated of, and excellent drawings are given of frames and blocks for holding the filaments during heating. The furnace is then considered, and a drawing is given of a convenient form of carbonising furnace, the chapter closing with instructions for removing the fragile carbons from their frames.

Chapter iv. treats of mounting the filaments on their leading-in wires, and after describing the early form of crayon holder used by Swan, the carbon tube of Lane Fox, and the bolt and nut of Maxim, he passes on to the perfection of all joints—that of deposited carbon. Drawings are shown of machines for making this joint, both in the "socket" and "butt" form, and minute instructions are given for depositing the carbon on the junctions, particularly from a liquid hydrocarbon. That recommended is a mixture of four parts kerosine to one part turpentine.

The next chapter goes thoroughly into the subject of "flashing." Touching briefly on the early days when carbon was deposited on the filament to remedy defects in their uniformity and remove bright spots, the author gives as the reason why it is still necessary to use the process "that the carbon deposited by the flashing process under certain conditions is much more durable than any that can be produced by any other methods." The various means that have been proposed and used for producing the deposit are then shown, and drawings are given for an apparatus for "coal gas flashing" at atmospheric pressure. It is, however, recommended that the pressure should be reduced, as otherwise there is danger of getting a soft deposit. A detailed description is next given with drawings of an apparatus for flashing in "pentane" vapour at reduced pressure. Different methods for flashing filaments to a uniform resistance or candle-power are described, and it is noted that the specific resistance of hard white carbon deposited from pentane is one-tenth that of carbon deposited from amyloid. Several pages are given to a consideration of the best thickness for the deposited carbon, and a curve diagram is given, showing the effect of reduction of resistance due to flashing for filaments of various diameters.

In chapter vi. are given useful formulæ for finding the sizes for filaments for lamps of various candle-powers, with either round, flat, square, or tubular filaments, based on the data obtained from amyloid carbon with unpolished surface. In connection with tubular filaments, the fallacy of supposing them to be more economical than the solid form "because all the power is used in heating the surface," is explained.

Chapter vii. gives the sizes necessary for the production of lamps of various candle-powers, using flashed filaments. This is far more difficult than in the case of unflashed carbons, and instead of giving the cumbrous formula necessary, a number of different cases are worked out separately, and the results given in a series of curves from which the sizes for any other candle-power can be quickly obtained. At the conclusion of this chapter, the author alludes to a very amusing instance of what he calls the "happy-go-lucky" method of working that he encountered in a factory some few years ago. The name of the works in question is not divulged, and as he speaks of it being in a country where "very badly matched lamps" could be sold as of the same voltage, we hope England is not responsible. We thoroughly endorse his opinion that the most carefully made lamps, even though the price may be higher, will prove the cheapest in the end. This is a point in the manufacture of lamps which deserves more attention than is usually given to it, and a thorough grasp of the contents of these chapters will be of great value to anyone intending to take up the subject seriously. The aim of the manufacturer should be to turn out the most perfect lamp possible, and one in which the limit of endurance has been attained. Practice will then reduce the cost of production.

Chapter viii. contains a brief description of various gauges used for measuring the diameters of filaments. Although it is not mentioned, we should think the beautiful little instrument used for measuring the thickness of microscopic cover glasses would answer the purpose admirably.

A chapter is devoted to glass-making, including a list of ingredients necessary for the manufacture of lead glass, the kind of pots for melting the "metal" in, and a short description of the method of blowing "pot-bulbs" in a mould. Glass-blowing is fully gone into, and, after describing the playful way in which the old-fashioned orthodox glass blowers "spoiled" the electricians in the early days of lamp-making, we come to the invention of the glass-blowing machine, and the final springing into existence of a race of girl glass-blowers free from the vices of drink, strikes, and "Saint Monday."

We then have a few pages with illustrations showing the various forms of blowpipes, ending with practical instructions for making lamp bulbs from glass cylinders. This is given somewhat briefly, doubtless owing to the fact that it is pretty evident that the day is not far distant when this method of forming bulbs will entirely give place to the quicker and more suitable method of "pot-blowing."

Chapter xi. is headed "Sealing in," and contains some good drawings and descriptions of the methods used for fixing the filaments in the glass bulb. The small annealing oven to stand on the workman's bench, and receive the lamps as they are finished, is a very useful piece of apparatus, and is a great advance upon the old method of holding the work in a smoky flame, a practice which is not only dirty, but wastes both time and gas.

Touching upon glass grinding and the manufacture of taps, it is remarked that good taps can be bought cheaply made of German glass, but there is very great difficulty in joining them to the lead glass used in the exhausting apparatus. It is not generally known that this can be easily and effectually done by interposing between the German and the lead glass a thin stratum of soft white enamel or "arsenic" glass, used as a solder. Compound joints made in this way are perfectly sound, and are not at all liable to crack.

The important subject of exhausting is treated of in chapter xii. and it is pointed out that to produce a good lamp a high vacuum is absolutely necessary. The reasons against leaving a residual atmosphere of nitrogen or other inert gas are discussed, and then follows a complete description of the various forms of mercurial pumps in use. Several kinds of short-legged pumps are shown and described in detail. The "Sprengel pump" does not hold the prominent place it occupied some years ago, preference being given to the various forms of Geissler pump. The reason for this may lie in the great number of india-rubber joints that appear to be used. This way of making pumps always gives constant trouble through leakage, and poor efficiency is unavoidable. We cannot agree with the author that india-rubber joints are to be allowed. There is no doubt that india-rubber joints are almost universal in modern lamp factories, but we have equally little doubt that the short life of many of the lamps now on the market is due to imperfect exhaustion; and having had considerable experience in high vacua, we have no hesitation in saying that a vacuum sufficiently good for a long-lived incandescent lamp can only be obtained if all the joints are hermetically sealed together. We have still in use lamps dating from 1882 exhausted properly with sealed joints, and they have outlived generations of bought lamps made with the use of india-rubber joints.

For testing the vacuum the McLeod gauge is noted, but is not considered to be of much use to the lamp-maker. The size of the bubble in the chamber of the "Geissler," and the appearance and "hammer" of the mercury in the legs of the "Sprengel," are taken as sufficiently good indications for the purpose. This certainly savours of the "rough and ready" method, but in the absence of any good indicator it probably answers the purpose. The coil test is mentioned, but it is very properly pointed out that the appearance of the luminosity in an exhausted bulb is not "under all conditions an indication of the state of the vacuum."

A good chapter is devoted to the testing of voltage and candle-power. The methods of using the photometer are fully described; the "Harcourt" pentane lamp is said to make the most trustworthy standard, but for regular factory use an argand burner with a Methven screen is recommended. This is occasionally tested with the pentane lamp. Then follows a full description, with drawings, of Evershed's wattmeter; and the chapter closes with a method of finding the mean horizontal candle-power of lamps with either flat or cylindrical filaments.

A short description is given of the method of capping the finished lamp. The author finds that the addition of a small percentage of dextrine to the plaster of paris makes a very hard cement, and he warns makers against using an acid flux for soldering the wires and connections. Nothing but rosin should ever be used.

In the chapter on efficiency and duration, allusion is made to the expression "watts per candle-power," instead of the more correct term "candle-power per watt," pointing out that it is more easy to grasp the meaning of a certain number of watts than of a particular fraction of a candle-power. In connection with duration tests, it is very justly said that "life tests pure and simple" are worthless unless the actual candle-power of the lamp at different periods of its life are given.

In the life of a lamp the advantage of the hard coating of deposited carbon shows itself. This hard carbon, combined with a good vacuum, greatly retards the falling off of candle-power due to the blackening of the bulb. It is explained that the disintegration of the carbon acts in three ways. Firstly, by coating the glass with deposited carbon and thus obscuring the light; secondly, by altering the surface of the filament and increasing its emissivity so that it is at a lower temperature; and thirdly, by increasing its resistance so that it takes less current. The data of experimental tests on several lamps for efficiency and duration close the chapter.

The last chapter takes up the relation between light and power in incandescent lamps, and details are given of the recent tests made under the direction of Prof. Ayrton at the City and Guilds of London Institute, with drawings of curve diagrams showing the candle-power and watts of lamps of various makes, up to the breaking point. In conclusion it is said that the ideal lamp would be one in which the radiation is wholly luminous, and that the carbon incandescent lamp falls very short of this desirable consummation. Brief reference is made to the beautiful experment of Nicola Tesla.

On the whole, readers will find the book to be of very considerable interest, dealing as it does with an entirely new industry of very great elegance; and the practical knowledge diffused by its publication will certainly help to advance the evolution of an efficient lamp which can be sold for a reasonable price.

ALGEDONICS.

Pain, Pleasure, and Æsthetics; an Essay concerning the Psychology of Pain and Pleasure, with special reference to Æsthetics. By Henry Rutgers Marshall, M.A. (London: Macmillan, 1894.)

ALGEDONICS is the term which Mr. Marshall suggests for the science of pain and pleasure. In his sixth chapter he gives the derivation of the term thus: "ἄλγος, pleasure; ἡδονή, pain"; the discovery of which, when he glanced over the pages of the completed volume, must, we fear, have given him an algedonic thrill. There is good stuff in the work, and the author is evidently well up in the literature of his subject.

In the first chapter, on the classification of pleasure and pain, Mr. Marshall discusses the psychological status of algedonic states. He argues, successfully we think, against the view that pleasure and pain are psychical elements *sui generis* with special nerves and specialised cerebral centres; and for the view that they are due to algedonic tone associated with any or all of the psychical elements. "Pleasures and pains," he says, "may be differential qualities of all mental states of such nature that one of them must, and either of them may, under proper conditions, belong to any element of consciousness." In his discussion, however, he does not bring out the fact, which is readily explicable on his view, that in popular speech we apply the term pain to the somewhat heightened affections of common sensibility, even when these affections are pleasurable. If, for example, we lightly touch a slight bruise, we term the sensation pain; but such "pain" may be, if we can trust our own experience, distinctly pleasurable. Since the fibres by which impulses from the nerve endings of common sensibility are transmitted, have special cortical endings, and seem to run, in part at least, along different tracts or in a different manner in the spinal cord, some colour has been lent to the view, that there are specialised fibres and centres for pain. If, however, such "pain" is merely the algedonic tone of common sensibility (as hinted, but not in so many words, by Mr. Marshall, on p. 18), these observations are quite in accordance with the view which our author advocates. Mr. Marshall quotes Mr. Herbert Spencer's opinion that "a relation proves itself to be itself a kind of feeling—the momentary feeling accompanying the transition from one conspicuous feeling to another." The word "feeling" is here used in its most general sense as an affection of consciousness. But Mr. Marshall appears to miss the importance of the fact that such feelings of relation have their algedonic tone no less than sense-impressions, a realisation of which would, we think, have helped him in his consideration of æsthetics.

In accordance with the view adopted in chapter i., we find that the emotions are regarded in the second chapter as deriving their character from the algedonic tone of complex co-ordinations of motor activity. Describing the psychological equivalents of these complex co-ordinations as, in their sensation aspect, "instinct-feelings," he regards them in their algedonic aspect as emotions. But here again he is rightly anxious to lay stress upon the fact, that the emotions, like pleasure and pain, are not something apart from but are inseparably bound up with sensory complexes. It is probable that the difficulty or impossibility of the psychological analysis of emotional states is due to the fact that their synthesis is effected in the physiological field below the threshold of consciousness, so that consciousness can deal only with the net result of inherited physiological co-ordinations—a view which is, again, in full accord with Mr. Marshall's own conclusions.

We must pass over the interesting discussion of "a group of co-ordinated activities tending to bring about attraction of other individuals," which Mr. Marshall terms the art-impulse, artistic creation having this end in view, though not cognised as the end. His contention is to some extent corroborated by that thirst for appreciation and recognition which forms part of the artistic temperament, and it harmonises with many observations on animal activities.

Coming now to the field of æsthetics, the author seeks to find some criterion by which æsthetics may be differentiated from algedonics. The conclusion to which he is led is as follows:—"That object is to be considered beautiful which produces a psychosis that is permanently pleasurable in revival," while "that object is to be considered ugly which produces a psychosis that is permanently disagreeable in revival." Thus "only those pleasures are judged to be *æsthetic* which (relatively speaking) are permanently pleasurable in memory." We believe that the author is here on the road to, but falls somewhat short of, the true criterion of æsthetics. The key of the problem, we think, lies in the recognition of the algedonic tone of *perceived relations*. It is this superadded element which raises the algedonics of sensory experience to the level of æsthetics. The æsthetic effect of the geometrical tracery in the chapter-house of Wells Cathedral is due to the emotional tone associated with perceived relationships. And it is just because in memory the relationships with their emotional tone are more abiding than the sense-elements, that to be permanently pleasurable in revival becomes a criterion of æsthetics. This criterion is, however, secondary. The primary criterion is the perception of relations with its associated emotional tone.

It is difficult to do justice, in the short space which remains to us, to the author's views as to the physical basis of pleasure and pain. These primitive qualities of psychical states are conceived to be "determined by the relation between activity and capacity in the organs, the activities of which are concomitants of the psychoses involved." When an organ during rest has stored up energy, the response of the organ to stimulus is pleasurable. But when the organ is spurred to activity beyond the limits of its stored up energy, its functioning is painful. "Pleasure thus results when the balance is on the side of the energy given out, and pain when the balance is on the side of the energy received. Where the amounts received and given have equivalence, then we have the state of indifference." We have seen that Mr. Marshall does not accept the hypothesis that there are separate end organs, nerve fibres, or cerebral centres for pleasure and pain. Unless, therefore, there is a qualitative difference in the impulse transmitted from an organ according as it is well-stored with energy or exhausted, a position which is hardly tenable, the algedonic tone must be due to quantitative difference that is to say, difference in the intensity of stimulus. Hence it would be better, so far as the organ is concerned, to lay the primary stress on the intensity of stimulus therefrom, and to make the state of the organ a condition of this intensity. Mr. Marshall ought also, we think, to supplement his view by reference to the condition of the cerebral centre concerned. The condition of the centre is possibly of even greater importance than the condition of the organ from which afferent impulses are transmitted. We cannot, however, further discuss the question here, and must refer our readers to the author's own treatment of the question in the fourth and fifth chapters of his work.

Although we do not agree with all his conclusions, we have no hesitation in saying that the book is written in the right spirit and on right lines. Fully aware of the necessity for careful introspection, he sees that the results so reached must be correlated with the conclusions arrived at through the investigations of the physiologist. It is only where the two modes of investigation thus go hand in hand that progress in psychology can be secured.

C. Ll. M.

OUR BOOK SHELF.

Physiology Practicums. By Burt G. Wilder, Professor of Physiology, Vertebrate Zoology, and Neurology in Cornell University, U.S.A. (Published by the Author, 1893.)

THESE consist of a series of twenty-seven plates, with accompanying descriptions (large octavo), said by their originator to embody "explicit directions for examining portions of the cat, and the heart, eye, and brain of the sheep, as an aid in the study of elementary physiology." The author is well known in anatomical circles as the founder of a notoriously ambitious terminology, not wholly destitute of useful points. The present venture has furnished him a new peg upon which to hang this, and his title savours of the kind of treatment which the subject receives at his hands. Plate xviii. Fig. 19 (which deals with the "pelvic viscera, etc." [*sic*], of the female cat), and Plate xiii. Fig. 14 (which is said to represent the "head and neck of cat partly dissected"), may be taken as fair examples. With their faulty delineation of things which may be at once determined from descriptions alone, their ugly letters sprawling over them, and their apologetic descriptions, they are useless and uncalled for; and the matter is the more nauseous, as more than one finished anatomical treatise happens to deal with this animal. We put the plates down with the feeling that they are calculated to repel rather than encourage the student, and that although they may be of service in the work of the Cornell University, in connection with which they have arisen, there would be cause for alarm should they be adopted elsewhere.

The Fauna of British India, including Ceylon and Burmah. Published under the authority of the Secretary of State for India in Council. Edited by W. T. Blanford. "Moths." Vol. ii. By G. F. Hampson. (Pp. xxii. 609, 325 woodcuts). London: Taylor and Francis, 1894.)

THE second volume of Mr. Hampson's important work on the moths of India includes the *Arctiidæ*, *Agaristidæ*, and the bulk of the *Noctuidæ*, and considerably exceeds the first volume in bulk, 1545 species being described in vol.

ii. as against 1158 in vol. i. Under *Arctiidæ* the author includes the following groups as sub-families, which have usually been treated as families by previous authors:—*Arctiinæ*, *Lithosiinæ*, *Nycteolinæ*, and *Nolinæ*. The *Agaristidæ* are a small family of handsome day-flying moths, and certainly look rather out of place in the position which they occupy in this book. The extensive family of *Noctuidæ* is divided into ten sub-families (*Trifinæ*, *Acontiinæ*, *Palindiinæ*, *Sarrothripinæ*, *Euteliinæ*, *Stictopterinæ*, *Gonopterinæ*, *Quadrifinæ*, *Focillinæ*, and *Deltoidinæ*), of which the two last are held over to the forthcoming third volume of the book.

Concerning the *Noctuidæ*, Mr. Hampson remarks, "The lowest forms are those of which the larvæ have five pairs of abdominal prolegs, and the perfect insects have vein 5 of the hind wing fully developed, and from the centre of the discocellulars, this ancestral form being only found in some *Deltoidinæ* and *Sarrothripinæ*."

As the plan of the second volume is identical with that of the first, which we had the pleasure of noticing in NATURE for February 23, 1893 (pp. 387–388), we need only add that there seems no falling off in its execution. It is hoped that the third volume, including the *Epicopiidæ*, *Uraniidæ*, *Epiplemidæ*, and *Geometridæ* will be completed in the course of the present year.

W. F. K.

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.*]

Panmixia.

MR. ROMANES has requested those students of natural history who cannot accept the doctrine of Panmixia to show the error which they believe to lie in his reasoning. I therefore ask leave to explain why I am unable to accept either the first proposition put forward by Mr. Romanes in NATURE of to-day, or the doctrine itself. Mr. Romanes says:—

The survival-mean must (*on cessation of selection*) *fall to the birth-mean*, &c. This statement involves neglect of a way in which selection may, and often must, operate. A simple example will show this. The mean height of adult Englishmen is roughly 67½ inches; and if I offer to enroll in a regiment every adult Englishman who is more than 66 and less than 69 inches high, the mean height of my regiment will, as every statistician knows, be still 67½ inches, but I shall be obliged to reject more than half the population. A form of selection, involving the destruction of more than half the population, may therefore occur without affecting the mean value of the character selected. I hope shortly to publish evidence, based on the measurement of many thousands of animals of one species, at many stages of growth, showing that selection does in fact operate in this way in particular cases. That it must so operate in many cases is obvious from the fact that many wild animals remain for several generations without sensible change in their mean character. In these cases either selection acts as I suggest, or it is incapable of affecting a change in the mean, or it does not act at all.

The second and third propositions put forward by Mr. Romanes are not demonstrated by any statistics with which I am acquainted; and with regard to the extreme statement that "*any* failure in the perfection of hereditary transmission will be weeded out" by selection in a wild state, I would urge the need, which has lately been well pointed out by Bateson, of a *quantitative* measure of the efficiency of selection. The frequency of even considerable abnormalities in specialised organs of wild adult animals, of which so many admirable examples are described in Mr. Bateson's recent work on variation, show, if it needed showing, that natural selection is in most cases an imperfect agent in the adjustment of organisms.

But my main difficulty is that neither Mr. Romanes, nor Prof. Weismann, nor any other advocate of the doctrine, has shown that in some given case Panmixia does in fact occur, and that the results predicted are in fact produced. On the other hand, Mr. Galton has shown that civilised Englishmen are themselves in a condition of Panmixia, at least with respect to several characters, especially stature and the colour of the eyes. Now the mean stature of Englishmen is known to be slowly increasing, and there is no evidence of the disappearance of coloured eyes.

My objections to the position of Mr. Romanes and others are therefore two: first, that it is based on the assumption that selection, when acting on a species, must of necessity change the mean character of the species—an assumption incompatible with the maintenance of a species in a constant condition; and secondly, that in the only case which has been experimentally investigated, the consequences said to result from a condition of Panmixia do not, in fact, occur.

W. F. R. WELDON.

University College, London, April 26.

On Some Sources of Error in the Study of Drift.

As a general rule we may feel sure that the boulders scattered over the surface of a district which consists chiefly of boulder clay, have been derived from the underlying deposit. There are, however, some cases in which the inference is unsafe. For instance, the Thames now marks the southern limit of the glacial drift—a curious circumstance, and one of which a wholly satisfactory explanation has not been given. Many think that this sharp definition of the southern limit of the glacial drift is so improbable that they would fain attribute some deposits in North Kent to the glacial period, or at any rate would expect to find a few sporadic boulders stranded on the slopes of the North Downs; and there far-transported fragments do not unfrequently occur.

But there is this great source of error. All along the lower Thames barges carry refuse and rubbish of every description from London, and this is taken, such as it is, and laid on the adjoining lands.

So you find carried on, with road scrapings, fragments of every kind of road metal; with soil turned out in digging foundations, specimens of all the materials used for building; with the contents of middens, every variety of object of domestic use or ornament. It is marvellous what large lumps get on to the land in this way. When, then, anyone produces a specimen, even a large specimen eight or ten inches in diameter, and perhaps taken out of a deep loam, the evidence is rejected. The stone may have been carried on to the land with the manure, and the loam may in that district be quite recent rain-wash. It may be that some of them were really of glacial origin, but all are equally distrusted. Some of them certainly cannot be referred to ice action. I have seen large pieces of Napoleonite found on the surface in North Kent. By what accidents they came to be there we cannot tell, but we may, at any rate, acquit the ice of having had anything to do with the transport of that peculiar Corsican rock.

When walking along the base of a cliff of boulder clay, we may generally infer that the far-travelled boulders that lie at its base have just been washed out of it. In most cases they have been; but in some, and those often the cases in which it is of greatest consequence to have the origin of the boulders clearly established, we have another serious source of error, of which I have just seen a good example.

A Norwegian vessel, carrying timber from Christiansund to Boston, in Lincolnshire, ran aground and became a total wreck off Old Hunstanton last winter. I saw her in January. The vessel looked sound enough to a landsman's eye; but she was dismasted and gutted, and the salvage was on the sand dunes close by. About her a pool of varying breadth had been formed by the swirl of the water round the hull. The currents had been deflected by various circumstances here and there, as especially where a quantity of ballast had been thrown out. This consisted of large boulders of various kinds of gneiss and porphyry, and the weighty pile looked as if it were little affected by the currents of the incoming and receding tides.

In April, I visited the spot again, expecting to find that the boulders had been driven along the shore by the fierce storms which had raged along that coast since my previous visit, and intending to make note of their dispersal and the distance to which they had travelled. I found, however, that the keel and a portion of the lower part of the wreck remained, and that the surrounding pool was greatly deepened and extended.

Through the deep clear water I saw the heap of ballast, which had been undermined and was settling down into the depths, being already far below the level of the surrounding sand. When the last of the timbers shall have yielded to the axe and the waves, the sand will soon level up the hole caused by the scour round the obstructing mass, and this heap of Scandinavian boulders will lie buried in the sand till some exceptional storm shall shift the banks, and expose them again, and perhaps transport them along the shore.

Had this vessel been thrown on a hard rocky shore instead, the ballast would have started at once with the other boulders on the shore, and been scattered, according to size and form, along the coast. As it was, however, these have got buried deep in sand, and preserved till, perhaps, the habit of using such boulders for ballast shall have been given up, and then, washed out by the accidents of weather, of coast destruction, and of shifting sand, they will appear among the fallen fragments of a boulder clay cliff, and be appealed to in proof of its origin.

How many ships with Scandinavian ballast have been wrecked along our eastern coast ever since the time of the Vikings? How many hundred tons of such boulders are still travelling round our shores?

Another source of error I observed, this spring, along the Norfolk coast near Lowestoft. A perpetually changing undercliff is formed by slips along the base of the cliffs. When the wind blows hard from the north-east, the shingle is thrown up against these broken masses, and much of it rests on the ledges and terraces at various heights above the sea. Shells are tossed up still higher, and gravel and sand from the upper part of the cliff slide and pour down, and find a resting-place here and there on its irregular face. When all these various processes are seen going on around, and the easily identified patches of recent shingle and shells or ancient sand and gravel can be observed, with their track from above, or their obvious equivalent below, there is not likely to be any difficulty. But when, in subsequent storms, landslips have covered these diversified patches with the samples of the various deposits that make up the cliffs on that changeful coast, the interpretation is not always so clear. Here we find in the boulder clay a mass of gravel with shells derived largely from the crag, there a streak of shelly sand tossed up from the recent shore, and covered by a slipped mass of boulder clay. Large boulders from the glacial drift lie side by side with others that have travelled along the shore from buildings or from wrecks; the explanation of the companionship being here and there given by the occurrence of a tobacco-pipe or the thick end of a glass bottle.

These are some of the more recent sources of error in our attempts to learn the history of deposits from their boulders. We must remember also in East Anglia that much of the drift is derived from cretaceous boulder-bearing beds, and where these appear sporadically in the drift they cannot be distinguished from others which the ice has received first hand from the parent rock—except when clear traces of glaciation have been preserved. It is not enough, therefore, to record that a boulder has been found on such a shore, or even in such a cliff, unless the observer has been careful to note the exact conditions and the surroundings of each find.

Cambridge. T. McKenny Hughes.

On the Tritubercular Theory.

In a brilliant address, read last year before the American Association for the Advancement of Science,[1] Prof. H. F. Osborn has brought together and laid before us the latest results of American research to which Mammalian Palæontology owes so much. Necessarily much space is given to the exposition of the theory of the development of the cusps of mammalian teeth. Never before has the tritubercular theory been so lucidly explained, so logically followed out; never before have its weaknesses been so obvious, its errors so plain.

Prof. Osborn first calls attention to "Cope's demonstration of the tritubercular molar as the central type in all the mammalia" as "a great step forward. In looking over the odontographies of Cuvier, Owen, Tomes, and Baume, we find there is no suspicion of this common type around which the highly diverse mammalian molars centre." Further on he states that "all the specialised mammalian series, ungulates, primates, carnivores, insectivores, rodents, and marsupials are found playing similar, yet independent adaptive variations upon one type," that of the Marsupials and Placentals "every known triassic, Jurassic, cretaceous, and basal eocene fossil (excepting Dicrocynodon) is in some stage of trituberculy," and that he is "able to bring forward evidence that the multitubercular molar instead of being primitive was derived from the tritubercular." In short, the arguments from palæontology and embryology in favour of considering the tritubercular pattern of molar as the primitive type are forcibly put before us. The place occupied by this common type amongst teeth, is compared to that held by the pentadactyle type in the morphology of the limbs of the four-footed vertebrates. What trituberculy is for the teeth, "pentadactyly has long been for the feet," and later, "the molars of the clawed and hoofed mammals can now be compared, as we compare the hand or foot of the horse with that of the cat, because they spring from a common type." At the risk of being tedious, I have thought it necessary to give all these quotations to make Prof. Osborn's position quite clear.

What is our astonishment, then, when a little further on we come upon the statement that, "upon the polyphyletic theory of the origin of the mammals here advocated [namely, the independent origin of the Monotremes, Marsupials, and Placentals from a common ancestral stock, the Pro-mammalia], we must admit, first, the independent evolution of trituberculy in different phyla; and second, the branching off of several great groups in the pre-tritubercular stages." (!) We are then told that the Prototheria, the Metatheria, the Insectivora, and the higher Placentals have all independently, and more or less rapidly, entered "into trituberculy."

How do these statements agree with the evidence mentioned above? What becomes of the comparison with foot structure? Are we to believe that the pentadactyle limb has been considered to be the common or central type, because the various vertebrate groups have acquired it independently? The words "common" and "central," as applied to a type of structure, have no significance nowadays unless equivalent to ancestral. It seems hardly necessary to point out that such mythical types hovering over organs, and compelling them to assume a certain form, have no place in modern biology. We might be willing to accept the tritubercular as a generalised, archaic, or ancestral type; but it is out of the question, at the same time, to claim that it has been independently acquired by the groups in which it occurs. Could the divergence in general structure, and habits within the Marsupials, and the Placentals, lead to a convergence to one type of tooth? And, more extraordinary still, to the same type in both cases?

Moreover, many of the mammals, which, according to Prof. Osborn, so readily pass "into trituberculy," only do so, apparently, to pass no less readily out of it. According to this theory the living forms which possess triconodont teeth, amongst the Marsupials on the one hand and the Placentals on the other, have been derived from ancestors with triconodont molars, which passed through the tritubercular, and again back into the triconodont type.

There is a very grave objection to such a fickle mode of cusp development, which seems to have escaped the notice of the supporters of the theory. All the various types of teeth met with amongst the mammalia are adaptations to particular kinds of food, and methods of feeding; the appearance or disappearance of a few cusps here and there may seem a matter of trivial importance to anyone forming a theory of cusp development, but there is no reason to think that it is so to the animal which possesses the teeth. The independent passage of all these groups of mammalia through a triconodont stage would imply, that they all and severally took to a particular kind of food (that for which the triconodont molar is an adaptation), and again their passage into a tritubercular stage would imply, that they afterwards took to another method of feeding (that for which the tritubercular molar is an adaptation). It is evident that the difficulties encountered in the attempt to derive the tritubercular tooth from a triconodon form in each group are overwhelming; we must, therefore, fall back on the supposition that the original mammalian teeth were provided with many cusps, not placed in one line, and the exact pattern of which remains still to be found.

There is much evidence for the view that the upper molars of the Pro-mammalian ancestor were of the tritubercular, and the

[1] "The R[illegible] of t[illegible] M[illegible] in N[illegible] A[illegible]." Studies from the Biol. Laboratories [illegible] College, [illegible] reprinted in NATURE, [illegible] vol. xlix. [illegible]

lower molars of the tubercular-sectorial types [1]; in fact, I think, we cannot do better than accept Prof. Cope's generalisation,[2] if not as a definitely established theory, at all events as an excellent working hypothesis, "that the superior molars of both ungulate and unguiculate mammalia have been derived from a tritubercular type; and that the inferior true molars of both have been derived from a tubercular-sectorial type." These, indeed, are the types which occur most constantly amongst the earlier fossil forms, and the most primitive living representatives both of the Marsupials and Placentals. The Pro-mammalia, when they first arose as a small group struggling amongst their reptilian and amphibian rivals, very possibly adopted some method of feeding for which teeth of these or similar patterns were well adapted. Subsequently, with increasing number and divergence, just as in the pentadactyle limb some digits have been lost and others become unduly developed, the tritubercular teeth have been modified to suit various needs; with this difference that, although digits are not easily added, new cusps often have arisen in the course of adaptation.

Oxford, April 21. E. S. GOODRICH.

[1] In a former paper, "On the Fossil Mammalia from the Stonesfield Slate" (*Quart. Jour. Micr. Sci.* xxxv. 1894), I brought forward some additional evidence in favour of this theory.

[2] "On the Trituberculate Type of Molar Tooth in the Mammalia" (*Proc. Am. Phil. Soc.* 1883), and "Origin of the Fittest."

Zoological Regions.

WITH reference to the paper of Mr. Wallace in NATURE (vol. xlix. page 610), I agree with Mr. Wallace's aim and with his estimate of the importance of the subject.

A naturalist, who deals with a single large genus as Pedicularis, makes his own map, showing the distribution of the species and his own view of the lines of descent of his sections in geologic periods. He cannot do this on a map showing the division of the world into six biologic regions according to the Mammalia in them. Or, at all events, none of our monographers, so far as I know, has done it. The difficulty in dealing with a whole natural order is still greater.

The consequence is that, if some other botanic writer wishes to compare the distribution of Pedicularis with that of some allied genus, or to give a view of the distribution of the sub-order to which Pedicularis belongs, he cannot make any use of the results of the Pedicularis monograph without taking it all to pieces and re-arranging the whole material. This is in every case a laborious, in many cases an impossible task.

I therefore agree with Mr. Wallace that we require a division of the globe into "areas absolutely defined, easily remembered," so that, after the monographer has treated his genus or order in natural regions, he may also "tabulate" his facts on these standard areas; in order that his numerical results may be (at least in the rough) accessible for immediate use by others who may not have time (or sufficient special knowledge) to get up the monograph.

It is evident that Mr. Wallace has overlooked my paper on biologic regions and tabulation areas in *Trans. Linn. Soc.* vol. clxxxiii. [1892] (B) pp. 371-387. Otherwise he could hardly have written (NATURE, vol. xlix. p. 612) that his regions readily enable us to tabulate the distribution of a group (and many other statements). In my paper I have pointed out that where I know, as in the case of many Sikkim plants, the exact boundary line of distribution of many species, I cannot tell whether these should be tabulated in Wallace's Region 1, or in his Region 3, or in both. The number of species which are in this predicament is so great that by exerting a choice how I would tabulate them I could bring out any result that might be wished. The more accurately I know the distribution of a species the more impossible is it for me to tabulate it on Wallace's map. And the more perfectly a region is biologically laid down (with peninsulas, islands, &c.) the more impossible it is to use it as an "area" for tabulating on. But, I must not trouble you with a recapitulation of my paper above cited, to which I refer Mr. Wallace and others who may be interested. C. B. CLARKE.

Kew, April 30.

The Earthquakes in Greece.

THE severe earthquake felt in Greece on April 27 at 9.20 p.m. was observed in Birmingham by the aid of a delicate bifilar pendulum, with which observations are now being made on behalf of the Earth Tremor Committee of the British Association. This instrument, designed by Mr. Horace Darwin, and made by the Cambridge Scientific Instrument Company, is described in the Report of the Committee presented at the Nottingham meeting last year.[1] I may merely mention here that a tilt of the ground in an east-west direction is magnified about 3000 times by the rotation of a mirror about a vertical axis; and that the image of a fine wire in front of a movable gas-jet, after reflection by the mirror, is observed in a fixed telescope in the passage outside the cellar in which the pendulum is erected.

Shortly before 8 p.m. (Greenwich mean time), I went down to take the usual reading, and found the image of the wire moving slowly from side to side of the field of view, showing that the ground was rocking gently backwards and forwards, the time of a complete pulsation being from twelve to fourteen seconds. It was difficult under the circumstances to make any exact measurements, but the maximum east-west component of the tilting cannot have been less than a quarter of a second. The pulsations were first observed at 7h. 59m., and my impression is that the range slightly increased until 8h. 3m. It then rapidly diminished, being about $\frac{1}{30}$ of a second at 8h. 12m., and never less than $\frac{1}{300}$ of a second until 8h. 28m., after which the pulsations ceased to be perceptible.

The time given by the newspaper correspondents is, I suppose, Athens time, and corresponds to 7h. 45m. Greenwich mean time. The interval between the occurrence of the earthquake and the arrival of the pulsations in Birmingham was therefore not greater than 14m., and, the distance traversed being roughly 1550 miles, it follows that the average velocity of the pulsations cannot have been less than 1·84 miles per second.

Gillott Road, Birmingham, May 1. C. DAVISON.

[1] An account of a new and improved form of the pendulum will appear shortly in NATURE.

"Vermes."

I WISH to enter a protest against the continued use of the word "Vermes" as a term of systematic significance with the same value as "Mollusca," "Arthropoda," &c. Linnæus used the term to include all soft-bodied invertebrates—*i.e.* everything then known except the Arthropoda (his "Insecta") and Vertebrata. Then Lamarck employed the word in a much more definite and unexceptional sense, to include the parasitic worms, the Chætopoda being separated as "Annelida." But what do modern writers meant by "Vermes"? Why, it has nearly as indefinite a limit as that given to it by Linnæus, for it is used to include almost *any* invertebrate animal—never mind its structure—which does not fit in the Mollusca, Arthropoda, Echinoderma, Cœlentera, or Protozoa. In fact, the term, as employed in such authoritative publications as the *Zool. Record*, *Zool. Jahresbericht*, &c., as well as by Jackson in "Forms of Animal Life," and in Lang's text-book, &c., embraces all, or most, of the following groups of animals:—Cestoda, Trematoda, Planaria, Nemertina, Archiannelida, Chætopoda, Hirudinea, Gephyrea, Polyzoa, Brachiopoda, Nematoda, Acanthocephala, Rotifera, Sagitta, Echinoderes, and sundry other small worm-like forms, and even Balanoglossus, and occasionally Chætoderma and Neomenia.

I do not intend to enter into the classification of this heterogeneous assemblage of forms, nor need I do more than refer to the fact that definite terms with scientific limitations are in existence under which the members of the assemblage can be (and are) grouped.

I am perfectly ready to admit that "Vermes" may be a useful descriptive term, if used to imply a certain general form of body, as opposed to some other groups; but I do wish to urge the abolition of it from text-books or titles of papers by well-known zoologists. That the eradication of the word presents considerable difficulties, I am aware; since it is not in England alone that "Vermes" still holds sway, but in all the European countries the equivalents "Vers," or "Würmer," &c., are employed with a more or less equivalent indefiniteness. Nevertheless, several such terms *have* been abolished, and no one nowadays would think of speaking, even in a popular, still less in a scientific work, of "Radiata" or "Zoophytes" or "Infusoria," in the antique significance of these words.

Oxford, April 18. WM. BLAXLAND BENHAM.

On Iron Crows' Nests.

Three years ago, the removal of an old tree in the Cossipore Ordnance Factory, near Calcutta, brought to light a singular bird's nest, composed mainly of bent and twisted fragments of stout iron wire, such as is used to bind up bundles of bar iron for transport. The pieces, which were all about as thick as stout telegraph wire, were of considerable length and weight, and were keyed together by their own irregularities; but as there was no evidence by which to identify the builder, I merely made a note of the circumstances.

Last year, however, attracted by the laboured flight of a crow carrying in its bill a very unwieldy and apparently heavy load, I watched the bird until, frightened by a passing object when about two feet from the ground, it dropped its burden, which I at once secured. I found it to be a piece of crumpled iron wire, which on measurement in my laboratory proved to be 23½ inches long between its apparent extremities (straightened out it measured 35½ inches in length), to have a diameter of 0·125 inches (= No. 11 B.W.G.), and to weigh 55·72 grammes, or nearly 861 grains. The bird was in the main road, about 300 yards from the site of the original nest.

This evidence as to the ownership of the nest, and of the weight which an Indian crow can carry, may perhaps interest some of your readers.

Walter G. McMillan.

Mason College, Birmingham, April 20.

Early Arrival of Birds.

Mr. Prideaux, in the last issue of Nature, having recorded the unusually early arrival of the summer migrants in Surrey, it may perhaps be permissible to state the date of arrival here. The cuckoo, uttering its festive note, flew into a tree in my garden on March 25, attracting the attention of the whole household, and has been heard at intervals in the neighbourhood of Worcester ever since. The swallow and martin were here on the 4th inst., the willow warbler and the white-throat on the 7th, and the red-start on the 16th. Nidification was remarkably early this season. In my garden the song thrush, blackbird, and robin hatched out by March 30, and the missal thrush in an orchard close by was, as usual, earlier in its family arrangements. I heard the swift on the 26th inst. The spring flora was also early: lilac, hawthorn, bluebell, cowslip, primrose, wood anemone, spotted orchis, and orchis morio were in blossom on the 20th inst.; the sweet violet gone, and the dog violet blooming profusely in its place.

There is nothing wonderful in the cuckoo being here in March. The wonder is that it was then vocal.

J. Lloyd Bozward.

Henwick, Worcester, April 28.

Irritability of Plants.

In your issue for April 19 (vol. xlix. p. 586) there is a short notice of a paper by Prof. Pfeffer on the "Irritability of Plants." In it you say: "Pfeffer instances the remarkable researches of Hegler on the effect of mechanical traction on growth stems, which when stretched by a weight, gain mechanical strength through the development of the mechanical tissues, which follows as a response to the pull to which they are subjected."

This recalls to mind the interesting passage in Tennyson's "Idylls of the King":

> S[illegible] the part [illegible] fl[illegible]h[illegible] in ar[illegible].
> I[illegible] n a[illegible] t[illegible] a[illegible] k the [illegible]ield
> A[illegible] n[illegible] a [illegible]pear of grain
> [illegible] en[illegible] n[illegible] ite, and tight
> W[illegible] tre[illegible] tee

Derby, April 24.

R. M. Deeley.

The Action of Light on the Diphtheria Bacterium.

Some time ago it was reported that colonies of the diphtheria bacterium do not thrive well when exposed to light, and it occurred to me that the electric light might afford a means of checking the development of the false membranes by projecting a very powerful arc light on the throat, for it is known that the tissues are to some extent penetrated by light. Or possibly the arc light could be sent into the throat through the mouth. I know that in Germany microscopic objects have been lighted with the aid of a lamp placed at some distance, and connected to the microscope by a curved glass rod, which conveyed the light by internal reflection. Incandescent lamps might be used in a similar manner, and some means could be devised in order to intercept the heat they produce, if it be objectionable.

A few days ago I noticed an article on Dr. Phillips' electric lamps, which he has employed to light the mouth, and the cavities between the mouth and the nose, and you recently published a paper read before the Royal Society, by Prof. H. M. Ward, on the bactericidal action of light, which partly confirms my views. It seems worth while, therefore, to make experiments with arc rays projected indirectly as above, and with incandescent lamps, and that especially upon diphtheria membranes.

J. Erede.

Rome, April 18.

Centipedes and their Young.

In No. 1275 of Nature (vol. xlix. p. 531), Mr. Urich, of the Trinidad Field Naturalists' Club, asks for information about the breeding habits of centipedes.

Similar observations to those made by the members of the Trinidad Club, and described by Mr. Urich, have been published by Kohlrausch ("Beitrage zür Kenntniss der Scalapendriden." Diss, Marburg, 1878), and these are referred to in the standard work on Myriapoda by Latzel ("Die Myriapoden der Osterreichisch-Ungarischen Monarchie." Wien, 1880, p. 136), and also in the "Lehrbuch der nerglischenden Entwicklungsgeschichte" (Jena, 1890), by Korschelt and Heider, p. 725.

Czernowitz, April 25.

R. v. Lendenfeld.

Marsupites in the Isle of Wight.

In a recent visit to the Isle of Wight, plates of *Marsupites* were found by Mr. R. M. Brydone and myself at Freshwater.

The locality is one in which these fossils might be expected to occur, but so far as I know they have not been recorded hitherto from any part of the island; certainly not by Barrois, nor in the last edition of the "Survey Memoir."

Winchester College.

C. Griffith.

POINCARÉ ON MAXWELL AND HERTZ.[1]

At the time when Fresnel's experiments compelled all researchers to admit that light is due to the vibrations of a very subtile fluid filling the interplanetary spaces, the researches of Ampère made known the mutual actions of currents, and founded electrodynamics.

But one step more was required to suppose that this same fluid, the ether, which is the cause of luminous phenomena, is at the same time the vehicle of electrical actions. This step Ampère's imagination enabled him to take; but the illustrious physicist, while announcing this seductive hypothesis, did not see that it was so soon to take a more precise form, and receive the beginning of its confirmation.

It was still, however, but a dream without consistence, till the day when electric measures indicated an unexpected fact—a fact recalled by M. Cornu in the last *Annuaire*, at the end of his brilliant article devoted to the definition of electric units. To pass from the system of electrostatic units to the system of electrodynamic units, a certain transformation-factor is employed, the definition of which I will not recall, as it is to be found in M. Cornu's article. This factor, which is also called the ratio of unities, is precisely equal to the velocity of light.

The observations soon became so precise that it was impossible to attribute this concordance to chance. One could not doubt therefore that there were certain intimate relations between the optic and the electric phenomena. But the nature of these relations would perhaps still have escaped us if Maxwell's genius had not guessed it.

[1] Translation of an article by M. Poincaré, in the *Annuaire* of the Bureau des Longitudes for 1894.

Currents.

Everyone knows that bodies can be divided into two classes: conductors where we prove the transference of electricity, that is to say, of voltaic currents, and insulators or dielectrics. To the old electricians dielectrics were purely inert, and their part consisted in opposing the passage of electricity. If this were so, we could replace any insulating body by another of a different kind without changing the phenomena. Faraday's experiments have shown that it is nothing of the kind. Two condensers of the same shape and dimensions put in communication with the same sources of electricity will not take the same charge (even if the thickness of the isolating wire be the same), if the *nature* of the isolating matter differs. Maxwell had made too deep a study of Faraday's works not to understand the importance of dielectric bodies and the necessity of restoring to them their proper function.

Besides, if it be true that light is but an electric phenomenon, it follows that when it is propagated through an insulating body, this body is the place of the phenomenon, therefore there must be electric phenomena localised in dielectrics; but of what nature are they? Maxwell answers daringly: they are currents.

All the experiments up to his time seemed to contradict this; currents had never been observed except in conductors. How could Maxwell reconcile his audacious hypothesis with such a well-founded fact? Why do the hypothetical currents under certain circumstances produce manifest effects, which under ordinary conditions remain absolutely unobservable?

It is because dielectrics oppose to the passage of electricity, not a greater resistance than the conductors, but a resistance of a different kind. A comparison will make Maxwell's thought clearer.

If we endeavour to bend a spring, a resistance is encountered which increases in proportion as the spring is bent. If, therefore, we have at our disposal only a limited force, a moment will come when the resistance being unsurmountable, the movement will stop and equilibrium be established; at last, when the force ceases to act the spring will bound back, giving back all the work expended to bend it.

Suppose, on the contrary, that we wish to move a body immersed in water. Here again we meet with resistance which will depend on the velocity, but which, if this velocity remains constant, will not increase in proportion as the body advances; the movement will therefore continue as long as the force acts, and equilibrium will never be attained; finally, when the force ceases to act, the body will not tend to return, and the energy used for making it advance cannot be restored; it will have been entirely transformed into heat by the viscosity of the water.

The contrast is manifest, and it is necessary to distinguish between *elastic* and *viscous* resistance. Then dielectrics would behave, for electric movements, like elastic solids in the case of material movements, whilst conductors would behave like viscous liquids. Hence two categories of currents: current of displacement or Maxwell's currents which traverse dielectrics, and the ordinary conducting currents which circulate in conductors.

The first, having to overcome a sort of elastic resistance, can be but of short duration; for, this resistance increasing continually, equilibrium will be rapidly established.

The currents of conduction, on the contrary, having to overcome a sort of viscous resistance, can consequently last as long as the electromotive force which causes them. Let us look again at the convenient comparison which M. Cornu has borrowed from hydraulics. Suppose we have water under pressure in a reservoir; let us put this reservoir in communication with a vertical tube; the water will rise in it, but the movement will stop so soon as the hydrostatic equilibrium is reached. If the tube is large, there will not be any friction, or loss of charge, and water thus raised could be used for producing work. We have here a picture of displacing currents.

If, on the contrary, the water of the reservoir flows out by a horizontal tube, the movement will continue so long as the reservoir is not empty; but if the tube is narrow, there will be a considerable loss of work, and a production of heat by friction. We have here a picture of conducting currents.

Although it is impossible and of little use to try to represent to ourselves all the details of this mechanism, one may say that all happens as if the displacement currents had a number of little springs to bend. When the currents stop electrostatic equilibrium is established, and the springs are so much the more bent as the electric field is more intense. The work accumulated in these springs, that is to say, the electrostatic energy, can be wholly restored so soon as they can unbend themselves. It is thus that mechanical work is obtained when the conductors are allowed to obey the electrostatic attractions. These attractions would thus be due to the pressure exercised on the conductors by the bent springs. Finally, to follow the comparison to the end, the disruptive discharge must be likened to the rupture of overstrained springs.

On the other hand, the work employed for producing conduction currents is lost and wholly transformed into heat like that expended in overcoming the friction or the viscosity of fluids. *It is for this reason that the conducting wires get hot.* From Maxwell's point of view there are only closed currents. For the old electricians this was not so; they looked upon a current as closed which circulates in a wire joining the two poles of a battery. But if, instead of reuniting the two poles directly, one puts them in communication respectively with the two armatures of a condenser, the instantaneous current, which lasts until the condenser is filled, was considered open; it went, it was thought, from one armature to the other across the wire of communication and the battery, and stopped at the surface of the two armatures. On the other hand, Maxwell supposed that the current traverses the insulating plate, which separates the two armatures, under the form of a displacement current, and that it is thus completely closed. The elastic resistance which it meets on the passage explains its short duration.

Currents can manifest themselves in three ways: by their calorific effects, by their action on magnets and currents, by the induced currents to which they give rise. We have already seen why conduction currents develop heat, and why displacement currents do not do so. On the other hand, however, according to Maxwell's hypothesis, the currents which he imagines, must, like the ordinary currents, produce electromagnetic, electrodynamic, and inductive effects.

Why have we hitherto been unable to put these effects in evidence? It is because a displacement current, however feeble, cannot last long, in the same direction; for the tension of our springs, ever increasing, would soon stop it. There cannot therefore be in dielectrics, either continuous currents of long duration, or sensible alternating currents of long period. The effects will, however, become observable if the alternation is very rapid.

The Nature of Light.

According to Maxwell, this is the origin of light. A luminous ray is a series of alternating currents produced in dielectrics, or even in the air or the interplanetary vacuum, which changes its direction a thousand billion times every second. The enormous induction due to these frequent alternations produces other currents in the neighbouring parts of the dielectric, and it is thus that the luminous waves spread from point to point.

Calculation shows us that the rate of spreading is equal to the ratio of the units, that is to say, to the velocity of light.

These alternating currents are a kind of electrical vibrations; but are these vibrations longitudinal like those of sound, or transversal like those of Fresnel's "ether"? In the case of sound the air undergoes condensation and rarefaction, alternatively. On the contrary, Fresnel's ether, when vibrating, behaves as if it were formed of incompressible layers, capable only of sliding one over the other. If there were *open* currents, the electricity going from one extremity to the other of one of these currents would accumulate at one of the extremities; it would condense or rarefy itself like air; its vibrations would be longitudinal. But Maxwell admits only closed currents; this accumulation is impossible, and electricity behaves like Fresnel's incompressible ether; its vibrations are transversal.

Experimental Verification.

So we find again all the results of the undulatory theory. But this was, however, not enough to induce the physicists, who were more charmed than convinced, to accept Maxwell's ideas. All that could be said in their favour was that they did not contradict any of the observed facts, and that it was a great pity if they were not true. But experimental confirmation was wanting; it had to be waited for during twenty-five years.

A divergence had to be found between the old theory and Maxwell's, which was not too delicate for our rough means of investigation. There was only one which afforded an *experimentum crucis.*

The old electrodynamics required electromagnetic induction to be produced instantaneously; but according to the new doctrine it must, on the contrary, be propagated with the velocity of light.

The question was therefore to measure, or at least to ascertain, the rate of propagation of inductive effects; this has been done by the illustrious German physicist, Hertz, by the method of interferences.

This method is well known in its applications to optical phenomena. Two luminous rays issuing from the same source interfere when they meet at the same point after having followed different paths. If the difference of these paths is equal to the length of a wave—that is to say, to the path traversed during one period, or a whole number of wave-lengths—one of the vibrations is later than another by a whole number of periods; the two vibrations are therefore at the same phase, they are in the same direction, and they reinforce each other.

If, on the contrary, the difference of path of the two rays is equal to an odd number of half wave-lengths, the two vibrations are in contrary directions, and they neutralise one another.

The luminous waves are not the only ones susceptible to interference: all periodic and alternating phenomena propagated with a finite velocity will produce analogous effects. It happens with sound. It ought to happen with electrodynamic induction, if the velocity of propagation is finite; but if, on the contrary, the propagation be instantaneous, there will not be any interference.

But one cannot put these interferences to the proof if the wave-length is greater than our laboratories, or greater than the space that the induction can traverse without becoming too feeble. Currents of very short period are absolutely essential.

Electric Exciters.

Let us first see how they may be obtained with the help of an apparatus which is a veritable electric pendulum. Suppose two conductors united by a wire; if they are not of the same potential, the electric equilibrium is broken in the same way as the mechanical equilibrium is deranged when a pendulum is swung from the vertical. In the one case as in the other, the equilibrium tends to re-establish itself.

A current circulates in the wire, and tends to equalise the potential of the two conductors in the same way as a pendulum seeks the vertical. But the pendulum will not stop in its position of equilibrium; having acquired a certain velocity, it passes this position because of its inertia. Similarly, when our conductors are discharged, the electric equilibrium momentarily re-established, will not maintain itself, and will be destroyed by a cause analogous to inertia; this cause is *self-induction.* We know that when a current stops it gives rise in the adjacent wires to an induced current in the same direction. The same effect even is produced in the wire in which the induction current circulates, which finds itself, so to speak, continued by the induced current.

In other words, a current will persist after the disappearance of the cause which produced it, as a moving body does not stop when the force, which had put it in motion, ceases to act.

When the two potentials shall have become equal, the current will therefore continue in the same direction, and will make the two conductors take opposite charges to those which they had to start with.

In this case, as in that of the pendulum, the place of equilibrium is passed; in order to re-establish it, a backward movement is necessary.

When the equilibrium is regained, the same cause immediately destroys it, and the oscillations continue without ceasing.

Calculation shows that the duration depends on the capacity of the conductors; it suffices, therefore, to diminish sufficiently this capacity, which is easy, to have an electric pendulum susceptible of producing alternating currents of extreme rapidity.

All this was well established by Lord Kelvin's theories and by Feddersen's experiments on the oscillating discharge of the Leyden jar. It is, therefore, not this which constitutes the original idea of Hertz.

But it is not sufficient to construct a pendulum; it must also be put into movement. For this, it is necessary for some agent to move it from its position of equilibrium, and then to stop abruptly—I mean to say, in a time very short in relation to the duration of a period; otherwise the pendulum will not oscillate.

If, for example, we move a pendulum from its vertical position with the hand, and then, instead of loosing it suddenly, we let the arm relax slowly without unclasping the fingers, the pendulum, still supported, will arrive at its place of equilibrium without velocity, and will not pass it.

We see then, that with periods of a hundred-millionth of a second, no system of mechanical unclamping could work, however rapid it might appear to us with regard to our usual units of time. This is the way in which Hertz has solved the problem.

Taking again our electric pendulum, let us make in the wire, which joins the two conductors, a cut of some millimetres. This cut divides our apparatus into two symmetric halves, which we will put in communication with the two poles of a Ruhmkorff coil. The induced current will charge our two conductors, and the difference of their potential will increase with a relative slowness.

At first the cut will stop the conductors from discharging themselves. The air plays the part of an insulator, and keeps our pendulum away from its position of equilibrium.

But when the difference of potential becomes large enough, the jar spark will pass, and will make a way for the electricity accumulated on the conductors. The cut will all at once cease to act as an insulator, and by a sort of electric unclamping, our pendulum will be freed from the cause which prevented it returning to its equilibrium. If the complex conditions, well studied by Hertz, are fulfilled, this unclamping is sudden enough to enable oscillations to be produced.

The apparatus, called an "exciter," produces currents which change their direction from 100,000,000 to 1,000,000,000 times per second. Because of this extreme frequency they can produce inductive effects at a great distance. In order to render these effects simple, another electric pendulum, called a "resonator," is employed. In this new pendulum, the cut and the coil, which only serve for the unclamping, are suppressed; the two conductors reduce themselves to two very small spheres, and the wire is bent back in a circle in a way to approach the spheres to each other.

The induction due to the exciter will put this resonator in vibration the more easily as the periods of the two are less different. At certain phases of the vibration, the difference of potential of the two spheres will be large enough to produce sparks.

Production of Interferences.

We have thus an instrument which shows the effects of an inductive wave emitted from the exciter. We can study what happens in two ways: either expose the resonator to the direct induction of the exciter at a great distance, or else make this induction work at a short distance on a long conducting wire, along which the electric wave will go, and which will work in its turn by induction at a short distance on the resonator.

Whether the wave propagates itself along a wire or across the air, one can produce interferences by reflection. In the first case, it will reflect itself at the extremity of the wire, which it will follow again in an inverse direction; in the second, it will reflect itself on a metallic leaf which acts as a mirror. In the two cases the reflected wave will interfere with the direct wave, and we can find places where the spark of the resonator will cease to pass.

The experiments made with the long wire are easier; they furnish us with very precious instruction, but they will not serve as *experimenta crucis;* for in the old as well as the modern theory, the quickness of an electric wave along a wire must be equal to that of light. The experiments on the direct induction at a great distance are, on the contrary, decisive. They show that not only the quickness of propagation of induction across the air is finite, but that it is equal to the quickness of the wave propagated along a wire, complying with the ideas of Maxwell.

Synthesis of Light.

I shall insist less on other experiments of Hertz, more brilliant, but less instructive. Concentrating with a parabolic mirror the wave of induction taken from the exciter, the German savant obtains a veritable cluster of electric rays, capable of reflecting and refracting themselves regularly. The rays, if the period, already so small, were a million times shorter still would not differ from the luminous rays. We know that the sun gives out several kinds of radiation, some luminous because they act on the retina, others obscure ultra-violet or infra-red, which manifest themselves by their chemical or calorific effects. The first only owe their qualities, which make them appear to us of a different nature, to a kind of physiological chance. To the physicist the infra-red does not differ more from the red, than the red from the green; the length of a wave is only greater; those of the hertzian radiations are much greater still, but there are only differences of degree, and one may say, if Maxwell's theories are true, that the illustrious Professor of Bonn has realised a veritable synthesis of light.

Conclusions.

But our admiration for so much unhoped-for success must not make us forget the progress which still remains to be accomplished. Let us therefore try to exactly summarise the results which are definitely attained.

First, the velocity of direct induction across the air is finite, without which the interferences would be impossible. The old electro-dynamics are therefore condemned. What must one put in its place? Is it Maxwell's theory (or at least something approaching it, for one would not expect the divination of the English savant to have foreseen the truth in all its details)? Although the probabilities accumulate, the complete demonstration is not yet reached.

We can measure the length of a wave of hertzian oscillations; this length is the product of the period by the velocity of propagation. We should, therefore, know this velocity if we knew the period; but this last is so small that we cannot measure it; we can only calculate it by a formula due to Lord Kelvin. This calculation leads to numbers which agree with Maxwell's theory; but the last doubts will only be done away with when the velocity of propagation has been directly measured.

This is not all: things are far from being so simple as one might think, from the above short account. Diverse circumstances come to complicate them.

First, there is round the exciter a radiation of induction; the energy of this apparatus radiates, therefore, externally, and as no fresh source comes to supply it, it soon disperses, and the oscillations die out very rapidly. It is here that one must look for the explanation of the phenomenon of multiple resonance, which was discovered by MM. Sarasin and De la Rive, and which at first appeared irreconcilable with the theory.

On the other hand, we know that light does not precisely follow the laws of geometrical optics, and the difference which produces diffraction, is more considerable as the length of the wave is greater. With the great length of the hertzian undulations these phenomena must assume an enormous importance, and trouble everything. No doubt it is fortunate, for the moment at least, that our means of observation are so coarse, otherwise the simplicity which seduced us at the first sight would give place to a labyrinth where we should be lost. It is from this probably that different anomalies arise, which have hitherto not been explained. It is also for this reason that the experiments on the refraction of rays of electric force have, as I said above, but little demonstrative worth.

There still remains a difficulty which is more serious, but which is no doubt not insurmountable. According to Maxwell, the coefficient of electrostatic induction of a transparent body ought to be equal to the square of its index of refraction. This is not so; the bodies which follow Maxwell's law are exceptions. We are evidently in the presence of phenomena much more complex than we thought at first; but one has not been able to explain anything, and the experiments themselves are contradictory.

There still remains, therefore, much to be done; the identity of light and electricity is from to-day something more than a seducing hypothesis: it is a probable truth, but it is not as yet a proved truth.

THE RECENT WORK OF THE CATARACT CONSTRUCTION COMPANY.

SOME arrangements recently made by the Cataract Construction Company show that the works are extending in a very satisfactory manner. The Niagara Falls Paper Company is now well under way. They make paper from wood pulp, and a large amount of power is used for grinding the trees down into pulp. They have fixed turbines in their own wheel-pit, and take water from the Cataract Construction Company's canal, and pass it after use into the tunnels belonging to this Company. The turbines drive a vertical shaft which, at the surface of the ground, is geared by bevel wheels to the main shaft, on which are the pulp grinders. This is the only case likely to occur where the power is used directly. In all other cases it is likely to be transmitted electrically. The first electrical application is to the works of the Pittsburgh Reduction Company for the manufacture of aluminium. The Niagara Falls Power Company has undertaken to supply them with continuous current at 160 volts to the extent of 7000 horse-power. The first 1500 horse-power is now being put in. In order to do this, Prof. Forbes has arranged to carry the alternating current by two circuits in two phases. This is the character of current generated by the dynamos. At the works, 2500 feet from the power-house, the current is to be transformed from 2000 volts to 115 volts alternating. It is then passed through three of the commutating machines, like those shown by Schuckert and others at the Frankfort Exhibition of 1891. These are continuous current machines, each with four rings attached to certain bars of the commutator. The alternating current is passed to these rings by brushes: the armature revolves synchronously with the generator in the power-house and with the turbine. The other brushes, which rub on the commutator, give off continous current to the aluminium baths at 160 volts, the E.M.F. being in normal conditions raised in its change form alternating to continuous current in the ratio of $\sqrt{2}:1$. A shunt direct current with variable resistance in the circuit excites the field magnets. It is found that the electromotive force of the direct current can thus be regulated. The explanation of this remarkable fact has been worked out by Mr. Steinmetz. The whole of this plant, transformers, commutating machines, and switchboard was tendered for by different firms, and the bid of the General Electric Company has been accepted; 33 per cent. of spare plant is held in reserve. The dynamos and power-house switch-board, on the other hand, are in the hands of the Westinghouse Company. It is expected that both types of machinery will be in operation in the course of a few months.

The patent for Prof. Forbes' construction of dynamo, which is being built, has been just allowed by the United States Patent Office. One object to be attained was to have a fixed armature, so that the armature might be wound so as to give a very high E.M.F. without being subjected to the enormous centrifugal forces of the revolving part. Another object was to attain a maximum fly-wheel effect with a minimum weight. The revolving parts of the turbine and dynamo, and the vertical shaft connecting them, are all supported hydraulically by means of a piston in the turbine. The supporting power of this piston amounted to the weight of the revolving part of the dynamo to [illegible] lbs. The governor of the turbine demanded to fulfil the required conditions of regulation a momentum equal to that of 1,100,000,000 lbs., moving at the rate of 1 foot per second.

Both of these objects are attained by Prof. Forbes' construction, which consists in making the armature fixed and ring-shaped, with a space inside for getting at the bearings, and in making the fields of a bell-shape, the poles being on the inside of a nickel steel ring, which is supported by the top piece or cover, which in its turn is rigidly fixed to the vertical axis. This novel construction gives all the fly-wheel effect required without making the weight too great. Every design which had been made previously required the addition of a fly-wheel costing at least £[illegible] or £1[illegible]. The construction for which Prof. Forbes' patent has now been granted has also the great merit that the magnetic pull between the armature and the fields tends to diminish the breaking strain of centrifugal force on the revolving part to a very sensible amount. When the revolving part is inside the magnetic pull assists centrifugal force in its destructive effect.

THE EPPING FOREST CONTROVERSY.

THE meeting of the Essex Field Club, which, as we announced last week, had been convened for the inspection of the thinned districts of Epping Forest, was in every way a remarkable gathering. Nearly 150 members and visitors assembled in Monk's Wood, among them, in addition to the conductors and officers of the Club, being Sir John Lubbock, Mr. J. Bryce, M.P., Chancellor of the Duchy of Lancaster, Prof. Boulger, Prof. W. R. Fisher, Dr. Church, Mr. Arthur Lister, Mr. Andrew Johnston (chairman of the Essex County Council), Mr. David Howard, Mr. Salmon (chairman of the Epping Forest Committee), Sir Frederick Young, Mr. Bernard Gibson, and others interested in the question of the Forest management. A thorough examination of Monk's Wood was made, Mr. E. N. Buxton giving a detailed explanation of the policy which the Conservators had been pursuing, and pointing out the reasons that had led to the present necessity for thinning. The party were then conducted to Lord's Bushes, which, as an example of the beautifying effect of judicious thinning, is almost unrivalled, this district having been submitted to the operation repeatedly since the Forest was taken over by the present Conservators. After tea at the Royal Forest Hotel, Chingford, a meeting of the Club was held, Mr. F. Chancellor, the President, in the chair. The discussion was opened by Prof. Meldola, who commenced by explaining that the statements which had been inserted in the newspapers respecting the attitude taken by the Club in the present controversy had been made without authority, and were devoid of foundation. He then went on to show that the observations made by him in 1883 in connection with the agitation against the railway scheme with which the Forest had then been threatened (see the article quoted in our columns in last week's note), had recently been applied to the present thinning operations without his concurrence, and in direct opposition to the views which he had formed after five visits to the districts now being dealt with, and after an intimate acquaintance with the Forest for a period of more than twenty years. Having explained the general grounds on which he based his opinions, he stated that in his belief the Forest as a whole showed a marked improvement since it had been under the care of the present management, and he considered that much of the recent criticism had been most unjust, and the newspaper accounts exaggerated to an extent bordering on the ludicrous. Two or three speakers took an adverse position, but Prof. Boulger, Mr. Howard, Mr. F. C. Gould, Mr. W. Crouch, the President, Mr. William Cole, and others who knew the Forest well, expressed general approval of the recent operations. Mr. Angus Webster, the Duke of Bedford's forester, who accompanied the party, was of course obliged to reserve his opinion owing to his official connection with the committee of experts appointed by the Corporation, the report of this committee not having as yet been presented. As the outcome of the discussion, it may safely be said that the public will not be so ready in future to give credence to the opinions of irresponsible and inexperienced scribblers who, often with the best of motives, may seriously hamper the work of the Conservators in their endeavour to restore the Forest to a more natural condition in those parts which have for so many centuries been made unnatural and unsightly by the existence of the rights of lopping. Although it had not been the original intention of the officers and conductors to allow a formal motion to be put, a strong desire was expressed that this should be done, and on taking a vote a large majority decided that some resolution should be framed. Not the least important feature of the meeting were the speeches made by Sir Frederick Young (formerly chairman of the "Forest Fund"), and others who had taken up an antagonistic attitude in the correspondence. Having visited the place and heard the explanations given on the ground, these gentlemen admitted that as the result of the afternoon's inspection they had seen good reason for modifying their views, and they finally voted for the following resolution, moved by Prof. Boulger and seconded by the Rev. W. C. Howell, of Tottenham:—"That in the opinion of this meeting the general action of the Conservators in the recent thinnings has been judicious." Forty-one voted in favour of this resolution, and eight against. The views of those whose opinions should count for much in reassuring the public that no alarm need be felt as to the future of the Forest, have thus been expressed in very decided terms.

THE UNIVERSITY OF LONDON.

A GENERAL meeting of the Association for Promoting a Professorial University for London, was held in the rooms of the Chemical Society, Burlington House, on Saturday, April 28; the Right Hon. T. H. Huxley was in the chair.

The committee reported that having carefully studied the report of the Gresham Commission, they considered it is generally in accord with the principles of the Association.

In accordance with this report a resolution, moved by Prof. Rücker, and seconded by Prof. Ramsay, was unanimously carried, expressing general approval of the scheme. The committee were also empowered to draw up a memorial to the Government, to be signed by members of the Association, and others who may agree with it, urging the Government to appoint a Statutory Commission to establish a Teaching University in London on the basis of the scheme of the Royal Commission.

This action on the part of the Association is, we hope, another step towards the realisation of the scheme of the "Gresham Commission."

It was at one time to be feared that it would be impossible to reconcile the various divergent views which had been expressed as to the best constitution for the University. Now, however, that the Colleges of Physicians and Surgeons, the Governing Body and Senate of University College, and the Professorial Association, have all expressed a general approval of the scheme, while the London County Council finds in it nothing inconsistent with its own views, it is evident that the Commissioners have achieved a remarkable success. The University of London has not yet spoken, but the opponents of the scheme in Convocation were unable to carry their resolutions, and it is to be hoped that the University may yet be saved from the discredit of blocking the way.

NOTES.

A STATUE of Durand-Claye, the pioneer of the system for the agricultural utilisation of sewage, was unveiled at Gennevilliers, on Friday last. The funds for the erection of this monument were raised by international subscription, in accordance with a proposal made at the Congress of Hygiene held in Paris in 1889.

WE regret to announce the death, at Geneva, of the eminent chemist, J. C. Galissard de Marignac. We have also to record the death of Laureano Calderon, Professor of Biological Chemistry in Madrid University.

THE Kazan Society of Naturalists will celebrate the twenty-fifth anniversary of its foundation on May 25, by a general meeting of members, at which a statement will be read of the works published by the Society during its existence.

THE *Times* says that the Attorney-General has given his sanction to the sum of £25,000, the residue of the legacy of the late Mr. Richard Berridge, being given, in trust, to the British Institute of Preventive Medicine, for the endowment of a laboratory devoted to the bacteriological and chemical examination of the water supply, with special reference to the best means of preventing the conveyance of disease through water. A large laboratory is now in course of erection for the purpose on the site secured by the institute at Chelsea.

EARTHQUAKES continue to be felt in Greece. A severe disturbance, having its centre in Atalanti, occurred on Friday, April 27 (see p. 7), and the *Times* correspondent says that the inroads of the sea in this district have extended inland for a distance of three kilometres. The surface of the sea in many places is coloured with the products of submarine eruptions. A chasm has opened in the ground not far from Atalanti, and extends in a south-westerly direction for about twelve kilometres.

AT the anniversary meeting of the Zoological Society, held on Monday, Sir William H. Flower, K.C.B., F.R.S., was re-elected President, Mr. C. Drummond, Treasurer, and Dr. P. L. Sclater, F.R.S., Secretary to the Society for the ensuing year. The following were elected into the Council, in the place of retiring members:—Dr. John Anderson, F.R.S., Mr. Herbert Druce, Sir Joseph Fayrer, F.R.S., Major Henry P. St. John Mildmay, and Prof. A. Newton, F.R.S.

THE opening meeting of the British Association this year will take place on Wednesday, August 8, when Prof. Burdon Sanderson, F.R.S., will resign the chair, and the Marquis of Salisbury will assume the presidency and deliver an address. On Thursday, August 9, a soirée will be held. On August 10, a discourse will be delivered by Dr. W. H. White, C.B., F.R.S., on "Steam Navigation at High Speeds"; on August 13, Prof. J. S. Nicholson will lecture on "Historical Progress and Ideal Socialism"; on August 14 there will be another soirée, and the concluding meeting will be held on Wednesday, August 15.

THE committee for the establishment of a station at Cumbræ, for the study of marine zoology and botany, are making good progress with their arrangements. The *Ark* has now been put into order for the summer months, and the services of an experienced keeper secured. Mr. David Robertson, the well-known "naturalist of Cumbræ," takes a warm interest in the scheme, and is giving it his personal supervision. A number of students have intimated their intention of availing themselves of the facilities for research thus provided. A considerable sum has been subscribed for the erection of a permanent building, and also for the annual expenses of the station—about half of what is required in each case; and the committee have good hopes that the remaining half will soon be obtained.

THE Geologists' Association have arranged an excursion to Oxted and Titsey for Saturday next, under the direction of Mr. G. Leveson Gower and Mr. W. Topley, F.R.S. The district is not only interesting geologically, but contains a number of archæological remains. During Whitsuntide a long excursion has been arranged to Cambridge and Ely, and on May 26 Mr. John Hopkinson and Mr. Worthington G. Smith will conduct a party to Luton, Caddington, and Dunstable. In the neighbourhood of Caddington are numerous pits in Drift (brick-earth, &c.), and Tertiary remanié beds, worked for clay and sand for brick-making, and for gravel. In these pits Mr. Smith discovered an old Palæolithic land-surface on Tertiary remanié, surmounted by re-laid Tertiary clay, and contorted, implementiferous red plateau drift. On this Palæolithic floor flint flakes of all kinds occur in hundreds, nearly all as keen-edged as knives. That these flakes were made on the spot is shown by the fragments found, which have been struck off, and in many instances have been replaced in their original position, the flint being thus rebuilt. A large Saxon tumulus is also to be seen at Caddington. Close to Zouches Farm is an old pasture, believed to have been a place for making bricks or tiles in mediæval or, perhaps, Roman times; and near Blows Downs is a group of early British hut-foundations. From this it will be seen that the excursion will be one of unusual interest.

Two lectures on "The Æther and its Relations to Material Phenomena" will be delivered at Gresham College, Basinghall Street, on the evenings of May 8 and 9, by Dr. J. Larmor, F.R.S. Prof. Karl Pearson will deliver two final lectures on "The Geometry of Chance," on May 9 and 10.

For misleading statements, and the suppression of facts, commend us to the opponents of Pasteur's anti-rabic treatment. If the general public are gulled into believing half of what it sees posted on the public hoardings concerning the results of the treatment at the Pasteur Institute in Paris, it must liken the eminent head to a veritable Frankenstein. In our issue of April 19 we noted a few of the facts from the official report contained in the current number of the *Annales de l'Institut Pasteur*. This brought us a letter from Mr. F. E. Pirkis, accompanied by a black-edged document, published by the Victoria Street Society for the Protection of Animals from Vivisection, and headed "M. Pasteur's Double Hecatomb. The Tale of the 257 Dead. (New Edition. Revised to November 20, 1893.)" In our note we recorded that only 72 deaths had occurred amongst the Institute patients since the commencement of the inoculations in 1886. But this fact does not tally with the misrepresentations widely advertised by the anti-vivisectionists; so Mr. Pirkis essays to put us right. In reply to his remarks, we would first point out that the note in question simply gives a summary of the published statistics without any critical commentary thereon. This summary, however, clearly indicates that only those deaths which take place *after* the lapse of fifteen days from the date of the last inoculation are included as having occurred *in spite* of the treatment. Our correspondent has apparently not understood this part of the statement, otherwise he would not express surprise at the discrepancy between the 72 deaths given in the statistical report and the 195 deaths which is the total alleged in "M. Pasteur's Double Hecatomb" to have taken place amongst all-comers to the Pasteur Institute. Further, he contrasts the 72 deaths mentioned in the note in Nature with 257 deaths given in the anti-Pasteur circular; but he has apparently not noticed that only 195 of the latter are alleged to have been treated at the Paris Pasteur Institute. A superficial glance at the black-edged document at once shows that many of the deaths there recorded took place *within* fifteen days of the last inoculation, and would, therefore, certainly be excluded from the official statistics of the Pasteur Institute, for the reasons already given. Assuming the total of 195 deaths to be correct, and there are no grounds for impugning the accuracy of the figure, and taking the total number of persons inoculated at the Paris Institute as 14,553—a figure obtained by adding to 14,430, which is the total number of those inoculated at Paris *given* in the official statistics, the number 123, which assuming the correctness of the figures in the anti-Pasteur document represents the number of those patients who were excluded from the official statistics, owing to their death having taken place *within* fifteen days of the last inoculation—it appears that the *total mortality* amongst all the inoculated is only 1·3 per cent. The mortality amongst persons bitten by rabid dogs, and not submitted to treatment, is commonly accepted to be from 15–20 per cent. If the agitators against the establishment of Pasteur Institutes would only look such facts as these in the face, there might be more hope that they would be led to see the error of their ways.

After the close of the recent Medical Congress at Rome, many of the members took part in various excursions organised for their recreation and instruction. It was during an excursion to the Island of Capri that Prof. Todaro related the following interesting story, which we take from the *Lancet*. Early in this century the riches of the Gulf of Naples for naturalists came to be appreciated by local investigators, and their reports attracted the special notice of Cuvier, from whom the reported riches were communicated, always with fresh increment, through Milne Edwards to Quatrefuges. Another and still mightier name to be attracted to the Gulf was Johann von Müller of Berlin, the most encyclopædic of biologists, who, long interested in the inferior vertebrata, had written a classical monograph on them. A contemporary of his, Oronzio Costa of Naples, an investigator of rare powers, had discovered in these waters the *amphioxus*, already known to British and Russian naturalists as the *Branchiostoma lanceolatum*. Costa recognised its true nature, and described it as the first and lowest of the vertebrata. His description at once engrossed von Müller's attention, insomuch that he had barely read it when he said to his wife, "My dear, you must come with me to the Bay of Naples." Travelling in those days was effected by diligence, and it was not till after some weeks that the great German biologist and his lady reached the bay. Alighting at the Albergo di Roma at Santa Lucia, he sent at once for a mariner to get him a specimen of the *amphioxus*. This man turned out to be Costa's own mariner, Giovanni by name, who forthwith in the grey morning, as the result of a "miraculous draught" under Posillipo, obtained the animal and brought it to von Muller, who was still in bed. Overjoyed with his possession, von Muller put it at once into alcohol, woke his wife, who, tired with the long journey, was sleeping profoundly, and said, "My dear, get up immediately, we are going back to Berlin." Von Muller's enthusiasm was caught up by his compatriot Krohn, who from his sojourn at Messina in 1844 drew his German friends to those waters, till year by year, each spring and autumn, the Teutonic universities sent relays of young naturalists to that seaboard—among them Anton Dohrn—a most accomplished student of nature, to whom we owe the scientific institute founded at Naples and opened in 1873. Since that year the Stazione Zoologica has become more and more the resort of biologists, and now there is hardly a seat of learning in Europe which does not contribute to its maintenance in return for facilities afforded to the student for prosecuting research.

The Italian Meteorological Office has succeeded, after some difficulty, in establishing a fairly satisfactory thermometrical station on Mount Etna, at an altitude of about 9850 feet, by means of a recording instrument made by Richard, of Paris, which goes for 40 days. By this method 207 days' observations were secured in the year 1893, and direct observations were also made on 72 days. During seven months of the year the mean temperature was below the freezing point. The maximum temperature observed was 60°·8 in September, and the minimum 13°·5 in March. The characteristic of the annual variation is that the low temperatures are prolonged until June, and, in the autumn, the mild temperatures extend up to December.

An important contribution to the meteorology of South-eastern Europe has been made by the publication of the means of observations for Sophia (Bulgaria) for the years 1891–3, for three hours each day, and for the month and year. During this period the extreme temperatures have varied between −24°·2 in January 1893 and 97°·7 in August 1891. The mean annual rainfall was 31·2 inches, and the greatest daily fall 2·76 inches, in September 1891. The mean annual relative humidity was 74·1 per cent. At the meteorological conference at Munich, in 1891, the wish was expressed for observations (especially telegraphic reports) from Bulgaria, and the publication of these results by Prof. Watsoff, director of the Central Meteorological Station at Sophia, is a good step in the right direction.

IN a letter to the local press, Mr. H. C. Russell, F.R.S., the Director of the Sydney Observatory, recently brought together some facts concerning icebergs and their relation to weather. The letter was written with the view of showing that the icebergs seen near Australia do not influence the weather in the manner commonly supposed. All the reports of icebergs seen within the last two years or so, were collected, and it was found that they numbered eighty-four. In order to locate these icebergs, the position of each ship when ice was seen, was plotted on a map of the world. Of the eighty-four positions thus marked on the map, sixty-one, or 73 per cent., were under the lee of Patagonia, as if they had been carried there by the strong winds and the Cape Horn current, which sets northwards after passing Cape Horn. Round the Cape of Good Hope was another, though less numerous, group of positions, numbering thirteen, and making 90 per cent. of the whole collected in the two localities. About the Crozets two ships reported ice, and two ships reported seeing ice on the same day and in the same longitude at a point 500 miles south-west from Albany. Six other locations were between New Zealand and Cape Horn. Of the eighty-four ships reporting, only two saw ice anywhere near Australia, and that was more than two years ago, on December 14, 1891. As to the effect of icebergs in lowering the temperature, Mr. Russell points out that many observers have reported that the thermometer is not a good indicator of the proximity of ice, no matter whether it is placed in air or in the sea; and this is not surprising if it be remembered that fresh supplies of ocean water and wind are always flowing past the icebergs, and distributing their cold over such wide areas that it becomes inappreciable. Even under the lee of Patagonia, where, in a sense, the ocean is full of icebergs for an area measured by hundreds of miles each way, it does not appear that any very remarkable effect on the temperature is produced, and near Australia, where now and then a few scattered icebergs are seen in the distant offing, no appreciable effect can result from their presence.

AT a recent meeting of the Academy of Sciences of St. Petersburg, Dr. S. Wild read an interesting paper on some improvements in the design and construction of magnetic instruments. The paper is divided into four parts, the first containing the results of some experiments which show that metallic wires are preferable to the silk threads usually employed for the suspension of the magnets in magnetographs. The second part deals with the question of the accuracy of the readings given by the instruments employed to record the variations in the magnetic elements, when these instruments are contained in buildings composed of a material (such as ordinary red brick) containing iron. The experiments on this subject, commenced in 1878, have been continued, and show very clearly that a brick building has no influence on the measurements of the strength of the field, while the influence on the dip is quite negligible. The above result has also been deduced theoretically by M. Chwolson by means of the known value of the susceptibility of the bricks. The third part of the paper contains a description of a small magnetometer for determining the value of the horizontal component of the earth's magnetism, designed for the use of travellers in countries where it would be difficult to carry the ordinary instruments. The instrument fits on Hildebrandt's small universal theodolite, which instrument is fitted with a compass. The combined instrument, although of small weight, is capable of giving results of considerable precision. Thus the dip can be determined to within half a minute of arc, and the horizontal component to within one part in four thousand. Lastly, the paper contains a description of some changes which Dr. Wild has introduced into the portable magnetometer.

IN the April number of the *Journal de Physique*, M. H. Abraham gives an account of a method for measuring self and mutual induction, which he says is capable of giving the quantity which is being measured to within one part in a thousand. The method employed consists essentially of balancing a steady current passing through one pair of coils of a differential galvanometer against a succession of induced currents sent, by means of a commutator rotating at a known speed, through the other coils. The commutator then being stopped, the secondary circuit, containing one pair of coils of the galvanometer, is connected with the extremities of a resistance r in the primary circuit. The value of r is altered till the galvanometer is undeflected, then, from a knowledge of the value of r and the speed of rotation of the commutator, the value of the mutual induction can be calculated. In many ways the method resembles that employed by Profs. Ayrton and Perry in their secohm-meter.

THE line spectrum of oxygen has recently found another careful investigator in Max Eisig, who gives an account of his work in *Wiedemann's Annalen*. The wave-lengths photographed and measured ranged from 2433·6 to 4710·4. The oxygen was generated by the electrolysis of water acidulated with pure phosphoric acid. The form of vacuum tube adopted was that consisting of two vessels joined by a thin tube at right angles to their length, which allowed the gas to be seen through the length of the tube. The end was closed by a plate of quartz to permit the passage of the ultra-violet rays. The tube was cleaned by flushing it with oxygen for several weeks. Of the four different oxygen spectra described by Schuster, only the elementary line spectrum was studied; 93 lines were recorded and measured. A comparison of these lines with a Rowland solar spectrum led to the conclusion that no identity between these oxygen lines and lines in the solar spectrum can be established.

PROF. JULIUS THOMSEN, universally known from his researches in thermo-chemistry, has just finished a series of observations on the ratio of the atomic weights of hydrogen and oxygen (*Zeit. für phys. Chem.* xiii. 398). In order to avoid the errors incidental to the direct methods of estimating the ratio, he employs an indirect method, which consists in estimating the ratio of the molecular weights of hydrogen chloride and ammonia. Pure hydrogen chloride is passed into a flask containing water, and the increase in weight is determined. Pure dry ammonia is then introduced into the solution until the hydrochloric acid is neutralised, and the weight again determined. After introducing all corrections, a large number of observations, in which the initial amount of hydrogen chloride varied between 4 and 20 gr. indicate that the value for the ratio, HCl/NH_3 is $2·13934 \pm 0·00009$. This number leads to the result that 1 : 16 represents the value of the ratio H : O with an accuracy as great as is warranted by the numbers in use for the atomic weights of chlorine and nitrogen, and which have of course to be employed in the calculation. Dumas and Erdmann and Marchand, from the synthesis of water from copper oxide and hydrogen, found respectively 1·0025 : 16 and 1·0017 : 16 as values of the ratio, and more recently Scott, from the volume composition of water, gives the higher value 1·0087 : 16.

IN a recent number of the *Centralblatt für Allgem. Pathologie* some exceedingly interesting experiments are recorded on immunity from the attacks of cholera germs artificially induced in the human subject. Drs. Sawtschenko and Sobolotny succeeded in preparing a vaccine from cultures of the cholera bacillus which so profoundly modified the system, that when they subsequently swallowed virulent cholera germs they experienced absolutely no evil effects whatever. But perhaps the most interesting results obtained, and which proved in a very remarkable manner the modification induced in the system by this vaccine, was the transmission of this induced immunity by means of blood serum to animals. Thus, twenty-five days after the last dose of vaccine had been taken, Sawtschenko and Sobolotny introduced some of their serum into guinea-pigs, and the latter were afterwards inoculated with virulent cholera bacilli. Instead, however, of these animals dying, as they usually do when treated with cholera bacilli, they remained alive. It was found that 0·01 g. of this human serum was sufficient to protect one of these animals subsequently treated with 0·006 g. of virulent cholera bacilli.

An inquiry into the pollution of the River Danube by the drainage from Vienna was carried out last year by Dr. Heider (*Das Österr.-Sanitätswesen*, 1893, No. 31). This river reaches Vienna in a satisfactory condition, containing about 2000 bacteria per cubic centimetre. The Danube canal on its way through the city receives the greater part of its sewage, resulting, as was to be expected, in an enormous accession of bacteria, 21,000—120,000 per c.c. being present. On uniting with the main-stream and becoming mixed with about seven times the volume of water, the pollution is chemically hardly discoverable. Bacteriologically, however, even 40 kilometres below the entrance of the canal, the contamination is still very easily perceptible, the rapidity of the current and the constant disturbance of the water by steam-boat traffic interfering with the efficient sedimentation of the bacteria present. Dr. Heider states that though the existence of disease germs in the water may be interfered with by the severe competition they would have to endure with the numerous harmless microbes, yet the vitality of, for example, cholera bacilli in river water has been shown to persist for several days, and in sewage for very considerable periods of time, so that too much reliance cannot be placed upon the efficiency of this factor. The action of light in destroying disease germs in the river, should they be present, is also discounted. Those who so ardently uphold the comfortable doctrine of the self-purification of rivers, permitting, as it does, of so inexpensive and ready a method of getting rid of sewage by turning it, without let or hindrance, into our streams, will gain but little support for their theories from Dr. Heider's report.

In the April number of the *Journal of Anatomy and Physiology*, Prof. R. Havelock Charles concludes an article on morphological peculiarities in natives of the Panjab, and their bearing on the question of the transmission of acquired characters. He shows that the bones of the lower extremity of the Panjabi adult have certain markings differentiating them from those of Europeans. Though these markings are found on the bones of the fœtus, the infant, and the child of the Panjabi, they are not found in the skeleton of either the European adult or child. Some of them have been found in the remains of Neolithic man in Europe, but are absent in the bones of peoples of the present day of similar geographical distribution. According to Prof. Charles, the explanation of this lies in the fact that the habits as to sitting postures of Europeans differ from those of their prehistoric ancestors, the cave-dwellers, &c., who probably squatted on the ground. The Orientals, however, have retained the sitting postures of their ancestors, and therefore exhibit similar markings. "Want of use," concludes Prof. Charles, "would induce changes in form and size, and so gradually small differences would be integrated till there would be total disappearance of the markings on the European skeleton, as no advantage would accrue to him from the possession of facets on his bones fitting them for postures not practised by him. The facets seen on the bones of the Panjabi infant or fœtus have been transmitted to it by the accumulation of peculiarities gained by habit in the evolution of its racial type—in which an acquisition having become a permanent possession 'profitable to the individual under its conditions of life' is transmitted as a useful inheritance. These markings are due to the influence of certain positions, which are brought about by the use of groups of muscles, and they are the definite results produced by actions of these muscles. . . . They are instances of the transmission of acquired character, which heritage in the individual function subsequently develops."

There are many evidences that a portion of the east coast of Florida was thickly populated in prehistoric times, and remains of this settlement are found in refuse heaps of villages and single habitations. These heaps are from a few square yards to many acres in extent, and from one to fifteen feet in depth. Some of their contents are described and figured by Dr. De Witt Webb, in an excerpt from the *Proceedings* of the U.S. National Museum (vol. xvi. No. 966). In connection with the remains, various members of the human skeleton have been found in positions which suggest cannibalism. There are hearths with accumulations of ashes and shells mingled with pottery (mostly in fragments) and implements and weapons of shell, all of which tell something of the mode of life of the race which apparently inhabited the region for many generations. As to the age of the heaps, Dr. Webb concludes it must be left to conjecture. Trees hundreds of years old are scattered over the remains, all instruments and implements of wood have long since perished, and not even a tradition is left to throw light upon the matter.

A second edition of "A Manual of Ethics" designed for the use of students, by Mr. John S. Mackenzie, has been published by the University Correspondence College Press.

Messrs. Cassell and Co. have commenced a new serial issue, in monthly parts, of Mr. W. Swaysland's "Familiar Wild Birds." In Part i. the Goldfinch and the Magpie are described and pictured. The descriptions, though brief, are very instructive, and the plates are extremely good.

In addition to the usual excellent summary of current researches, the *Journal of the Royal Microscopical Society* for April contains the fifth part of Mr. F. Chapman's paper on the foraminifera of the gault of Folkestone; a description of an inexpensive screen for monochromatic light, by Mr. J. W. Gifford; and an account of a gall-producing Copepod, *Enalstrogus Rhodymeniae*, sp. n., by Dr. G. S. Brady, F.R.S.

The long-expected work on the Carboniferous Insects of Commentry, France, upon which M. Charles Brongniart, of the Paris Natural History Museum, has been engaged some fifteen years, is now finished, and will appear in a few weeks. It forms a volume of 450 pages in quarto and an atlas of thirty-seven plates in folio. About 60 new genera and 100 new species are described. The work also contains a detailed study of the nervation of living *Neuroptera*, *Orthoptera*, and *Fulgoridae*.

A pamphlet, entitled "Notes on Birds of Central Mexico, with Descriptions of Forms believed to be New," by Mr. P. L. Jouy, has been issued as an excerpt from the *Proceedings* of the U.S. National Museum (vol. xvi. pp. 771-791). Most of the species enumerated are from the temperate table-land region corresponding to the southern borders of Arizona and New Mexico, and though few common tropical birds are given, the list will certainly be found valuable.

A propos of the early return of birds this year, Mr. J. H. Barbour, writing from Ballyholme, Ireland, says that on Saturday, April 28, about 10 p.m., he heard the corncrake several times, and it was heard in the district a fortnight before.

A LETTER has been received in reply to the one on "The Mass of the Earth," which appeared in our issue of April 19 (p. 575), but it was not accompanied by the author's name. If the author will send his name, the Editor will be glad to print his reply to "K."

DR. JENTINK, the Director of the Leyden Museum, reminds us that two specimens of *Rhinoceros simus* have formed part of the Museum collection for more than forty years, one of them being a remarkably fine animal. These are described in *Notes from the Leyden Museum* (1890, pp. 241–245), and we regret that they were not mentioned in the note on the two specimens recently modelled by Mr. Rowland Ward, printed in NATURE of April 19 (p. 584).

WE know of no collection of text-books in which the theory underlying industrial machines and processes is set forth in a more scientific and thorough manner than it is in the works of the Encyclopédie Scientifique des Aide-Mémoire series, edited by M. Léauté, and published by Gauthier Villars, and by Masson. Two of these volumes, which have recently appeared, deal with freezing machines, one being devoted to the machines depending upon easily liquefiable gases, and the other to machines in which air, or one of the so-called permanent gases, is caused to expand rapidly, and thus bring about a decrease of temperature. The titles of the two books are, respectively, "Machines Frigorifiques a Gaz Liquéfiables" and "Machines Frigorifiques a Air," and their author is M. R. E. de Marchena. Another volume, just added to the series, is "Construction and Resistance des Machines a Vapeur," by M. Alheilig.

WE have received the sixteenth yearly volume of *Aus dem Archiv der Deutschen Seewarte*, 1893, containing seven important discussions in meteorology and terrestrial magnetism. The current number of this valuable publication inaugurates a new departure, as a considerable amount of routine matter has been removed to another periodical, in order to make room for scientific discussions, and to allow of the work being brought out with less delay than heretofore. It is not practicable to mention here the whole of the subjects dealt with: among the most original investigations not already referred to in our columns are papers by Dr. C. Kassner on "Circular Cyclones," and by Dr. W. Köppen and Dr. H. Meyer, on the frequency of the various amounts of cloud as a climatological element. This last paper embraces the results of a number of long series of cloud observations in different parts of the globe, and a part of the North Atlantic Ocean.

IN general, a work which has reached a seventh edition needs no better testimony of its good qualities than that to be found in the fact of its survival. This is the case with Sir David Salomon's "Electric Light Installations and the Management of Accumulators," which is being issued by Messrs. Whittaker and Co. The edition has been mostly rewritten, and will be completed in three volumes. The first volume appeared a short time ago, and was confined entirely to the treatment of accumulators. Vol. ii., which has just been issued, deals with engines, dynamos and motors, and numberless pieces of apparatus concerned in the generation and utilisation of electricity. Special applications of such apparatus are reserved for description in vol. iii., now in the press. In the three hundred pages of which the second volume consists, as many as 296 illustrations are crowded; but as the author has confined himself to the representation of typical forms of instruments, he has saved the book from being merely an illustrated trade catalogue.

THE Cambridge University Press will shortly publish a treatise on the "Steam Engine and other Heat Engines," by Prof. Ewing; the seventh volume of the edition of Prof. Cayley's collected papers, and the first volume of the collected papers of the late Prof. Adams. An "Elementary Treatise on Electricity and Magnetism," by Prof. J. J. Thomson, is in the press, and also a new edition of Prof. Lamb's "Hydrodynamics," largely rewritten and extended. An "Elementary Treatise on Hydrostatics," by Mr. John Greaves, has just appeared, and a Key to Mr. C. Smith's "Arithmetic" is nearly ready. The completion of Mr. H. M. Taylor's "Euclid" is also announced, and will be published in August. The second volume of Dr. Creighton's "History of Epidemics" may be expected shortly, and a new volume of the Royal Society's Catalogue. In the series of Cambridge Natural Science Manuals, Mr. Glazebrook's volumes on "Light" and "Heat," recently published, will be followed by volumes by the same writer on "Mechanics and Hydrostatics," and on "Electricity and Magnetism," and by Messrs. Darwin and Acton's "Physiology of Plants."

DR. J. P. VAN DER STOK, the Director of the Batavia Meteorological Observatory, has sent us a report of the rainfall observations made in the East Indian Archipelago during 1892. This "Regenwaarnemingen in Nederlandsch-Indie" has now reached its sixteenth year. From it we learn that observations were made in 192 stations during 1892, of which 104 were in Java and Madoera, and 88 in Sumatra and other islands in the Archipelago. In addition to the volume of rainfall observations, the Government of Netherlands India has published one containing the observations made at the magnetic and meteorological observatory at Batavia during 1892, being the fifteenth volume of the "Observations" of the Observatory. No science can claim so many disciples as meteorology. There is scarcely a corner of the world, inhabited by civilised man, in which the temperature is not recorded and the rainfall measured. Indeed, the thermometer and the rain-gauge are the instruments by means of which the first continuous scientific observations are made in most parts of our globe. Meteorological observations, therefore, rapidly accumulate, and the volumes containing them have almost become unmanageable, both as regards number and size. One is sometimes tempted to ask whether these masses of statistics are worth publication, but the remembrance of past discoveries—such, for instance, as Schwabe's discovery of the solar cycle from his daily records of the state of the sun's surface during a quarter of a century—shows the importance of recording all observations that good may come from them.

A FURTHER paper by M. Lobry de Bruyn, of Amsterdam, upon the subject of free hydroxylamine, is contributed to the current issue of the *Berichte*. It contains an account of a number of experiments upon the stability of the isolated base, together with additional observations upon the mode of preparation. When M. de Bruyn prepared his large quantity of solid hydroxylamine three years ago, several small quantities, amounting to five or six grams in each case, were sealed up in small bottles previously cleansed with acid, and preserved in a dark room. Upon recently examining the contents, they were found to be mostly liquid, indicating a certain amount of decomposition. The melting point of pure hydroxylamine is 33°; two of the liquefied specimens referred to solidified again at 28°·5 and 25°·2 respectively. The amount of decomposition, however, is not very great, three of the specimens being found to contain 93, 84, and 73 per cent. respectively. Hence free hydroxylamine appears to be a tolerably stable substance at ordinary low temperatures, but the stability diminishes rapidly with rise of temperature. The decomposition is accompanied by the liberation of bubbles of nitrogen and nitrous oxide. The change appears to be one of self-oxidation and reduction, one portion eliminating oxygen and forming ammonia, and another part suffering oxidation to nitrous and hyponitrous acids, which combine or react with the ammonia and a further quantity of hydroxylamine. As hydroxylamine nitrite spontaneously decomposes, as M. de Bruyn has shown by experiment, it is probable that the hyponitrite of the base is incapable of existence; hence the liberation of nitrogen and nitrous oxide is fully accounted for. M. de Bruyn states that in preparing large quantities of the solid base by fractional distillation of the methyl alcohol solution under diminished pressure it is preferable, after distilling off the methyl alcohol, to divide the residue rich in hydroxylamine among several distilling flasks, and to thus complete the fractionation in small portions. For it is a somewhat remarkable fact that the yield is very much larger when the distillation occurs in this manner; it would appear that the amount of decomposition considerably increases with the bulk of liquid distilled. Moreover, the risk of explosion upon temporarily arresting the distillation in order to change the receiver, is greater with larger quantities, but usually an explosion may be prevented by immersing the distilling flask in cold water during the rapid change of receivers. Taking this precaution, M. de Bruyn has safely distilled as much as half a kilogram of the pure base.

ERRATUM.—In NATURE of April 26 (p. 603), and on the tenth line from the bottom of the first column, for "mosses" substitute "mirses."

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*) from India, presented respectively by Mr. C. Palmer and Miss A. Orvis; two —— Jackals (*Canis variegatus*), two Fennec Foxes (*Canis cerdo*), two Pale Fennec Foxes (*Canis pallidus*), a Syrian Fennec Fox (*Canis famelicus*), an Egyptian Cat (*Felis chaus*), a —— Genet (*Genetta*, sp. inc.), a —— Zorilla (*Ictonyx frenata*), a Crested Porcupine (*Hystrix cristata*), two —— Gerbilles (*Gerbillus*, sp. inc.), two Lesser Egyptian Gerbilles (*Gerbillus aegyptius*), three Spiny Mice (*Acomys*, sp. inc.), six —— Uromastix (*Uromastix ornatus*) from Suakin, a Libyan Zorilla (*Ictonyx lybica*), two Dwarf Jerboas (*Dipodillus*, sp. inc.), four Spiny Mice (*Acomys*, sp. inc.), three —— Hedgehogs (*Erinaceus auritus*), two Egyptian Jerboas (*Dipus aegyptius*) from Egypt, presented by Dr. John Anderson, F.R.S.; a Wattled Crane (*Grus carunculata*), two Cape Crowned Cranes (*Balearica chrysopelargus*) from South Africa, presented by Sir H. B. Loch, G.C.B., G.C.M.G.; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. John Penn, M.P.; two Robben Island Snakes (*Coronella phocarum*) from South Africa, presented by Mr. Barry McMillan; an Indian Civet (*Viverricula malaccensis*) from India, a Long-Legged Buzzard (*Buteo ferox*) captured in the Red Sea, a Mexican Deer (*Cariacus mexicanus*) from Mexico, deposited; four Red-headed Pochards (*Fuligula ferina*), European, purchased.

OUR ASTRONOMICAL COLUMN.

AN ASTRONOMICAL EXPEDITION FROM HARVARD.—A party, in charge of Prof. W. H. Pickering, will soon set out from Harvard College Observatory (says *Astronomy and Astro-Physics*) to establish an observing station somewhere in the State of Arizona, the principal object of the expedition being to observe Mars during the favourable opposition this year. The chief instrument to be conveyed to the site chosen is an eighteen-inch refractor by Brashear, the objective of which was exhibited at the Chicago Exposition. Mr. Percival Lowell, of Boston, who has generously provided the funds for the expedition, will accompany it as an observer.

ELEMENTS AND EPHEMERIS OF GALE'S COMET.—*Edinburgh Circular*, No. 42, contains the subjoined ephemeris for Gale's comet, computed by Mr. A. J. Ramsay.

Ephemeris for Greenwich Midnight.

1894.	R.A. h. m. s.	Decl. ° ′	Brightness.
May 3	8 17 17	7 20·6	
4	8 28 4	S. 3 26·6	5·42
5	8 38 18	N. 0 16·6	
6	8 48 1	3 47·4	
7	8 57 10	7 3·7	
8	9 5 49	10 5·7	3·97
9	9 13 59	12 52·7	
10	9 21 42	15 25·6	
11	9 28 57	17 45·4	
12	9 35 52	19 52·7	2·70
13	9 42 22	21 48·2	
14	9 48 28	23 33·3	
15	9 54 16	N. 25 10·7	2·00

The brightness at the time of discovery has been taken as unity.

THE HATCHERY FOR SEA FISHES, OF THE FISHERY BOARD FOR SCOTLAND AT DUNBAR.

IN recent years, owing to over-fishing, the scarcity of certain important marine food-fishes has become manifest in many countries, and as one way of meeting the constant drain on the fishing grounds, sea-fish hatcheries have been established in the United States, Newfoundland, Canada, and Norway. A year or two ago the Fishery Board for Scotland began the erection of a similar establishment at Dunbar, which has lately been completed; and for the last five or six weeks active operations have been going on in hatching plaice, with complete success, under the charge of Mr. Harald Dannevig, a Norwegian expert, whose services have been obtained by the Fishery Board. The hatchery consists of (1) a tidal pond; (2) a large "spawning" tank; (3) a chamber for the collection of the eggs and for filtering the water; and (4) the house in which the hatching apparatus is placed. The spawning fishes, male and female, number about 350, and are confined in the large elevated spawning tank (made of concrete) through which a constant current of sea water is maintained. They range from about 14 to 27 inches in length, and are vigorous and feed well. In this tank, which has a capacity of over 60,000 gallons, the fishes spawn naturally, just as they would in the sea; and as the eggs are buoyant they rise to the surface, or near it, and are collected in hundreds of thousands at a time in a specially constructed apparatus placed at the point where the overflow from the tank occurs. The fertilised eggs, which are among the largest of the pelagic forms, are then transferred to the apparatus in the hatching room, through which a continuous circulation of pure sea water is kept up. The hatching takes nearly three weeks to accomplish, and the little fishes are retained for some time after hatching until the yolk is almost absorbed. In smaller vessels with a higher temperature, hatching occurs more rapidly, but the period named (three weeks), probably approaches the normal period in the sea. The number of plaice eggs and larvae at present in the hatching boxes is 8,500,000, and over 7,700,000 fry have been already put in the Firth of Forth by the s.s. *Garland*. The supply of sea water required is considerable, and is obtained by means of two double-acting steam pumps, capable of throwing over 7000 gallons an hour, and driven by an 8 h.p. locomotive boiler. Before being conducted to the hatching apparatus, the water passes through a series of flannel filters, but from its purity when it comes from the sea the filtration gives little trouble. Strong evidence of the suitability of the water for the purpose, and of the satisfactory working of the arrangements, is afforded by the very low death-rate, that is to say, the proportion of eggs which succumb in the process of hatching. At Dunbar it has not exceeded 4 per cent.—a much lower death-rate, so far as known, than at any other marine hatchery. At the Newfoundland hatchery the death-rate has varied from about 37 per cent. to nearly 50 per cent. in different years:

and at the Norwegian hatchery the rate has been even higher. At these establishments, however, the ova of the cod have alone been dealt with, and they are somewhat more delicate than those of the plaice. Nevertheless, check observations with 500,000 cod eggs at Dunbar show a death-rate under 4 per cent. The density of the water has remained practically constant at a little over 1027; the temperature, which at the beginning of March was 4°·5 C., has gradually risen to 6°·3 C., and the hatching process is becoming accelerated.

So far as can be judged at this period, it is probable that the "turn-out" of young plaice during the present season will exceed 30,000,000—a much larger number than has been turned out in the first year at any other sea-fish hatchery. In Norway the first year's issue was 5,095,000 cod (it is now over 200,000,000), and at the Newfoundland establishment it was 17,000,000 cod. This is the first occasion in which plaice, or indeed any flat-fish, have been hatched on a large scale. It was anticipated that there might be difficulties in getting the fishes to spawn under the somewhat unnatural conditions; but none occurred. It is expected that, in the course of the summer, when the spawning period of the plaice is over, that somewhat valuable fish, the common sole—which is rare in Scottish waters—will be dealt with, as well as the lemon sole, and possibly the turbot. All these fish are becoming scarcer and dearer.

The present plant at the Dunbar hatchery—viz., the spawning pond, filtering apparatus, boiler, pumps, &c.—is adapted for a hatching house about three times as large as the present one. When the latter is extended, and the hatching apparatus increased, there will be no difficulty in turning out many hundreds of millions of the fry of the food-fishes every year. The actual hatching—and in many cases the rearing—of almost all the food fishes, has been accomplished for scientific purposes by Prof. McIntosh at the neighbouring laboratory at St. Andrews, and the experience thus gained will be of the greatest utility in carrying on the work from the commercial point of view. It is anticipated that large rearing ponds will be added, to enable the young flat-fish to be kept until they assume the habits of the adult, and thus greatly increase the usefulness of the establishment to the fishery industry.

T. WEMYSS FULTON.

THE FORTHCOMING CONGRESS OF HYGIENE AND DEMOGRAPHY.

FROM a circular just received, we learn that satisfactory progress has been made with the arrangements for the eighth International Congress of Hygiene and Demography, to be held at Budapest, from September 1 to 9. The work of the Congress will be carried out in two divisions, relating respectively to hygiene and demography. Hygiene comprises nineteen, and demography seven, sections. In Section I. of the former division (the etiology of infectious diseases, or bacteriology), notices of thirty papers had been received up to March 31; in Section II. (the prophylaxis of epidemics), thirty-six papers are at present announced; in Section III. (the hygiene of the Tropics), twelve papers; in Section IV. (the hygiene of trades and agriculture), twenty-nine papers; in Section V. (the hygiene of children), twenty-eight papers; in Section VI. (the hygiene of schools), thirty-nine papers. Thirty-six papers have been notified in Section VII. (articles of food); thirty-eight in Section VIII. (the hygiene of towns); eleven in Section IX. (the hygiene of public buildings); nine in Section X. (the hygiene of dwellings); seventeen in Section XI. (the hygiene of communications, that is, of railroads and navigation), and twenty-four in Section XII. (military hygiene). Fourteen papers are promised on the saving of life (Section XIII.), thirty-three on State hygiene (Section XIV.), six on the hygiene of sport (Section XV.), twenty on the hygiene of baths (Section XVI.), thirty-eight on veterinary matters (Section XVII.), seventeen on pharmacology (Section XVIII.), and eleven on general sanitarian affairs (Section XIX.).

The demographic sections of the Congress are (1) historical demography; (2) general demography and anthropometry; (3) the technicalities of demography; (4) the demography of the agricultural classes; (5) the industrial workmen from a demographic point of view; (6) the demography of towns; (7) the statistics of bodily and mental defects. Papers for each of these sections have been received or promised. Up to the end of March the total number of papers announced was 535, of which 437 belong to the hygiene division, and 98 to demography. There seems every probability that the Congress will be a worthy success or to former ones as regards the scientific value of the work, and its international character is vouched for by the fact that nearly 250 official delegates have been nominated.

In accordance with a resolution passed at the Congress of Hygiene and Demography held in London in 1891, an international committee has been formed to prepare for discussion questions relating to the cause and prevention of diphtheria. This committee contains the representatives of fifteen different nationalities, as follows:—Austria, Prof. Wiederhofer; Bavaria, Prof. Henry Ronde; Belgium, Dr. E. Tordeus; England, Dr. Edward Seaton; France, Dr. F. Roux; Germany, Prof. Frederic Loffler; Hungary, Dr. Cornelius Chyzer; Italy, Prof. Luigi Pagliani; Norway, Prof. Axel Johanessen; Roumania, Prof. Maldarescu; Russia, Prof. Nicolas Filator; Spain, Prof. Francisco Criado y Aquilar; Sweden, Prof. E. Almquist; Switzerland, Prof. Haganbach-Burkhardt; United States of America, Prof. S. Billings.

An exhibition will be held in connection with the Congress, but only of objects which serve to elucidate and exemplify questions brought up for discussion, and those which mark real progress in sanitary matters and public health. This is done in order to prevent the exhibition from becoming a vehicle for trade advertisement. No awards will be made, but objects of special importance will be named in the minutes of the closing meeting. No charge will be made for space, and objects sent in are duty free. Intending exhibitors must give notice before May 15 to the General Secretary, Prof. Dr. Coloman Müller, St. Rochus Hospital, Budapest, who will supply the proper application forms.

Membership of the Congress can be obtained by transmitting the amount of £1 (for ladies the sum is 10*s.*) to Prof. Müller. This fee entitles the sender to admission to all the meetings, excursions, and various social gatherings arranged, to a copy of the Proceedings of the Congress, and to railway journeys at reduced rates.

The Corporation of Budapest will hold a reception in the halls of the Town-Redonte, and a garden party in the grounds of the National Museum. All the learned societies and bodies interested in the work of the Congress have also made arrangements for receptions. At the Royal Opera House, the National Theatre, and the People's Theatre, special representations will be given in honour of the meeting; in fact, there is every reason for believing that members will come away with a favourable impression of Hungarian hospitality. As to the more serious side of the meeting, the list of papers down to be read shows that there will be no dearth of subjects for discussion. A number of important questions will therefore be ventilated, and even if many of them fail to elicit a definite opinion, a clearing of ideas is bound to result from their discussion.

SEWER GAS AND TYPHOID FEVER.

IT is now more than thirty years ago since two eminent physicians discussed, with some heat, in the columns of the medical papers and elsewhere their theories on the origin and distribution of typhoid fever. While Dr. Murchison and his party regarded the exhalations from drains as the *specific cause* of typhoid, Dr. Budd and his supporters argued that the gases from putrid liquids were only capable of producing this disease in the presence of some particular contagion. The discussion was taken up on the continent, and the sewer-gas theory was vigorously fought over, but towards 1880 the whole subject was revived, and its supporters were later confronted with the results of bacteriological investigations on sewer-air, which showed that there were not more organisms present in drains than in the outside air, and that under normal conditions, currents of air were unable to detach disease microbes, should they be present, from the effete materials present in the sewer.

Meanwhile English hygienic authorities, without waiting for the scientists to make up their minds on this crucial question, preferred to act, at any rate, on the assumption, supported as it was by much experience and many facts, that the exhalations from drains were undesirable and dangerous in our houses and surroundings, and should be rigorously excluded. The advance in sanitation, and its splendid results during the past ten years or so, is a sufficient testimony to the wisdom of the agitation which determined the crusade against bad drainage and unsanitary appliances in this country.

But the inquiring spirit of the scientist, which abhors blind empiricism, and seeks always to reach the root of the matter, has again been exercising itself on the question of the spread of disease by sewer-gas, and it is significant that in the most recent report to hand on sewer-air, the direct connection of the latter with the distribution of zymotic disease is declared to be still wrapped in mystery and uncertainty, and we find our precise and scientific information on this subject as meagre as it was some thirty years ago. All the more important and welcome, therefore, are some very original investigations which have just been published by Dr. Alessi, who has not contented himself with finding very few and harmless microbes in sewer-air, but has submitted the whole question of its relation to typhoid fever to a searching experimental inquiry.

For this purpose the effect of inhaling sewer-air and the gases from putrifying materials was examined on animals—rats, rabbits, and guinea-pigs being selected. After exposure to sewer-air, which was accomplished by placing them in a box with a perforated bottom communicating directly with a drain, they were inoculated with a small quantity of only a slightly virulent cultivation of the typhoid bacillus, whilst other animals were similarly treated, except that they were not compelled to inhale these noxious gases, but were kept in their ordinary surroundings. The rats, after inhaling this foul air, began to lose their vivacity, and after a time grew thin, although they eat voraciously, and out of forty-nine which were inoculated with typhoid germs thirty-seven died exhibiting the typical symptoms of typhoid infection. Of those forty-one rats, however, which, although infected with typhoid, had not inhaled sewer-air, only three succumbed. Thus the inspiration of drain-air had so far predisposed these animals to infection from typhoid that a small dose of an almost harmless growth of this organism proved very fatal to them. Guinea-pigs and rabbits exposed in like manner to gases from materials in a condition of active decomposition also acquired a predisposition to typhoid infection, for out of seventy-two guinea pigs inoculated, fifty-seven died, whilst not one of those treated with typhoid germs in ordinary surroundings succumbed. Every one of the eleven rabbits similarly treated died, but not one of the inoculated animals kept in ordinary surroundings. Dr. Alessi also found that the inhalation of these gases from putrid substances enabled a small dose of a weakened culture of the *B. coli communis*, normally present in the intestine, to produce fatal results when purposely introduced into the animals thus exposed.

It was also ascertained that it was during the first two weeks of exposure to these noxious gases that the animals were most easily predisposed to typhoidal infection, for no less than ninety per cent. of all the animals inoculated during the first fortnight died, whilst seventy-six per cent. succumbed of those inoculated in the third week. This fact may, says Dr. Alessi, partly explain how it is that some people who habitually breathe contaminated air do not appear to suffer any evil results, having gradually in course of time become accustomed to it, whilst a stranger exposed to the same conditions without previous experience may suffer very severely. The degree of predisposition, however, whilst varying in different animals, would also vary in different people.

These investigations must be regarded as a noteworthy and an important contribution to our knowledge of the distribution of hygiene, affording as they do so remarkable an experimental confirmation of the wisdom of a policy of sanitation dictated by instinct and intuition.

ANOTHER NEW BRANCHIATE OLIGOCHÆTE.

About two years since I described in the columns of this journal (vol. xlv. p. 189) an Annelid belonging to the family Tubificidæ, which was unique in that family in the possession of a series of branchial processes upon the posterior segments of the body. This worm, as I reminded the readers of NATURE in Jan. 11 (vol. xlix. p. 247) was found in the "Victoria Regia tank" at the Botanical Society's Gardens—a locality which has produced many interesting invertebrate animals. I have now to record the existence of another Oligochætous Annelid in which branchial processes of a very similar nature to those of *Branchiura sowerbyi* are found. This worm was sent to me by Dr. Michaelsen, of Hamburg, a well-known authority upon this group of animals; it had been collected by him in South America during a recent expedition for collecting purposes to that country. With great generosity he has handed over to me for study the bulk of the Oligochæta which were brought home by him from Patagonia, the Argentine, and Chili; and the species upon which I desire to say a few words here was among those worms. It was discovered in the river at Valdivia, in Chili. The worm, like *Branchiura*, is a member of the family Tubificidæ, but it clearly represents a new genus of that family, into the general characters of which I do not propose to enter here. The collection contains several species of this new genus, for which I suggest the name of *Hesperodrilus*. The gilled species is not unlike the common *Tubifex* of our streams and lakes in outward appearance, but it differs from *Tubifex* and agrees with *Branchiura* in having a series of branchial processes attached to some of the posterior segments of the body; as I have only examined one specimen, it is impossible to say whether the limited number of these gills, in comparison with those of *Branchiura*, is a distinguishing mark; but, in any case, they differ by reason of the fact that they are lateral in position, being attached to the body just below the lateral setæ; in *Branchiura* it will be remembered that they are dorsal and ventral in position (cf. *Quart. Journ. Micr. Sci.* March, 1892, for the more complete description of *Branchiura*). It is well known that the Tubificids, as a rule, live imbedded in the mud with the tail—and not the head—end extruded, and generally waving about in the water; it is thus intelligible how the development of gills upon the posterior, rather than the anterior, end has come about. The single specimen which I have examined possessed about thirteen pairs of branchiæ; these were at first very small, but gradually increased in size towards the end of the body, those upon the terminal segments being, if anything, larger than those upon any of the preceding segments; in *Branchiura* the gills diminish in length towards the extremity; it may be that my specimen of *Hesperodrilus branchiatus* had recently lost the tail, but there were no obvious signs of this. The genus differs from *Branchiura*—and, indeed, from any other genus of Tubificidæ known, unless my *Phreodrilus* be accounted a Tubificid—in that the spermathecæ (which are unusually long) open *behind* the male pores, instead of, as in the other Tubificidæ, *in front of* them. I mention this point to show that I have not confounded this new gilled Tubificid with *Branchiura*.

FRANK E. BEDDARD.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In a congregation held on April 26, Prof. A. H. Green and Prof. C. Lapworth were appointed Examiners in the Final School of Natural Science (Geology), and Prof. H. Marshall Ward and Prof. F. W. Oliver were appointed Examiners in the same school in Botany. All the appointments were made for one examination only.

Notice is given that the final examination for the degree of Bachelor of Medicine will begin on Monday, June 4. Names to be sent in by May 19. The examination for the degree of Master of Surgery will begin on Wednesday, June 13. Names to be sent in by May 30. The first examination for the degree of Bachelor of Medicine will begin on Friday, June 22. Names to be sent in by June 7.

The degree of D.C.L. *honoris causa*, was conferred on Wednesday on Prof. August Weissmann.

At a meeting of the Board of Faculty of Natural Science on Tuesday last, new regulations for the preliminary examinations in Animal Morphology and Animal Physiology were approved of. The new regulations will come into force in Michaelmas Term, 1894.

At a meeting of the council of University College, Liverpool, held on Tuesday, it was announced that Lord Derby had telegraphed his intention to provide for the endowment of the chair of Anatomy. It was resolved that Lord Derby be requested to allow his name to be permanently associated with the chair. Formal intimation was also given of the endowment of a chair of Pathology by Mr. George Holt with £10,000. It was decided that the new chair should be called the George Holt Chair of Pathology, and that candidates for the chair should be invited to send in their names. Another announcement made was that Mr. Henry Tate would present to the Tate Library a collection of standard books of the value of £5,500. The endowment of the chairs of Anatomy and Pathology completes the provision necessary in order to bring the medical department of the College into rank with similar departments at the older Universities and at Owens College, Manchester.

THE arrangements for the University Extension Congress, to be held in London in June next, have been announced. There are several reasons which render the present year opportune for such a gathering. In the first place, the University Extension movement attains its majority, the first Courses of Lectures having been arranged by the University of Cambridge in the autumn of 1873. And secondly, University Extension work has a defined place in the scheme for the establishment of a Teaching University for London. In view of the anticipated establishment of a Teaching University on the lines laid down in the Report of the Royal Commission, it is important to sum up and present the educational results of the twenty-one years' work in University Extension, and to consider, in the light of past experience, practical proposals and a general policy for the future of the whole movement.

The Congress, which will meet in the Lecture Theatre of the University of London, will include three sessions, to be held on Friday afternoon, June 22, and Saturday morning and afternoon, June 23. The Marquis of Salisbury, the Duke of Devonshire, and Lord Herschell, will preside at the three sessions respectively.

The subjects for discussion will be :—

(1) The means of preserving and further developing the educational character of University Extension work, and the relation of the more popular to the more strictly educational side of the movement.

(2) The essentials of efficient central and local organisation, and the relation, educational and financial, of the University Extension Movement to the State and to local authorities.

(3) The educational possibilities of University Extension work and methods in relation to regular University studies and University degrees.

These subjects will be considered beforehand by a committee or committees of experts, who will present reports and formulate the resolutions to be submitted for discussion to the Congress. The Right Hon. the Lord Mayor has intimated his intention of inviting the members of the Congress to a reception at the Mansion House on the evening of Friday, June 22.

AT the last meeting of the Council of the Durham College of Science, Mr. Henry Palin Gurney, formerly Fellow of Clare College, and Deputy-Professor of Mineralogy in the University of Cambridge, was appointed Principal.

SCIENTIFIC SERIALS.

American Meteorological Journal, April.—"Storms of the Gulf of Mexico and their prediction," by W. D. Stearns. Many of the storms which enter the United States from the Gulf of Mexico are very destructive, and give scarcely any indication of their approach by means of the barometer. The author has made a special study of local conditions and cloud movements which preceded a number of storms in 1892 and 1893, and thinks that by those means their presence may be detected in every case some hours in advance of their arrival. Notes are given of the phenomena preceding several storms.—A new chart of equal annual ranges of temperature, by J. L. S. Connolly. The chart was constructed on the basis of Dr. Buchan's "Challenger" isothermal charts. It shows that the torrid zone is, on the whole, a region of moderate annual range of temperature, while the north temperate zone has extreme variations compared with the south temperate. The effects of solar and terrestrial radiation are well shown; in northern Asia there is a range of 120°, and of 80° in the northern part of North America.

Bulletins de la Société d'Anthropologie de Paris, tome iv. No. 12.—This number contains a valuable memoir by M. L. Manouvrier on the normal and abnormal variations of the nasal bones in the human species. Whatever may be the original cause of variation, it is interesting to observe that that cause is sufficient to produce in one and the same race individual varieties suggesting all kinds of ethnic types. In one case, figured by M. Manouvrier, the nasal bones are entirely suppressed, their place being supplied by the frontal bone.—M. G. de Mortillet proposes an important reform in chronology; he points out the inconvenience of using several different eras, such as the Foundation of Rome, the Birth of Christ, the Flight of Mohammed, or the Proclamation of the Republic, and suggests that 10,000 years before the Christian era should be adopted as a general starting point; this would not only include all Egyptian chronology, as known at the present day, but would also leave 5000 years at the disposal of future discoverers.—At the Broca conference, Dr. Capitan delivered a lecture on the rôle of microbes in society.—M. J. Deniker has contributed a paper on the natives of Lifou, one of the Loyalty Islands. The average stature of these islanders is somewhat below middle height (1642 mm.), although in the case of four individuals out of the ten examined by Dr. Francois, whose observations form the basis of this communication, the stature was from 1670 to 1690 mm.; the head is dolichocephalic (cephalic index = 72·4), and the nose is platyrrhine (nasal index = 97·8); five out of the ten subjects were hyperplatyrrhine (index 101 to 117). The colour of the skin, in the majority of those examined, resembled chocolate with a reddish tinge (28–29 Broca), while one of them had a light brown skin, and two others were black. The colour of the iris varied from brown to dark brown, the darker tinge predominating.—In a paper on family property in Anam, M. Paul Denjoy describes the organisation of the family, the prescriptions of the law with regard to succession and wills, and the extensive system of registration employed. He gives a good general idea of Anamite legislation, and of the principles that underlie it. The number includes several short communications of much interest.

Wiedemann's Annalen der Physik und Chemie, No. 4.—On the formation of floating metallic films by electrolysis, by F. Mylius and O. Fromm. A zinc plate is laid on the bottom of a glass jar, and is covered with a layer of 50 per cent. solution of zinc sulphate. A platinum wire 0·2 mm. thick touches the surface of the solution vertically. On passing a current from a 3-volt battery through the solution, a bright film of metallic zinc is formed round the platinum cathode, which gradually expands, and exhibits an approximately circular form, but subsequently becomes irregular. The phenomenon does not take place unless the surface of the solution is tainted with some substance insoluble in water, such as oil of turpentine. This may form a separate thick layer, and the film is produced at the separating surface. It may also be produced at the lower surface of the zinc sulphate solution by first pouring a layer of chloroform on to the zinc anode. Other metals, such as iron, cobalt, cadmium, silver, show analogous phenomena.—On the elasticity and tenacity of some new glasses as dependent upon their chemical composition, by A. Winkelmann and O. Schott. The coefficients of elasticity, and those of resistance to tension and pressure, were determined experimentally for eighteen kinds of glass. The first lies between 4699 and 7592 kg. per sq. mm. The second lies between 3·5 and 8·5 kg. per sq. mm., and the third between 60·6 and 120·8. These results may be represented by formula depending upon chemical composition, the calculated values varying by 3 per cent. from the observed ones in the case of elasticity, and about 8 per cent. in the case of tenacity.—On the coefficient of thermal resistance of different glasses as dependent upon chemical composition, by the same authors. The thermal resistivity is the property enabling glasses to withstand sudden cooling without breaking. It depends upon the elasticity, the tenacity, the thermal expansion and conductivity, the specific heat, and the specific gravity of the glass in question. In most cases the resistivity can be calculated with fair approximation if these properties are known.

Internationales Archiv für Ethnographie, vol. vii. parts 1 and 2.—The new volume of this useful journal is continued along the same lines as the previous volumes; the publisher only is changed. Heer Trap still prints the letter-press, and turns out the plates in his usual skilful manner. Prof. G. Schlegel gives the first published illustration and full description of "A Canton Flower-boat," or, as it should be called, "Gaudy Boat." These are really floating cafe-chantants, in which the greatest decorum prevails; they are hired for evening festivals and suppers, by wealthy officials and others.—Leo V. Frobenius has an interesting article, illustrated by three plates, on "Ceramics and their origin from Wood-carving in the Southern Congo Basin." He deals with the pottery trade, the form of clay vessels, wooden vessels, ornamentation, images in wood and clay, &c. He comes to the conclusion that the leather-work is the oldest industry of the Negro, and was followed by wood and plaited work, from which finally arose ceramics. The author agrees with Schurtz that a Wooden age replaced the Stone age in Africa, and was followed by the Iron age: the latter took place quickly on account of the superiority of iron weapons and utensils over wooden ones, but pottery slowly superseded wooden vessels and gourds, and has undergone only a slight development. The second part is mainly taken up with an elaborate article by J. Walter Fewkes, on the "Dolls of the Tusayan Indians." These are carefully described, and their symbolism is noted; coloured illustrations are given of forty-three of them. He points out that the characteristic details are always found on the head, and adds, "this fact is one which gives a great importance to the study of helmets, masks, and all cephalic decorations which are used in ceremonial dances."—Prof. P. J. Veth, on "Signature-lore" (De Leer der Signaturer; signature being "the resemblance of a vegetable or a mineral to any part of a man's body."—The first part of an essay of a branch of sympathetic magic deals with the subject in general, and a detailed account of the Mandrake (*Mandragora*).—R. Parkinson sends a note, which is illustrated, on the boring of shells in the manufacture of armrings, &c. The shell is partially embedded in and lashed to a board, and the hole is drilled by means of a bamboo cylinder, to which a flat stone is fastened as a fly-wheel, sand and water is used as emery; when half cut through, the piece of shell is reversed.

Annalen des K.K. naturhistorischen Hofmuseums, Bd. viii. Nos. 2, 3-4. (Wien: A. Holder, 1893.)—Dr. O. Finsch, in the last number of this publication, completes his "Ethnologische Erfahrungen und Belegstücke aus der Südsee." The sub-title describes this as a descriptive catalogue of a collection in the Vienna Museum. It rarely happens that an ethnological collection in a museum is so fully described as this has been, but in this case the author describes the specimens he has himself collected. The catalogue commenced in the third volume (1888) of the *Annalen*, and now concludes, having run to 675 pages, and having been illustrated by twenty-five plates and numerous illustrations in the text. But it is more than a mere illustrated catalogue, for the author has incorporated original ethnological investigations as well as given authentic accounts of the various objects enumerated. The whole series of papers forms an invaluable addition to the libraries of museums and of those interested in such subjects. The current numbers contain Dr. Finsch's account of the Marshall Archipelago and of the Caroline Islands, including Kuschai, Ponape, Ruk, and Mortlock; to this are appended addenda to and corrections of statements in the earlier papers, and several indices.—Eight new species of Hymenoptera belonging to the genus *Gorytes*, Latr., are described by A. Handlirsch (p. 276).—Prof. F. Toula has (p. 283) a preliminary communication on the fauna of the Miocene beds of Kralitz in Mähren; the Foraminifera are most fully noted.—Dr. A. Zahlbruckner gives a description (p. 438) and plate of a new species of lichen (*Pannaria austriaca*).—Dr. F. Berwerth follows, also with a coloured plate, "On Alnoit from Alnö."—F. F. Kohl (p. 455) has a monograph, with three plates, on *Ampulex*, Jur. (s.l.) and allied genera of Hymenoptera. Numerous new species are described.—F. Siebenrock has an illustrated and carefully worked-out paper on the skeleton of *Uroplates fimbriatus*, Schneid., one of the Geckos.

SOCIETIES AND ACADEMIES.

London.

Chemical Society, March 15.—Dr. Armstrong, President, in the chair.—The following papers were read:—Formaldoxime, by W. R. Dunstan and A. L. Bossi. Formaldoxime has previously only been known as a gas or in solution; the authors have obtained it as a colourless liquid boiling at 84°–85°.—Derivatives of camphene containing halogens, by J. E. Marsh and J. A. Gardner. Chlorocamphene, $C_{10}H_{15}Cl$, is prepared by distilling camphene dichloride, and bromocamphene is obtained by the action of bromine and phosphorous chloride on camphor.—A sulphate of oxamide, by J. E. Marsh. A hot solution of oxamide in strong sulphuric acid deposits crystals of oxamide disulphate $(CONH_2,H_2SO_4)_2$, on cooling.—Fluoplumbates and free fluorine, by B. Brauner. The author has prepared a fluoplumbate of the composition $3KF, HF, PbF_4$; on treatment with sulphuric acid it yields lead tetrafluoride.—The action of nitrosyl chloride on unsaturated compounds, by W. A. Tilden and M. O. Forster.—Note on the action of nitrosyl chloride on amido-derivatives of benzenoid hydrocarbons, by W. A. Tilden and J. H. Millar. Nitrosyl chloride acts on aromatic amido-compounds yielding a diazo-derivative, a nitroso-compound, or a chloro-derivative.—Action of aluminium chloride on heptylic chloride; a correction, by F. S. Kipping.—Oximidosulphonates or sulphazotates, by E. Divers and T. Haga. A number of salts of oximidosulphonic acid have been prepared and their reactions studied.—Derivatives of tetramethylene, by W. H. Perkin, jun. Tetramethyleneamine is obtained as a colourless oil, by the action of potash and bromine on the amide of tetramethylenecarboxylic acid.—β-2-Dimethylglutaric acid, $COOH.CH_2.CMe_2.CH_2.COOH$, by W. Goodwin and W. H. Perkin, jun. This acid, which is probably closely allied to camphoric acid, yields an anhydride of the constitution

$$CMe_2\langle{}^{CH_2.CO}_{CH_2.CO}\rangle O.$$

—The products of the action of fused potash on camphoric acid, by A. W. Crossley and W. H. Perkin, jun.—Conversion of ortho-into para-, and of para- into ortho-quinone derivatives. II. Dinaphthyldiquinone, by S. C. Hooker and J. G. Walsh, jun.

March 22.—Anniversary meeting.—Dr. Armstrong, President, in the chair.—After the reading of the President's address and the Treasurer's report, a ballot was taken for the election of officers and Council for the ensuing session. The ordinary members of Council are the following:—C. F. Cross, H. Dixon, B. Dyer, R. J. Friswell, A. G. Green, F. S. Kipping, W. H. Perkin, jun., W. A. Shenstone, T. Stevenson, J. A. Voelcker, W. P. Wynne, and S. Young.

Zoological Society, April 17.—W. T. Blanford, F.R.S., Vice-President, in the chair.—Mr. Sclater made some remarks on the possibility of breeding the African Mud-fish (*Protopterus*) in the Society's Gardens, and called attention to a recently published paragraph in "Le Mouvement Géographique" in which some account was given of the phenomena of reproduction of this Mud-fish, as observed by the French missionaries on Lake Tanganyika.—Prof. Karl von Bardeleben, of Jena, read a paper on the bones and muscles of the mammalian hand and foot, in which he explained his views on the rudiments of the sixth and seventh digits or rays. These rudiments, as he showed, are situated both on the inner and the outer borders of the hand and foot; they are present in nearly all the orders of mammals, especially in the lower forms, and are always provided with special muscles.—Dr. G. Herbert Fowler pointed out the characters of a new species of Sea-Pen of the family *Veretillidæ* from a specimen belonging to the Madras Museum, and proposed to call it *Cavernularia malabarica*. Dr. Fowler likewise exhibited and made remarks on an example of *Lidaria phalloides* belonging to the same Museum.—Mr. F. E. Beddard, F.R.S., described two new genera comprising three new species of Earthworms from Western Tropical Africa.—A communication was read from Mr. Oldfield Thomas containing an account of a new Antelope from Somaliland, which he proposed to call *Neotragus rupicola*. Capt. H. G. C. Swayne, R.E., and his brother, Capt. E. Swayne, had discovered this Antelope during their recent explorations in that country, but had not been able to bring back specimens. Two skins and a frontlet, lately received by Capt. H. G. C. Swayne from his native hunters, had enabled Mr. Thomas to establish the species.

Geological Society, April 11.—Dr. Henry Woodward, F.R.S., President, in the chair.—Mesozoic rocks and crystalline schists in the Lepontine Alps, by Prof. T. G. Bonney, F.R.S. The author described the results of an examination of the infold of Jurassic rock in the Urserenthal, undertaken in the hope of finding some definite evidence as to the relations of the marble, exposed near the old church at Altkirche, and the adjacent Jurassic rocks.—The easternmost of the sections described occurs high up on the slopes north of the Oberalp road. Read off from the northern side it exhibits (1) gneiss, (2) phyllites with bands of subcrystalline limestone, &c.—Jurassic, (3) a little rauchwacke, (4) "sericitic" gneiss. The next section (about 250 feet above the St. Gothard-road at Altkirche) gives (1) gneiss, (2) covered ground, (3) slabby marble, (4) phyllite, (5) thicker mass of slabby marble, (6) phyllite, &c., (7) "sericitic" gneiss. The third section runs thus, using numbers to correspond with the last:—(1) gneiss, (4) phyllite, (5) slabby marble, (6) phyllite, &c., (7) "sericitic" gneiss. It must be remembered that on the slopes of the Oberalp farther south, between the "sericitic" gneiss and the "Hospenthal Schists," another dark phyllite is found, generally considered by the Swiss geologists to be carboniferous. The marble in the third section is in places distinctly banded with white mica, and passes on the northern side into fairly normal mica schist and quartzose schist. The fourth section, about a mile away, on the left bank of the Reuss valley, gives a practically continuous section in phyllite and dark limestone, without any marble. In the fifth section, rather more than a mile farther, if any marble is present, it is very thin and shattered. At Realp, about 3¾ miles farther, the next good section is obtained. Here the rocks go in the following order (from the northern side):—(1) Gneiss; (2) phyllite and limestone; (3) subcrystalline limestone, looking very crushed; (4) the marble; (5) phyllite, etc.; (6) Hospenthal schists. The last group of sections occurs near the Furka Pass. In the first, crossed by the high road, there is no marble, but a little rauchwacke on the southern side. The next one, on the slopes below the pass, seems to show two masses of the marble parted by a subcrystalline limestone like that at Realp, with phyllite above and below. Of the two masses of marble the southern one can be traced right across the pass, but the extent of the other is not so clear. Examination of the marble mentioned above shows in all cases that it has been considerably modified by pressure since it became a crystalline rock. The author discussed the evidence of these sections, and maintained that the hypothesis that the marble is an older rock intercalated by thrust-faulting among Jurassic strata leads to fewer difficulties than to consider it as belonging to the same system. In the latter part of the paper the results of a re-examination of the ravine-section in the Val Canaria, and of some studies of the south side of the Val Bedretto are described, which, as the author maintains, confirm the view already expressed by him, viz. that the schists with black garnets, mica, kyanite, dolomite, and calcite (the last sometimes becoming marbles) are not altered Jurassic rocks but are much older.—Notes on some trachytes, metamorphosed tuffs, and other rocks of igneous origin, on the Western Flank of Dartmoor, by Lieut.-General C. A. McMahon. In this paper the author noticed the occurrence of felsite and trachyte at Sourton Tor; of rhyolite and of aluminous serpentine at Was Tor; and of a dolerite at Brent Tor in the exact situation indicated by Mr. Rutley as the probable position of the throat of the Brent Tor volcano. The author described extensive beds of tuffs at Sourton Tor and Melton, the matrix of which has been converted, by contact-metamorphism, into what closely resembles the base of a rhyolite, and which, in extreme cases, exhibits fluxion-structure, or a structure closely resembling it. The fragments included in this base were so numerous that six or seven different species of lavas may be seen in a single slide; this fact, and a consideration of the extensive area over which these beds extend, led the author to believe that these beds were metamorphosed tuffs and not tufaceous lavas. He then described some beds on the flank of Cock's Tor, which give evidence on their weathered surface of an original laminated structure by exhibiting a corded appearance like corduroy cloth. These beds are composed of colourless augite, set in a base which in ordinary light looks like a structureless glass, but which between crossed nicols is seen to be an obscurely crystalline felspar. The author compared these rocks with that portion of the Lizard hornblende-schists for which a tufaceous origin was proposed by De la Beche and other writers, including Prof. Bonney and himself. He showed that the Lizard schists and the Cock's Tor rocks agree in specific gravity and in some other characteristics; and he concluded that at Cock's Tor the first stage in the conversion by contact-action of beds of fine volcanic ash into hornblende-schist had been completed, and the final stage, due to aqueous agencies, had just begun.

Linnean Society, April 19.—Prof. Stewart, President, in the chair.—Sir Joseph Hooker exhibited a portrait of Jeremiah Bentham, father of Jeremy and Sir Samuel Bentham, born 1710, died 1792.—Dr. Prior exhibited specimens of *Pinus Pinsapo* with undeveloped catkins, like berries, and other specimens of conifers in flower.—Mr. J. R. Jackson exhibited an Afghan knife, the sheath of which was bound with bark of *Caragana decorticans*, selected on account of its bronze-like appearance, and gave some account of the various native uses to which this bark is put.—On behalf of Mr. George Mayor and Mr. F. R. Maw, some photographs of abnormally situated nests of the robin were exhibited, one of which had been built upon a book-shelf in one of the studies at Tunbridge School, and another in an old tin teapot which had been flung aside as useless, and had lodged in a poplar.—Mr. B. Shillitoe exhibited and made remarks upon an abnormal hyacinth.—An account of British Trap-door spiders was then given by Mr. F. Enock, and by the aid of the oxy hydrogen lantern and some excellent slides, their appearance and mode of life was graphically delineated and described.—In view of the approaching anniversary meeting, the election of auditors was next proceeded with, when Mr. Batters and Prof. Howes were nominated on behalf of the Council, and Mr. Michael and Mr. J. Groves on behalf of the Fellows.—In the absence of the author, Mr. George Murray gave an account of Graf zu Solms-Laubach's monograph of the *Acetabularieæ*, and the principal points were illustrated with lantern slides. The limits of the group were defined as excluding *Dasycladeæ*, and containing the living genera *Acetabularia*, *Polyphysa*, *Halicoryne*, and *Pleiophysa*, of which the author maintained only the first and third named. The extinct forms, principally *Acicularia*, were dealt with very exhaustively, and their relation to the living ones indicated. The paper consisted of a morphological account of all the forms, as well as a detailed systematic review of them, and the author's views of the relationship of the grasses to the forms of *Dasycladaeæ*, *Cymopolia*, *Neomeris*, *Bornetella*, &c., possessed much novelty and interest.

PARIS.

Academy of Sciences, April 23.—M. Lœwy in the chair.—On an example of divergent successive approximations, by M. Émile Picard.—Some preliminary remarks on the mechanism for excretion of albuminoids, and the formation of urea in the economy, by M. Armand Gautier.—Observations on the remarks of M. Armand Gautier, by M. A. Chauveau. M. Berthelot followed with a further observation, affirming M. Gautier's view of the production of carbonic anhydride without direct oxidation by means of free oxygen.—On the fossils collected at Montsaunès by M. Harlé, by M. Albert Gaudry. The author brings forward a number of these remains as proving the warm-temperate climate obtaining at Montsaunès at the period to which the remains of a monkey found there belong.—A note by M. Potain explaining the scope and production of a work presented—"Clinique médicale de la Charité."—On rolling movements, by M. Hadamard.—On the agglomeration of explosive substances, by M. P. Vieille. The author continues his experiments showing the effect on the speed and character of combustion of the state of aggregation of a powder produced in its manufacture.—On the variation of rotatory power under the influence of temperature, by M. A. Le Bel. A decrease in amount of rotation is recorded, for several substances, with lowering of temperature. This is not due to polymerisation, but may be accounted for by a loss of mobility in the molecule—"la molécule subirait alors comme une sorte de congélation interne."—On the electrical capacity of mercury and the capacities for polarisation in general, by M. E. Bouty.—On the partition of the discharge of a condenser between two conductors, one having an interruption, by M. R. Swyngedauw. If the sparking distance in a part of the unbranched circuit be I_1 and in the interrupted branch I_2, then with I_1 constant the quantity of electricity passing through the uninterrupted branch increases continuously with the distance I_2, becoming greater than the total charge when I_2 exceeds a certain value. The value of I_2 giving this quantity equal to the total charge increases with I_1.—On the sodium derivative of ethyl acetoacetate, by M. de Forcrand. The preparation of the pure derivative is described, and, from experiments on the partially dehydrated salt, the heat of hydration of the anhydrous substance is given as 4·19 Cal., and the heat of solution in 4 litres of water at 12° is found to be 4·39 Cal.—On the detection of "abrastol" in wines, by M. L. Briand.—The parasitic Diptera of the Acridians: Bombylides. Larval "hypnodic" and metamorphosis with period of activity and period of repose, by M. Künckel d'Herculais.—On the circulatory apparatus of *Dreissensia polymorpha*, by M. Toureng.—Researches on the structure of lichens, by M. P. A. Dangeard.—On ligneous tumours produced by an Ustilago among the eucalyptus, by M. Paul Vuillemin.—Observations *àpropos* of the note by M. Calmette, relative to the poison of serpents, by MM. C. Phisalix and G. Bertrand. A claim for priority.—Experimental researches on the place of formation of urea in the animal organism. Preponderating rôle of the liver in its formation, by M. Kaufmann. The formation of urea is not entirely localised in the liver; all the tissues produce a certain quantity, though they are not so active as this organ. The production of urea seems to be allied to the phenomena of nutrition in the various tissues, and the phenomena of elaboration of nutritive materials in the blood by the hepatic gland.—The production of "glycosurie" in animals by psychical means, by M. Paul Gibier. The case of a dog is quoted in which isolation from its usual companions is followed after about three days by the appearance of sugar in the urine. The phenomenon persists during deprivation of liberty and companionship, but immediately ceases on restoration of the animal to its usual conditions.—On a new and special sense, by M. Danion.—A contribution to the study of the pest of fresh waters, by M. E. Bataillon. The diplobacillus described attacks fish at all stages of life. It also attacks crayfish.

AMSTERDAM.

Royal Academy of Sciences, January 27 (supplement).—Prof. van de Sande Bakhuyzen in the chair.—Prof. Kamerlingh Onnes gave the results of the measurements of Mr. C. H. Wind on the Kerr phenomenon in polar reflexion on nickel. The result is that the difference between the observed phase and that given by the theory of Prof. H. A. Lorentz has a constant value, as pointed out by Sisfingh and introduced in Goldhammer's theory. For the phase of Sisfingh the value of 37° was found. According to Drude's theory, it ought to be 60°. The difference is here much more marked than in the case of cobalt, from which Zeeman concluded in favour of Goldhammer's theory, and it leaves no doubt as to the validity of this conclusion. The experiments were described of Mr. M. de Haas, who has repeated the measurements of the coefficient of viscosity of methyl-chloride at temperatures approaching the critical temperature, previously made in his laboratory by Dr. L. M. T. Stoel. The results of Stoel were confirmed, and the method was modified so as to give the viscosity in absolute measure. The viscosities of CH Me and CO_2 in the neighbourhood of the critical point were also confirmed. A sufficient accordance was found with the theorem, that in Van der Waals' corresponding states of two fluids the viscosity is in a definite ratio that can be calculated from the critical data.

March 31.—Prof. van de Sande Bakhuyzen in the chair.—Prof. H. Behrens gave an account of experiments on alloys of iron with chromium and tungsten, performed by Mr. van Lingen and himself in the laboratory of the Polytechnic School at Delft. In a ferrochrome with 13·3 Cr, 5·5 C, a ground mass was found, showing a hardness a little superior to iron, and yielding Fe and Cr to hydrochloric acid. By treatment with aqua regia the metal was disintegrated, and when observed under the microscope showed well-defined monoclinic prisms, which had a hardness between that of quartz and topaz (7·5), and resisted the corrosive action of aqua regia for a fortnight. After washing with a heavy solution (s.g. 2.8), the composition of this compound was found to be 75·8 Fe, 16·8 Cr, 6·7 C. Chromium steel, with 7·5 Cr, 2·5 C, was subjected to the same treatment, yielding grains and small prisms of the same form and hardness. Analytical examination gave the following result:—73·5 Fe, 20·0 Cr, 6·7 C. From this the empiric formula $Cr_2C_3Fe_7$ can be deduced. Similar crystals were isolated from a ferrochrome with 50 per cent. Cr, much chromium being dissolved in strong hydrochloric acid. From ferrotungsten, containing much Mn and S, beautiful rhombic octahedra were obtained, containing 69·5 Fe, 28·9 W, 1·6 S; from another sample, poor in Mn and S, similar crystals, composed of 65·2 Fe, 28·6 W. Both have a hardness superior to felspar. Evidently the great hardness of these alloys must be ascribed to well-defined compounds of *three elements*, not, as heretofore, to allotropic modifications of iron. This investigation will be extended to ferromanganese and to bronzes, containing Al and S.—Prof. Kamerlingh Onnes described the experiments on electrolytic polarisation, made by Dr. T. H. Meerbury in Prof. V. A. Julius' laboratory at Utrecht. The polarisation during the first second was measured with a capillary electrometer by a zero method on the Fuchs principle, the apparatus giving the means of registering the time. The maximum of Cathodic polarisation was reached one second after the beginning of the polarising current. A formula for the increase of polarisation with time differing from that of Witkowski was deduced from theory. A careful repetition of Root's experiment on the transmission of electrolytic hydrogen by platinum foil of $\frac{1}{50}$ mm. gave a negative result. Insufficient isolation or some other error may have been the cause of what Root had observed.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—A Vindication of Phrenology: W. M. Williams (Chatto and Windus).—Exkursionsbuch zum Studium der Dogelstimmen: Dr. A. Voigt (Berlin, Oppenheim).—Electric Light Installations: Sir D. Salomons, Vol. 2, Apparatus. 7th edition (Whittaker).—A Manual of the Geology of India. R. D. Oldham, 2nd edition (K. Paul).—A Manual of Ethics: J. S. Mackenzie. 2nd edition (Clive).—Primer of Navigation: A. T. Flagg (Macmillan).—Eight Hours for Work: J. Rae (Macmillan).

PAMPHLETS.—Die Abstammungslehre und die Errichtung eines Institutes für Transformismus: Dr. R. Behla (Kiel, Lipsius and Tischer).—The Principles of Elliptic and Hyperbolic Analysis: Dr. A. Macfarlane (Boston, Cushing).—Les Femmes dans la Science: A. Rebière (Paris, Nony).

SERIALS.—Zeitschrift für Physikalische Chemie, xiii. Band, 4 Heft (Leipzig, Engelmann).—Memoirs of the Geological Survey of India. Palæontologia Indica, series 9, Vol. 2, Part 1; The Echinoidea of Cutch: J. W. Gregory (K. Paul).—Familiar Wild Birds; W. Swaysland, Part 1 (Cassell).—Zeitschrift für Wissenschaftliche Zoologie, lvii. Band, 3 Heft (Leipzig, Engelmann).—Mittheilungen der Prähistorischen Commission der Kais. Akad. der Wissenschaften, 1 Band, No. 2 (Wien, Tempsky).—Natural Science, May (Macmillan).—American Journal of Mathematics, Vol. xvi. No. 2 (K. Paul).—Quarterly Journal of Microscopical Science Special Complimentary No. dedicated to E. Ray Lankester (Churchill).—Agricultural Gazette of New South Wales, March (Sydney).—Records of the Geological Survey of India, Vol. xxvii. Part 1 (Calcutta).—Geographical Journal, May (Stanford).—Contemporary Review, May (Isbister).—New Review, May (Heinemann).—Scribner's Magazine, May (Low).—Sunday Magazine, May (Isbister).—Humanitarian, May (Sonnenschein).—Longman's Magazine, May (Longmans).—Good Words, May (Isbister).—Century Magazine, May (Unwin).—Chambers's Journal, May (Chambers).—English Illustrated Magazine, May (Strand).—Geological Magazine, May (K. Paul).—Travaux de la Société des Naturalistes à l'Université Impériale de Kharkow, tome xxvii. 1892–93.—A Manual of Orchidaceous Plants, Part x. (Veitch).—The Natural History of Plants: Prof. A. K. von Marilaun, translated by Prof. F. W. Oliver, Part 1 (Blackie).

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THURSDAY, MAY 10, 1894.

THE STUDY OF ANIMAL VARIATION.

Materials for the Study of Variation, treated with especial regard to Discontinuity in the Origin of Species. By W. Bateson, M.A., Fellow of St. John's College, Cambridge. (London: Macmillan and Co., 1894.)

MR. BATESON is to be congratulated on the completion of the first part of his work on variation in animals, which treats of variation in the number and position of organs forming parts of linear or symmetrical series. Variation in the structure of such organs is only partially dealt with, a fuller account being promised in a future volume. The present work may be divided into two parts—one purely descriptive, the other critical. These require separate notice.

It is impossible in a short space to give a proper account of the information brought together in the purely descriptive part of the book. Mr. Bateson has carefully examined many of the principal European collections, both public and private, and has in other ways collected a great store of original matter, which alone would make a respectable volume. In addition, he has compiled a series of abstracts, containing the essentials of a large number of records made by others. The labour expended upon the work of compilation alone may be gathered from the list of authors referred to, which contains some six hundred names.

The facts recorded are grouped in numbered paragraphs, on a system which makes reference to individual cases easy; the descriptions are for the most part admirable, and they are supplemented, where necessary, by adequate woodcuts. Full references are given, either to the actual specim ns described, where such reference is possible, or to the source from which descriptions are quoted.

The first twelve chapters deal with organs forming parts of linear series—such as the ribs, vertebræ, or teeth of vertebrates, and similarly "repeated" structures in other animals. In these chapters special attention is drawn to cases of variation, such as the assumption by a cervical vertebra of the characters proper to a dorsal vertebra; and many remarkable examples of analogous phenomena are given. For variation of this kind, in which an organ in one region of the body is "made like" a serially homologous organ in an adjacent region, the convenient word "homœosis" is proposed. Another interesting group of cases is described as showing that the number of specialised organs in a series may be altered by a process of actual division, such as that by which an increase in the number of eyes is effected in Planarians.

The thirteenth and fourteenth chapters deal with increase and reduction in the number of digits in the vertebrate limb, and should be read in connection with the twentieth and twenty-first chapters, where closely analogous phenomena, leading to duplication of arthropod appendages, are described. The wonderful relations of symmetry, which are shown to hold in so many cases between the "normal" and the "extra" limbs, have been shortly described by Mr. Bateson on previous occasions; but the fuller statement here given forms perhaps the most interesting portion of the book.

The remaining chapters deal with variations in radial series, such as those formed by many organs of cœlenterates and echinoderms, and with cases which involve the doubling of structures normally single, or the fusion in the middle line of organs which are normally bilateral and paired.

Such in bare outline is the subject-matter of the descriptive portion of the book. No quotation of isolated passages is attempted, because no such proceeding could give an adequate idea of its importance. The whole work must be carefully read by every serious student; and there can be no question of its great and permanent value, as a contribution to our knowledge of a particular class of variations, and as a stimulus to further work in a department of knowledge which is too much neglected. It is to be hoped that Mr. Bateson will not rest content with his already great achievement, but will proceed with his promised second volume, which will be eagerly looked for by those who read the first.

If the criticism and enunciation of opinions had been performed with the same care as the collection of facts, the commentary which runs through the book would have gained in value, and several inaccuracies, due partly to want of acquaintance with the history of the subject, would have been avoided. The only contention which can here be noticed is that alluded to on the title-page, namely that variation frequently proceeds in such a way that changes in an organ occur only by steps of definite and measurable magnitude; and that discontinuous variation of this kind is necessary for the evolution of new species. In Mr. Bateson's words:

"The first question which the study of variation may be expected to answer, relates to the origin of that discontinuity of which species is the objective expression. Such discontinuity is not in the environment; may it not, then, be in the living thing itself?"

The statement that discontinuity is not in the environment, is justified as follows:

"Here then we meet with the difficulty that diverse environments often shade into each other insensibly, and form a continuous series, whereas the specific forms of life which are subject to them on the whole form a discontinuous series. . . . Temperature, altitude, depth of water, salinity, in fact most of the elements which make up the physical environment are continuous in their gradations," and so on.

Here the reference is only to the physical conditions which form a part of the environment affecting animals. That these physical conditions do often form a "continuous series" is no doubt true, although it is also true that in a large number of cases they do not. But Darwin, Wallace, and the greater number of subsequent writers on the doctrine of natural selection, agree in believing that the most important part of the environment against which a species has to contend consists of other living things. This view is dismissed in the following short foot-note:

"It may be objected that to any organism the other organisms coexisting with it are as serious a factor of the environment as the strictly physical components; and that inasmuch as these coexisting organisms are discontinuous species, the element of discontinuity may thus be introduced. This is true, but it does not help in the attempt to find the cause of the original discontinuity of the coexisting organisms."

Now since the deposition of the earliest palæozoic rocks animals have demonstrably been surrounded by such "discontinuous" organic environment. The statement, that the environmental conditions "form a continuous series," is therefore untrue of all animals known to us. If it has ever been true, we cannot know. The question, whether the first living things which appeared upon the earth were alike or not, is as unprofitable as speculation about the beginning or the ending of any part of the order of things from which our experience is derived must always be.

These preliminary arguments in favour of Mr. Bateson's main contention therefore fail, when applied to any part of the process of evolution of which we can know anything. It remains to consider what experimental evidence is brought forward to prove that variation is in fact "discontinuous" in any living animals.

No definition of what exactly is meant by "discontinuous" variation is given; and the conception adopted is difficult to grasp, since such domestic animals as the bull-dog are taken as examples of its occurrence. It will therefore be necessary to examine the treatment of some special group of variations: and for this purpose the chapters on teeth may be selected. The question is propounded—

"What is the least size in which a given tooth can be present in a species which sometimes has it and sometimes is without it?"

And it is remarked that—

"Considered in the absence of evidence it might be supposed that any tooth could be reduced to the smallest limits which are histologically conceivable; that a few cells might take on the character of dental tissue. . . . Indeed, on the hypothesis that variation is continuous, this would be expected."

Mr. Bateson considers his evidence sufficient to show that "the least size of a tooth is different for different teeth and for different animals," and that therefore variation in the teeth of those animals discussed by him proceeds by integral steps, the magnitude of the step differing in different cases. But he gives no evidence that he has ever looked for teeth reduced to the smallest histological limits. The greater number of observations recorded are made upon dry skulls, in which such rudiments could not be demonstrated. It is notorious that in many animals, such as marsupials and whales, a whole set of teeth exists, which can only be demonstrated by careful histological examination of the entire jaw, at a definite period in the life of these animals. But more important is the fact that teeth have been demonstrated, consisting of a few cells, which have hardly progressed beyond the histological condition of an enamel germ, in several of the animals used by Mr. Bateson to support his view. These cases (*Cercopithecus*, probably *Cynocephalus*, the dog, and the cat) have been completely overlooked by Mr. Bateson; and similar cases in other vertebrates have been recorded. The condition, which is said to be necessary on the hypothesis that variation is continuous, does, therefore, in fact occur; and the contention as to the least possible size of particular teeth fails.

In somewhat similar cases Mr. Bateson lays stress upon the rarity of slight variations, as compared with more considerable abnormalities. In the present case, few persons have examined the jaws of mammals in such a way as to enable them to find the smaller abnormalities and there is no evidence worth discussion which shows whether they are rare or not. The only case in which large numbers of jaws have been examined by proper methods is that of man, in whom a fourth molar tooth is commonly present as a mere uncalcified rudiment, the cases in which this extra tooth becomes calcified and breaks through the jaw being rarer in proportion to the perfection of the extra tooth. A similar continuous series of variations is presented by the "wisdom tooth," which is most commonly a fairly perfect molar, cases of imperfection being rarer in proportion as the tooth approximates to the condition of "a few cells," hardly "taking on the character of dental tissue" at all, which it does occasionally assume. It is therefore curious, that in commencing his attempt to exhibit the discontinuity of dental variation, Mr. Bateson should dismiss the case of human teeth with the remark—

"I do not know that among these human variations are included phenomena different in kind from those seen in other groups, except perhaps certain cases of teeth united together."

Surely variation which proceeds by integral steps of the magnitude of a tooth may justly be held to differ in kind from variation which proceeds by indefinitely small gradations?

In the case of teeth, and in many other cases discussed, the method employed is not adapted to a determination of the least possible magnitude of variations. For in judging evidence based largely upon museum preparations and on printed records, it must always be remembered that there is a tendency among curators and others to regard a slight abnormality as not worth bottle, spirit, and a place on the shelf, or to think it too trivial for printed record. Anyone who has tried to obtain specimens for a museum knows that many persons will take pains to present a rare or striking specimen, who cannot be induced to send quite common things.

The only way in which the question can be settled for a given variation seems to be by taking large numbers of animals, in which the variation is known to occur, at random, and making a careful examination and record of each. Mr. Bateson's chapter on teeth, like all his chapters, is of great interest, and will doubtless serve to throw important light on many things. But a careful histological account of the jaws of five hundred dogs would have done more to show the least possible size of a tooth in dogs than all the information so painfully collected. And so in many other cases.

W. F. R. WELDON.

ALPINE GEOLOGY.

Ein Geologischer Querschnitt durch die Ost Alpen.—A Geological Transverse Section through the Eastern Alps.—By A. Rothpletz. (Stuttgart: Schweizerbart, 1894.)

THE title of this work at once announces its importance in Alpine geology. Most of us, young and old, are familiar with the section through the Eastern Alps which we owe to the veteran Austrian geologist Hofrath von Hauer. Since 1857, this section, from Passau to Duino, has held its place alone in atlas and text-book. In recent years, Swiss sections, more especially Heim's, have been placed side by side with it, but they only embrace the northern flanks and a part of the central chain. Dr. Rothpletz has given us in this volume the second complete section through the Alpine chain. He has laid the line of section farther east than von Hauer's, beginning at the Bavarian plain in the north, and traversing the Karwendel Mountains in the Bavarian Highlands and North Tyrol, the Tuxer and Zillerthal Mountains, east of the Brenner Pass, the Seisser Alpe, Schlern Rosengarten and the Predazzo district in South Tyrol, and the Sette Communi in the Italian Highlands.

The section, which is printed with colours, extends over a surface area 140 miles in breadth, and has the advantage of being drawn to true scale, vertical and horizontal (1:75000). So accustomed are we to exaggerated heights in Alpine sections, that this true-scale section conveys an impression of rather unimposing mountains and broad valleys. The eye misses also the familiar dotted lines connecting detached parts of the same geological strata, and helping one to a general appreciation of the author's conception of the whole section.

The absence of any such lines is almost a key-note to the character of the work. In the text, the author declares his opinion that (purposes of explanation, of course, excepted) geological sections should represent so far as possible only what has been actually observed, and should not suggest, by means of dotted lines or continued bands of colour, what may be, after all, only imaginary structural relations of the strata. The author's position in this respect is made very clear in the chapter on the "Glarner Double-Fold."

The bulk of the text is devoted to descriptive, stratigraphical, and tectonic details of the various districts surveyed by the author along the line of section, and is illustrated very fully by sketch-maps and sections. Rigid faithfulness of observation is a marked feature throughout. The same care and precision which may be traced in field-methods, has also been bestowed on the literary workmanship of the book. The treatment of the Bavarian Highlands is quite delightful. The drawings display so unmistakably the dependence of the main physical features on the strata, and the contrasts of landscape which tectonic disturbance has frequently produced. We read with equal interest of the synclinal fold in which the Walchen lake and the Jachenau valley now find themselves, and of the transverse faults which divert the Loisach and the Isar rivers out of their easterly course into a northern. On the other hand, in the case of the bend of the Inn Valley at Wörgl, it was a pre-Alpine oligocene basin whose soft strata guided the river northward to the Bavarian plain. Again, the author's powers of exposition are seen to advantage when he demonstrates the important fault-line between the Mesozoic limestones north of the Inn and the old crystalline rocks of the central massif. He proves also beyond dispute the geological independence of the Tuxer and Zillerthal groups north and south of the Inner Pfitsch valley. But we confess to a feeling of disappointment that although the section passes through these groups, it has been able to do so little to clear away the difficulties of the Central Alps. Several important questions are discussed without advancing us far—for example, the age of the granite intrusion north of Brixen, the significance of the serpentine rocks in the "Tarnthal Köpfe," the constant occurrence of a rocklike "sernifit" at the unconformable succession of Permian and Mesozoic strata on the old Palæozoic and crystalline floor.

Strict adherence to the truths observed in nature, while in itself laudable, seems somewhat to cramp boldness and freedom of thought, and we are landed in a mist of possibilities hovering over a conjectured Triassic period of mountain movement in the Central Alps, which may just as well have been post-Neocomian for all that is proved to the contrary. A similar uncertainty envelops the age-relationships of the overthrust at Tristkogl (Karwendel Mountains), whose special misfortune it is to be directed to the south, whereas the overfolding and overthrusting elsewhere in the Northern Limestone Alps are northward. It seems just possible that the overthrusts in this district are not all told?

One of the most striking chapters in the first part of the book is that on the origin of the Schlern Dolomite in South Tyrol.

Part iii. leaves no doubt as to the author's conception of the form of Alpine structure elucidated by his complete section. In his ideas he differs considerably from the recognised tenets either of Suess or of the Swiss school represented by Heim. Dr. Rothpletz puts the actual areal contraction due to late tertiary folding in the Alps at a much lower figure than Heim did. He emphasises the importance of vertical faults and the great part played by previous Alpine movements in determining the occurrence of overthrusting and overfolding during Pliocene pressure. He finds Suess' theory of the causes of mountain-movement insufficient, and suggests that if the earth's cooling resulted in radial expansion instead of radial contraction, as Suess assumed, a quite as likely explanation could be given of the actual facts observed in crust-movements.

Even if we cannot accept the dicta as final, we must welcome the thoroughly scientific spirit in which the author analyses the various doctrines, and shows what part or parts are doctrines of faith only, and what of the remaining are, in his experience, tenable or untenable. His own opinions are fixed upon most points, but he never seeks to impose *opinions* on his reader; *facts* alone are taught; and there is no more thirsty soil for facts than Alpine geology.

MARIA M. OGILVIE.

OUR BOOK SHELF.

The Natural History of Plants, from the German of Prof. Anton Kerner von Marilaun. By Prof. F. W. Oliver, M.A., D.Sc. London, Glasgow, and Dublin: Blackie and Son, 1894.)

THE high praise we gave to Prof Kerner's *Pflanzenleben* when it appeared, makes it almost unnecessary for us to say much about the English edition now in course of publication, and which will be completed in sixteen monthly parts. The German work was said in these columns to be "the best account of the vegetable kingdom for general readers which has yet been produced." This judgment can also be applied to the translation which Prof. Oliver has made, with the assistance of Miss Marian Busk and Miss Mary Ewart. In translating a work, some of the brilliancy of the original is necessarily lost. It is difficult, however, to find awkward expressions in the pages before us; in fact, very few of the idiomatic phrases of the original work have survived. And the translation is scientifically accurate, as well as entertaining and instructive. Lovers of nature will find every page of the book interesting, and the serious student of botany will derive great advantage from its perusal. The illustrations are beautiful, and, what is more necessary, true to nature. The complete work contains about one thousand engravings on wood, and sixteen plates in colours. Botanical science will benefit by the issue of Prof. Oliver's edition of a splendid book.

Notes on some of the more Common Diseases in Queensland in relation to Atmospheric Conditions, 1887–91. By David Hardie, M.D., Hon. Physician Hospital for Sick Children, Lady Bowen Maternity Hospital, Brisbane. (Brisbane: Beal, 1893.)

THE author of this work has a most important aim in view, viz. to establish the connection between the weather and the prevalent diseases in Queensland, and expresses a hope that, in time, he will be able, if furnished with a forecast of the weather, to predict with certainty the diseases likely to predominate during the various seasons of the year, and thus to lay the foundations of a practical system of preventive medicine.

The conclusions are so interesting that some of his leading results may be briefly given.

The annual death-rate of Queensland per 1000 population is 15·11, varying from 13·38 in August and September (spring) to 16·28 in November to March (summer and early autumn), as contrasted with the death-rate of Great Britain for the year, 18·8.

The yearly mortality is lowest in West Southern Queensland (Darling Downs and Warrego), where it is only 8·92 per 1000, a little over half of the average Queensland rate, and the highest is 34·70 in West Northern Queensland (Normanton), a tropical region at the extreme north of the colony. This would point to the great advantage of altitude, combined with dryness, as seen on the Darling Downs, over marine influence and moisture to be found in the sea-coast districts. When we come to different classes of disease, we find that diphtheria, though specially prevalent in April, May, June, and July (winter), is endemic to some extent in all seasons, and causes a mortality of 2·15 per cent. Whatever contributes towards cold and dampness of the air during the autumn and winter, causes an increase in the death rate from diphtheria, and, according to Dr. Hardie, the neighbourhood of swamps and marshes have considerable influence in this respect. Whooping-cough, on the other hand, attains its maximum during the warm and moist months of the year, and its close connection with a medium temperature for all seasons of the year with high relative humidity, is considered to support the assumption of its germ origin.

Phthisis is common along the eastern portion of the colony from Cooktown to Brisbane, reaching a maximum of 12·86 per cent. in the Rockhampton district; but this high mortality is partly to be attributed to the large Polynesian population, employed on sugar plantations in these districts, who are specially liable to phthisis. In the western and northern districts, however, it is much less prevalent, and the average percentage of deaths from all causes gives to phthisis 8·75. The months when the mortality is greatest are July, August, and September, and there seems to be no special connection between atmospheric moisture and phthisis mortality, but a low temperature in summer and autumn is favourable to a low phthisis mortality. Acute respiratory diseases, such as pneumonia, pleurisy, and bronchitis, are observed all over the colony, and vary in mortality in different parts; the highest on the coast and the lowest inland, the months of highest mortality being June, July, August, and September; the maximum is reached during and immediately after the colder period of the year.

The book, with its copious and valuable tables, is an honest attempt to deal with a very difficult problem, and thoroughly merits success, and if the author will only persevere in his researches, still more important results may follow.

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.*]

Panmixia.

I AM much obliged to Prof. Weldon for having so promptly answered my request, and hope that his example will be followed by any naturalists who may have any other grounds for questioning the doctrine of Panmixia. Meanwhile, however, there are two or three points touching which I should like to be sure that we correctly understand each other.

(1) Hitherto all naturalists who have written upon the subject have agreed, that "*the survival-mean must* (*on cessation of selection*) *fall to the birth-mean.*" And, in now questioning this view, Prof. Weldon appears to contemplate the difference between birth- and survival-means of only the first generation, which would be very unfair. Again, I do not follow Prof Weldon's meaning in what he says with regard to another point. Assuredly "every statistician knows" that selection can maintain the "mean height of a regiment" at 67½ inches, by enrolling only those individuals who are either "more than 66 and less than 69 inches high." But this would be *artificial* (*i.e.* intentional) selection. The "cases" to which he alludes, where *natural* selection could destroy individuals nearest the mean line, while favouring those which lie at greater distances *both above and below* this line, must be very exceptional.

(2) As regards the second cause of degeneration under Panmixia (viz. atavism), Prof. Weldon says merely that it is "not demonstrated by any statistics." This is true enough. But the same has to be said of natural selection. Whether in the building up of a structure by natural selection, or in the subsequent breaking down of a structure by atavism on the withdrawal of selection, the statistical method is equally unavailable for testing either theory: in both cases the most effective variations (*i.e.* deviations from the mean) at any given time are those which are most *numerous*, and therefore most *minute.* Hence, in both cases the best "demonstration" of the theory which can be offered is that which is yielded by the parallel facts in our domesticated animals.

(3) The only objection which is urged by Prof. Weldon against the last of the three causes which I mentioned (*i.e.* irregularities of heredity when uncontrolled by selection) is one which tells against the theory of Panmixia only because it does so against that of Natural Selection. As I understand, the argument is, "Natural selection is in most cases an imperfect agent in the adjustment of organisms": *ergo*, the cessation of

selection will not, in most cases, make much difference in the maintenance of such adjustment. Obviously this ground of objection to the theory of the cessation of selection opens up a much larger question than can here be dealt with, viz. the adjusting or eliminating value of the presence of selection. But if Prof. Weldon will read what I wrote last year in the *Contemporary Review*, during the Spencer-Weismann controversy, he will find that in this matter I am quite on the side of Mr. Bateson and himself. It has always been my endeavour to argue that the ultra-Darwinian school of Wallace and Weismann are pushiog deductive speculation much too far in maintaining "The All-Sufficiency of Natural Selection." I shall never believe —any more than Darwin believed—that what I have called "selection value" is unlimited. But this is not incompatible with the belief that *in whatever degree* natural selection may have been instrumental in the construction of an adjustment, *in some degree* must its subsequent cessation tend to the degeneration of this adjustment, especially where complicity as distinguished from size is concerned, as stated in my last letter.

Summing up his objections to the doctrine of Panmixia, Prof. Weldon says they are two: "First, it is based on the assumption that selection, when acting on a species, must of necessity change the mean character of the species—an assumption incompatible with the maintenance of a species in a constant condition." This refers to the paragraph of his letter which, as already stated, I do not understand. The doctrine of Panmixia, as far as we are now concerned with it, does not refer to "species," but to specific characters, *i.e.* structures, organs, instincts, &c. Again, the doctrine, even with regard to specific characters, makes no "assumption" touching the *presence* of "selection acting on a species"—least of all that such *presence* will not maintain the species in a constant condition. On the contrary, the very essence of the doctrine is, that it is the *presence* of selection which *maintains* the constancy of a species (or specific character), and *therefore* that it is the *cessation* of selection which *upsets* the constancy by withdrawal of the maintaining influence. Hence, I do not understand Prof. Weldon's first objection. His second is, "that in the only case which has been experimentallv investigated, the condition said to result from a condition of Panmixia does not, in fact, occur." This one case, he explains, is:—"Mr. Galton has shown that civilised Englishmen are themselves in a condition of Panmixia, at least with respect to several characters, especially stature and the colour of the eyes. Now the mean stature of Englishmen is known to be increasing, and there is no evidence of the disappearance of coloured eyes." But, as regards stature, it can scarcely be maintained that there is not *some* cause at work to account for the increase; yet, unless this is maintained, the case is clearly irrelevant. Again, the colour of the eyes of our mixed population cannot have had more than thirty or forty generations wherein to be affected by Panmixia, and therefore the most ardent supporters of this doctrine would scarcely expect any result to be yet appreciable in the case of so pronounced a racial character. Surely a better "case" is the one which I have already given in the most ancient and the most rapidly-breeding of our domesticated animals. It was the facts observed in this "case" which first suggested to me the doctrine of Panmixia, and so led me to question the inherited effects of disuse. Similarly, a year later, Mr. Galton, in his "Theory of Heredity" (which anticipated by about ten years all the fundamental parts of Weismann's), wrote of Panmixia thus:—"A special cause may be assigned for the effects of disuse in causing hereditary atrophy of the disused parts. It has already been shown that all exceptionally developed organs tend to deteriorate; consequently those that are not protected by heredity will dwindle. The level of muscular efficiency in the wing of a strongly-flying bird is like the level of water in the leaky vessel of a Danaid, only secured to the race by constant effort, so to speak; let the effort be relaxed ever so little, and the level immediately falls. . . . That this is a universal tendency among races in a state of nature, is proved by the fact that existing races are only kept at their present level by the severe action of selection." GEORGE J. ROMANES.

Oxford, May 5.

P.S.—I gladly accept the verbal correction in Prof. Weldon's third paragraph.

Physiological Psychology and Psychophysics.

OWING to my bookseller's habit of forwarding NATURE in monthly batches, I have only just seen the remarks appended to my letter in the issue of March 15. I think that the terminological question is sufficiently important to warrant a reply to these.

(1) I do not, of course, "subsume" psychophysics to physiological psychology. The latter, I stated, is both wider and narrower than experimental psychology; and wider, because it includes the consideration of certain ("the most important") psychological problems—not of *all* such problems. (For this view of physiological psychology, *cf.* Wundt, "Physiological Psychology," fourth edition, I. p. 9.)

(2) Fechner, "the coiner of the word," defines psychophysics as "eine exacte Lehre von den functionellen oder Abhangigkeitsbeziehungen zwischen Körper und Seele, allgemeiner zwischen Körperlichen und geistigen, physischer und psychischer Welt." (*cf.* "Psychophysik," second edition, I. p. 8.) What my critic says on this head is, therefore, incorrect.

(3) In the most widespread and important school of experimental psychology existing to-day—that of Wundt—there *is* agreement upon definitions. And even if my critic's remarks were true, it would not follow that a number of wrongs made a right.

(4) I might, in my last letter, have adverted upon the term, *psycho-physiological*. I did not understand what it exactly meant. In NATURE of March 29, Prof. Ll. Morgan defines it (p. 504) as the equivalent of Fechner's internal psychophysics. (*op. cit.* p. 10). In this sense it is not wanted; the phrases "external" and "internal psychophysics" are in use. (It might, however, be used to signify that part of physiology which has a conscious correlate.)

(5) My critic triumphantly adduces "reaction-times" as a subject treated of in the University College course. That course, *i.e.* deals with *one* conscious element, and with *one* type (action) of *one* of the two modes of conscious combination (association: fusion is left out of account). Prof. Münsterberg (Preface to *Psychological Laboratory of Haward University*) speaks of "the error, which is so prevalent, that experimental psychology is confined to the study of sensations and simple reaction-times."

(6) I am sorry that Dr. Hill's name should have been mentioned. I should not think of offering any opinion upon his work. I know no more of it than do the other readers of NATURE. If he sees these remarks, I hope he will believe that my original criticism was meant to be quite impersonal.

(7) "By far the larger part of the really fruitful work [in psycho-physiology]" says my critic, ". . . . has been done in the investigation of the senses." If he means by psycho-physiology what Prof. Ll. Morgan does, I must disagree with him. To substantiate either view would need an article. As he writes not as a working psychophysicist (else he would have been acquainted with Fechner's *Psychophysik*), I think that the *onus probandi* lies with him.

(8) As to Prof. Ll. Morgan's paper on "the scope of psycho-physiology [= internal psycophysics]," I must plead guilty to finding the writer's eclecticism somewhat unintelligible, and his whole treatment a little general and superficial.

(9) A very interesting minor question is that of the relation of Wundt's physiology psychology to Fechner's internal psychophysics. (*cf.* Kulpe, *Arch. f. Geschichte du Philosophie*, 1892, pp. 183-4.)

Cornell University, April 16. E. B. TITCHENER.

IT seems hardly profitable to carry on a discussion with Dr. Titchener at intervals of more than a month. I readily confess that through an error of memory, for it is a good while since I read the "Elemente der Psychophysik," I misrepresented Fechner's use of the term psychophysics. The fact, however, that he recognised an "outer psychophysics," and the further fact that, as he shows ("Elemente," i. p. 11), nearly the whole of his inquiry has to do with establishing the relation of external stimuli to psychic phenomena, show that the error I fell into was not altogether unnatural. Are not the inquiries of Weber, Fechner, and their successors still brought under the head of psychophysics by those who reject Fechner's peculiar "psycho-physical" interpretation of the results? And do not nine students out of ten, who are not themselves "working psycho-physicists," associate the term "psychophysics" with these important lines of inquiry? If so, I would contend that there is room for a reconsideration of the terminology of the subject. The retention of Fechner's "outer psychophysics" seems confusing if, as I understand Dr. Titchener to say, "psychophysics" has properly to do with the correlation between psychic processes and intra-organic and (I suppose) more especially, central nervous processes. With respect to the term "psycho-physiological," used by Dr. Hill in his syllabus, it may at least be said that it avoids the ambiguity of "psychophysics," as coined and defined by Fechner, while it is the direct descendant of the term "mental physiology," which is well fixed in British scientific literature.

I have only to repeat that Dr. Titchener's attempt to distinguish between the domains of physiological psychology and psychophysics seems to me far from adequate. It has about it, to my irreverent eyes, something of Wundt's own oracular obscurity.

In calling atttention to reaction-time experiments, I did not refer to *simple* reaction-times. I thought the various lines of experiment in which the processes of hesitation and selection, and so forth, are elucidated by measuring the intervals between sensory stimulus and muscular reaction might be brought under the head of reaction-time experiments. But not being in the privileged circle of working "psycho-physicists," I daresay I erred here too.

This little discussion will not be in vain if it wake up Dr. Titchener, or some other working psycho-physicist, to the obscurities that hang over their new field of research for the outside student. It seems to me that we want careful definitions of the respective scopes of the several departments of research which are either psychological or which bear directly on psychology, more especially experimental psychology as a whole, psychophysics, and physiological psychology. Neither Wundt's nor Dr. Titchener's definitions satisfy some of us who, on this benighted island, provokingly placed between two luminous continents, are doing our best to catch some of the rays which they are shooting forth in such abundance.

THE WRITER OF THE NOTE.

Some Oriental Beliefs about Bees and Wasps.

SINCE Baron Osten Sacken's letter appeared in NATURE (vol. xlix. p. 198), I have been taking an occasional survey in my small library of Oriental literature, to inform him of passages referring to the Bugonia-superstition. So far as I could find, the people of the far East seem not to have possessed any belief about oxen-born bees; however, *à propos* of this matter, I have come across several legends relating to some Hymenoptera, which I may group as follows:—

(1) *Fossores Story.*—Of all the insect stories of the far East, this may claim very high antiquity; it was first celebrated, more than two thousand years ago, by a verse in the Confucianist "Book of Poems," and is, to this date, preserved by a well-known metonymy "Ming-ling" (that is, the caterpillar), meaning the Foster-Child. This story, according to Yang Hiung, a Chinese philosopher (53 B.C.–18 A.D.), was that "the Fossores, having no females, capture infant caterpillars from mulberry-trees, and address them a spell 'Mimic me, mimic me,' whereby they are turned into the young Fossores." Indeed, the Japanese name of the Fossores is Jiga (that is, "Mimic-me"). Against this Tao Hung-King, a Tauist sage (452–536 A.D.), has argued that these insects have had offsprings of their own, but used to deposit the eggs on bodies of other insects to provide them with food in future.

(2) *One-legged Wasp.*—In Li Shi-Chin's work, cited above, we read:—"This production of Ling-nan, resembling a wasp, small and black, has one leg united with the root of a tree; it can move but cannot escape." Also a One-legged Ant is mentioned. I would suggest that these insects were infested by the forms of Cordyceps, as is instanced in the stories of La Guêpe Végétale.

(3) *Fungus-born Wasp.*—Twan Ching Shih's "Miscellanies," book xvii., contains the following note:—"A poisonous and noctilucous Fungus of Ling-nan is, after rain, metamorphosed into a large black wasp with serrate mandibles more than three-tenths of an inch long. At night it tries to enter the ears and nostrils of a man, and hurts him in his heart."

(4) *Production of Amber from Bees.*—In the same work, book xi., is the following quotation from the "Record of Southern Savages":—"The Bees with Broken Waists exist in the sandhills of Ning-chau, and come out when banks fall down; the natives make amber by applying fire to them." Obviously this erroneous inference was drawn from the presence in amber of some hymenopterous remains.

(5) *Diptera mistaken for Hymenoptera.*—Sie Tai-Kang, in his "Miscellanies of Five Phenomena" (Japanese edition, 1661, book ix., p. 43), narrates thus:—"In Chang-sha I saw honey-bees all without stings, so that, when trifled with upon the palms, they were quite harmless: having no difference from flies, that was strange!" No doubt he has seen some Eristalis, as is indicated by Baron Osten Sacken.

(6) *Horse-hair Wasp.*—Tazan Kan, a Japanese literatus (1748–1827), writes on this subject in his "Rambling Notes" (Tokio, 1890, p. 22):—"About 1817 a half-rotten trunk of *Celtis sinensis* gave birth to wasps, whose tails they could not withdraw from the tree, thus causing many to die. Having the tails cut with scissors the survivors gladly departed. One winter a man bought a heap of fuel comprising a half-rotten oak abounding with the similar wasps, several of which were strung on a horse-hair in the same manner as a rosary, there being altogether several dozens of such hairs. The author's informant took home a hair passing through three or four wasps, and folded it in paper; afterwards the hair became divided, and the insects bit through the paper: the informant's suggestion was—'probably these wasps had been transformed from horse-hairs tangled round the rotten wood.'" Several times I have seen in Japan this so-called "Babi-bō" (the Horse-hair Wasp), still an object of popular amazement: it is nothing but an ichneumon-fly, *Bracon penetrator*, whose ovipositor of unusual length has been the principal cause of such a superstition.

KUMAGUSU MINAKATA.

15, Blithfield Street, Kensington, W., April 30.

P.S.—In my letter on the "Constellations of the Far East" (NATURE, vol. xlviii. p. 542), I gave from Twan Ching-Shih's "Miscellanies" portions of the list of the objects of Indian fancy as to the resemblances of the constellations. Last March, my reverend friend, Atchârya Dharmanâga, then in Paris, kindly sent me an extract from Roshin Sennin's Lecture on the Constellations, recorded in Mahâsannipâta Sûtra. After comparison, I find that both quite agree except for a few variations, so that that Chinese author of "Miscellanies" seems to me to have extracted his list from the above-mentioned Indian authority.

K. M.

The Mass of the Earth.

I HAVE no intention of reopening a discussion on the advisability and necessity of carefully separating in our minds those two notions, the *weight* of a body and its *mass*, which to me (and to a great many others) are now so completely distinct. The subject has already been treated of in these pages. Hence, in reply to the letter signed "K." I shall be very brief. The *mass* of a body is simply the quantity of matter which it contains; its *weight* is the force with which the earth pulls the body towards the centre of the earth; this force varies slightly at different points on the earth's surface, varies very much both when the body is removed outwards from the earth or inwards towards its centre, and would be nothing at all at the centre; the *weight* would be practically nothing if the body were removed a few millions of miles away from the earth. But through all these changes, and through all mere changes of *place*, the *mass* of the body is perfectly unaltered. *Weight* is a mere contingent property of *mass*, logically and physically distinct from it; a more contingent property than *shape*; for, while a body must have some shape, it need have no weight. The terms *weight of the earth*, *weight of Jupiter*, *weight of the sun*, &c., are absolutely ridiculous. The mass of the earth is acted upon by no force whatsoever except the attraction of the sun and the disturbing attractions of the moon and the planets. The earth attracts itself with no force; it has no weight. So much for positive statement.

The notion that the earth has weight—the inability or neglect to distinguish the necessary property of constant *mass* from the contingent property of *weight*—has given rise to many absurdities. "If everything on the earth has weight, the whole earth has weight," is a fallacy of composition worthy of a mediæval dialectician. That the earth is a very *heavy* body (with, of course, an inveterate tendency to fall "down"), has supplied us with the assumption that it is supported on the back of an elephant, these two exceedingly *heavy* bodies being together supported on the back of a tortoise, and so on. To compare the *weight* of Jupiter with that of the sun, "imagine a gigantic balance with equal arms and equal pans; let the sun be placed in one pan; then, *in order to preserve the balance*, more than 1000 Jupiters must be placed in the other pan."

I need not multiply examples of this world-wide fallacy. We have the two words *mass* and *weight*; let us keep them distinct, and thereby help towards an understanding of the nature of an absolute unit of force and other physical entities.

"K." says "the earth's weight, or mass, is 6·14 × 10^{21} tons. What is unmeaning or unscientific in this clear, intelligible, and accurate statement?" Answer, the identification of *weight* with *mass*. He is mistaken in supposing that Prof. Poynting's book has a double title. It is simply "The Mean Density of the Earth." The determination of the "constant of gravitation" is a deduction, and is, of course, so treated by Prof. Poynting.

THE REVIEWER.

Icebergs and Weather.

WITH reference to the notice in NATURE of May 3 (page 15), of a letter by Mr. Russell on icebergs and their relation to weather and temperature, I should like to give you a personal experience of my own with an iceberg in mid-Atlantic, when on board the steamship *India*, on its voyage from New York to Newcastle-on-Tyne, in June last year.

Our recorded temperatures of 43° F. and 45° F. of one day fell to 34° F. in water and in air on the next day. On reporting this to the chief officer, an extra look-out was kept, and the vessel put on half-speed, as the weather was foggy, and icebergs were likely to account for the sudden fall of temperature. Twenty minutes afterwards an iceberg was sighted, which showed a length of 1200 feet, and a height of 200 feet above water.

Leeds, May 7. A. SYDNEY D. ATKINSON.

Early Arrival of Birds.

I WAS at Sellack, Ross, Herefordshire, on March 22 and following days. Chiff-chaffs had arrived on the 22nd; cuckoos were heard on the following day. The willow-warbler and garden-warbler followed.

In quest of food, birds follow the path of least resistance. Thus their migrations, in the economy of nature, depend not simply on food, power of flight, distances, temperatures, &c., but on the associated extent of systems of wind.

May 4. W. CLEMENT LEY.

THE EFFECT OF EXTERNAL CONDITIONS UPON DEVELOPMENT.[1]

THERE is now ample justification for the belief that evolution is not due merely to internal causes, though we are as yet by no means quite clear as to the manner in which external influences have formed and transformed organisms. There is still a conflict between rival theories, and important points, though often apparently clear, are in reality not so.

It is often assumed, without sufficient proof, that a particular variation of an organism is the direct consequence of some external influence, simply because some causal connection exists between the two; but such an assumption is based upon a totally false idea as to the interconnection of the phenomena. In many cases this will be readily granted; take, for instance, that of the leaves of *Mimosa*, which close when they are touched. The actual cause of the movement is here due to the peculiar constitution of the plant, and not to the touch. The geotropism of plants, again, is not the direct effect of gravity, but is due to a special power of adaptation possessed by the plant. In reference to the histological adaptation of animal tissues, let us take as an example the structure of the lattice-work in spongy bones. Roux has shown that this is due to processes of selection and for a struggle for existence between the various parts of the body. Prof. Weismann speaks of this process as "intra-selection," and attempts to show that its effects are not inherited, as assumed by Roux, but that heredity only concerns those potentialities from which structures are developed by intra-selection. He believes that the potentialities have not arisen through the struggle between the parts of an organism, but through that between individuals; not by intra-selection, but by the ordinary process of natural selection. The *causa efficiens* of this histological adaptation is not, therefore, the tension or pressure which acts on the bones, but the adaptive material upon which such forces operate. The theory of intra-selection thereby loses nothing of its value, but on the contrary, is admitted to be of the greatest importance in maintaining the "co-adaptation" of parts during the metamorphosis of species.

The organism can, however, also be affected by external influences for which it is not adapted in advance. This is the case as regards the ordinary seasonal dimorphism of butterflies; but even seasonal differences may be produced by adaptation—here a double adaptation—in which the external influences of temperature do not act as the direct causes of change, but only as stimuli, which determine as to which of the two forms of the species shall arise.

In the case of neuters of social insects, the external influence—scanty food—is not, as Herbert Spencer assumes, the true *causa efficiens* which produces the sterility of their caste, but only the stimulus by which the primary constituents (*Anlagen*) of the worker-type are brought into activity. At least three kinds of primary constituents—those of the male, the fertile female, and the worker—must be contained in the eggs of ants, bees, and termites; the nature of the stimulus acting upon the egg determines the kind of primary constituent which shall come into activity. These opinions are confirmed by experiments made on flies, which show that insufficient nourishment supplied to the larva does not in any way affect the development of the ovary. The disappearance of typical organs—such as the ovarian egg-tubes of bees and ants—is thus shown to be a phylogenetic and not an ontogenetic process: it does not depend on mere influences of nutrition, but on variation in the primary constituents of the germ; and thus can only come about in the course of numerous generations. The case of social insects is therefore far from contributing any support to the view that acquired characters are inherited, and that the inheritance of the effects of use or disuse play a part in the transformation of species, as is assumed by Herbert Spencer.

Thus we see that external influences in many cases serve as the impulse which starts the process of development in certain of the primary constituents. The actual cause of these individual dissimilarities is in all cases to be sought in the modification occurring amongst the primary constituents of the body itself; and such purposeful modifications can only have originated by selection. Even when to all appearance external influences have had direct action in causing purposeful modifications, a more careful examination will always show that they have only served to bring some preformed adaptation into activity. This is proved in a specially conclusive manner by the consideration of sterility in the workers of bees and ants: the sterility is not due to poor nourishment, but to natural selection, which has determined the nature of the primary constituents in the ovary. This case is of especial interest, as it has been so much relied on as a support to the Lamarckian principle of the inheritance of acquired qualities. Here, as in all other instances, the Lamarckian hypothesis is untenable; selection has been the only principle on which the development of the organic world has been guided on its course.

[1] Abstract of the Romanes Lecture delivered in the Sheldonian Theatre at Oxford, on May 2, by Prof. August Weismann, Ph.D., D.C.L.

THE PLANET SATURN.

IN these days, when the telescope is in more or less common use, and so many have opportunities of observing the heavenly bodies, it is interesting to look back on the past and survey in a general manner the thoughts and ideas of those who in the earlier period of observational astronomy were not so well equipped. To take the case of the great Florentian astronomer, who practically had the whole Cosmos, so to speak, at the end of his telescope, since he was the first who surveyed the objects in the sky with something in addition to the naked eye—one can picture him sweeping with his "optik tube" or small telescope the starry heavens, and suddenly coming across the planet which we have under consideration. Here he had an object which was quite unique, and which, with his small power of magnification, must have puzzled him considerably.

In a letter to the Grand Duke of Tuscany, he refers to Saturn as appearing triple (tergeminus). Later, in a communication to the Austrian Ambassador (November 13, 1610), he makes the interesting statement: "When I observe Saturn with a telescope magnifying more than 30 times, the largest star appears in the middle; of the others, one lies to the west and the other to the east in a line which does not coincide with the direction of the equator, and seems to touch the central star. They appear to me as two servants, who wait upon the aged Saturn, travelling with him and not departing from his side. With a telescope of smaller magnifying power the star appears elongated and of the form of an olive."

Such, then, is the earliest telescopic observation of this planet that we have on record, and it might be interesting to pursue Galileo's inquiries a little further, and follow his state of mind when these "two servants" disappeared, as was the case in his later observations, causing him to look upon his earlier observations as phantoms or illusions.

With us to-day the case is different, and what we see in place of the "two servants" is the beautiful series of rings which girdle the planet in the region of his equator. Huyghens it was who first announced this ring system, and since then observations have shown many details of great interest, both in the ring itself and on the planet's surface.

Many are the objects of inquiry which lead observers to make a study of the appearance of this planet. The ring system and its varied shades, the belts girdling the planet's surface, the dark and light spots on the belts, the period of rotation &c., are only a few that might be mentioned.

Recent oppositions have enabled much work to be done in these lines, and the one just passed (April 11) has, we hope, still more increased our stock of knowledge. About the present time the planet and the brightest star in the constellation of the Virgin (Spica) make a fine pair in the sky. Both are fairly bright objects, and Saturn is known by the more golden hue with which he shines. At the present moment Saturn is retrograding, *i.e.* moving in the westward direction, and his position about the present time is to the north of Spica. The next stationary point in his orbit will be reached on June 21, conjunction occurring on October 23.

With reference to the general brightness which the planet and his ring system exhibit at different times, Dr. G. Muller[1] has recently made some interesting observations. The light-conditions, on account of the rings, are referred to as very complicated. If sufficient observations be considered, he has found that distinct changes in brightness are apparent depending on the phase of the planet, while much more apparent and naturally greater variations are noticeable, depending on the change of the plane of the ring from the line joining Saturn and the earth. When the rings are broadest, the planet in mean opposition shines a little brighter than Arcturus, and when they are invisible Aldebaran may be taken as their equal in brightness. In referring to some of the larger light changes, such as those which occur at different times with the planets Mars and Jupiter, the proportions here developed do not, we are told, tell us anything. In 1883–85, for instance, the reduced magnitude at opposition (0·85) was a little brighter than that for 1880 (0·90), 1880–83 (0·88), and 1886–88 (0·90). Other magnitudes at opposition, eight in number, have been derived by Sildel: thus in 1852 three values gave the mean opposition magnitude as 1·16 ± 0·07, the remainder (5), made from 1857–58, gave 0·97 ± 0·02. At a later date (1862–65) Zöllner from fourteen observations suggested a magnitude of 0·95; while Müller, in this paper, after a formula of his own, obtains 0·88 as the mean oppositional magnitude.

With regard now to the period of rotation of the planet, Herschel, in 1793, was the first who studied this question, giving its length as 10h. 16m. 0·4s., a value, accurate as he stated, "to much less than two minutes either way."

Since that time several more minute discussions have arisen, from which have resulted different values, among which may be mentioned Prof. Asaph Hall's period of 10h. 14m. 23·8s. ± 2·3s.

The latest important results on this question are due to Mr. Stanley Williams,[1] who has taken every pains for the determination of an accurate value, and to free the results from any possibility of their being influenced by preconceived ideas. With regard to the method of observation employed, and the details of the observations themselves, we must refer the reader to the publication mentioned below, but a brief summary of the results may not be out of place.

The observations were made in 1893, and two kinds of spots were observed: (1) dark spots upon a conspicuous double belt in the northern hemisphere; and (2) bright spots in the equatorial zone.

In the case of the former, the period was obtained from numerous spots, but eleven of them have been used as giving well-ascertained values, a table of these figures showing that they can be arranged into two classes, the means of which are 10h. 14m. 29·07 and 10h. 15m. 0·74s. Between these values there is a difference of over half a minute, a quantity too large, judging from the way sets of observations agree *inter se*, to be due to errors of observation.

With the bright spots a similar result is noticed, only here the difference is not the same. Out of the five series of deduced values, four may be coupled well together giving a mean value of 10h. 12m. 59·36s. The fifth or outstanding value is 13 seconds shorter than this.

These different values for the periods of rotation point out pretty distinctly that the spots that have been observed are by no means fixed relatively to the planet's surface, but are endowed with a proper motion of their own. In the case of the dark spots, the surface material must have rotated over half a minute more quickly in the same latitude upon one side of Saturn than upon the other. Mr. Stanley Williams summarises the results of his discussion in the following words:—

"Between N. Kronometric latitudes 17° and 37° the surface material of Saturn rotated in 1893 at the rate of 10h. 14m. 29·07s. ± 0·27s. between longitudes 45° and 140°, and at the rate of 10h. 15m. 0·74s. ± 0·56s. between longitudes 175° and 340°, whilst between longitudes 340° and 45° there was a region in which the surface material rotated at a rate intermediate between the above values.

"Between N. Kronocentric latitude 6° and about 2° S. latitude, the surface material of Saturn rotated in 1893 at the rate of 10h. 12m. 59·36s. ± 0·27s. between latitudes

[1] "Publicationen des Astrophysikalischen Observatoriums zu Potsdam," No. 30, Stück 4.

[1] *Monthly Notices* of R.A. Society, vol. liv. No. 5, March 1894, p. 297.

0° and 140°, whilst between longitudes 140° and 360° the rate of rotation was rather quicker, the average period of rotation here being well represented by . . . . 10h. 12m. 45·8s."

The importance of such results as those stated above will help considerably to unravel the mystery surrounding the circulation of the envelope of this great planet, but, for the observations to be comparable, they must be accurate, systematically made, and extend continuously over moderately long periods. For the years 1891–93, Mr. Stanley Williams points out that the acceleration in the motion of the bright equatorial spots can be clearly deduced from the different periods of rotation.

They are for—

	h. m. s.
1891	10 14 21·8
1892	10 13 38·4
1893	10 12 59·4

For the determination of the latitudes of Saturn's belts, the Rev. W. Freeman has recently published a method[1] which should prove useful for observers wishing to measure kronocentric latitudes.

Recent work on Saturn has, however, been done in another direction, Miss Klumpke having undertaken a further investigation of the problem of the figure of a fluid ring or a solid ring covered with liquid, in equilibrium about Saturn. This has been previously treated of by Laplace, and in recent times by M. Tisserand and Mdme. Kowalewski. Miss Klumpke has carried on Mdme. Kowalewski's work, but includes terms of a higher order, showing that the main result is very little altered. The second part of her thesis deals with the hypothetical case in which Saturn's mass is taken as zero: the rings thus will be subject only to the centrifugal force of its motion and mutual attraction of its particles. A first approximation gives the cross section of the ring as a circle, the second becomes an ellipse, and the third cross section is inclined to be egg-shaped, one end being oval.

W. J. L.

NOTES.

THE New York Mathematical Society proposes to organise a general session, extending over several days, to be held annually during the summer vacation, at some appropriate place and time. This year the session is to be held in Brooklyn, on August 20, 21, 22, the days immediately preceding the session of the American Association for the Advancement of Science. The Council of the same Society has been considering with great care its present organisation. One of the recommendations made by it is that the name should be changed to the American Mathematical Society.

WE regret to have to announce the death of Mr. Adolph Leipner, Professor of Botany in University College, Bristol. Prof. Leipner occupied the office of honorary secretary of the Bristol Naturalists' Society from its inception in 1862, and was elected President of the Society last year. The loss caused by his death, not only to the Society, and the College he served, but also to all those who are interested in the natural history of the Bristol neighbourhood, is a serious one, for he was a naturalist of wide experience, ever ready to place his stores of knowledge at the disposal of his fellow students.

THE death is announced, at an advanced age, at Marseilles, of M. A. Derbès, one of the pioneers in the study of the life-history of Algæ. His "Recherches sur les zoospores des Algues et les anthéridies des Cryptogames," published in 1847, in conjunction with M. Solier, was a perfect mine of new facts with regard to the reproduction of Cryptogams, and formed the basis of all later observations on the same subject. For many years M. Derbès had been prevented, by the results of an accident, from the pursuits of botany, with the exception of the duties of his professorial chair.

[1] *Monthly Notices*, liv. No. 1, Nov. 1893.

AT the Annual Congress of German Naturalists and Physicians, which will be held at Vienna towards the end of September, there will be an exhibition of objects of interest in natural history and medicine.

THE Government of India are making systematic inquiry into the efficacy of hypodermic injections of strychnine in the treatment of snake-bite. The Punjab Government have at their request forwarded a list of cases so treated in the province during the past year.

AT the congress of the Sanitary Institute, to be held in Liverpool next September, Dr. Klein, F.R.S., will act as President of Section I.—Sanitary Science and Preventive Medicine; Dr. T. Stevenson has accepted the presidency of Section III.—Chemistry, Meteorology, and Geology.

AN earthquake was felt in several districts of South Wales on Wednesday, May 2. At Caerphilly, dwelling-houses were so shaken that light articles of furniture were upset, and crockery-ware fell to the ground. The tremor was also felt at Cardiff, a decided vibration being experienced at about half-past twelve in the day.

THE sum of five thousand rupees has been given by the Maharajah of Bhownagger towards a Pasteur Institute for India. Though the scheme has met with some opposition, the strong committees that have been formed in various parts of India in order to support it, leaves little doubt that the Institute will eventually be established.

THIS year's conversazione of the Society of Arts will take place on Friday evening, June 22, at the Imperial Institute.

THE Institution of Electrical Engineers will hold a conversazione in the galleries of the Royal Institute of Painters in Water Colours, Piccadilly, on the evening of Thursday, May 31.

THE Yorkshire Naturalists' Union will hold a meeting at Sedbergh, for the investigation of the neighbourhood of Dowbiggin, Lune Valley, and Uldale, on Whit-Monday, May 14.

ON Thursday last a public meeting was held in Prince's Hall, Piccadilly, in support of the proposal to erect a memorial to the late Sir Andrew Clark. The Duke of Cambridge took the chair as President of the London Hospital, and the audience contained a large number of persons eminent in all branches of knowledge. Mr. Gladstone testified to his late physician's high character, referring to him as a representative of all that is best and noblest in the medical profession. He concluded by moving:—"That in recognition of the great services rendered to the community by Sir Andrew Clark, Bart., M.D., a memorial be established which shall perpetuate his name and his work." This resolution was carried, and also the following, moved by Canon Wilberforce:—"That steps be taken to raise a sum sufficient for the erection of a block of buildings at the London Hospital, to bear the name of Sir Andrew Clark, which will afford increased facilities for the relief of suffering and the advancement of medical science." Mr. Jonathan Hutchinson, who was one of Sir Andrew Clark's colleagues, made some very appropriate remarks in supporting the first resolution. Medical men did not claim for the deceased physician the discoveries of a Harvey, a Jenner, or a Hunter, he said, but they nevertheless held that he was in the highest and best sense of the word a representative man, to whom it was the duty and the privilege and the interest of the whole community to do honour. Shakespeare had said "one good deed, dying tongueless, slaughters a thousand," and he (Mr. Hutchinson) took that to mean that an injury was inflicted on future ages if a single good deed were allowed to die without suitable commemoration, and in the life of Sir Andrew Clark they had a record which would be a treasure for generations yet to come.

The arrangements for the sixty-second annual meeting of the British Medical Association, to be held at Bristol on July 31, August 1, 2, and 3, are given in the *British Medical Journal*. The President-elect is Dr. E. Long-Fox. An address in Medicine will be given by Prof. T. G. Stewart, one in Surgery will be delivered by Dr. Greig Smith, and Sir Charles Cameron will discourse on Public Medicine. The Sections and their Presidents are as follows:—(A) Medicine, Dr. Frederick T. Roberts; (B) Surgery, Dr. W. Mitchell Banks; (C) Obstetric Medicine and Gynæcology, Prof. J. G. Swayne; (D) Public Medicine, Prof. W. H. Corfield; (E) Psychology, Dr. G. F. Blandford; (F) Pathology, Dr. G. Sims Woodhead; (G) Ophthalmology, Dr. F. R. Cross; (H) Laryngology and Otology, Dr. P. McBride; (I) Dermatology, Dr. A. J. Harrison; (J) Diseases of Children, Dr W. Howship Dickinson. The Annual Museum in connection with the meeting will be arranged in the following sections: Section A.—Food and Drugs, including Prepared Foods, Chemical and Pharmaceutical Preparations, &c. Section B.—Instruments, comprising Medical and Surgical Instruments and Appliances, Electrical Instruments, Microscopes, &c. Section C.—Books, including Diagrams, Charts, &c. Section D.—Sanitary and Ambulance Appliances. All communications on general matters connected with the Museum, and all applications for space, should be addressed to Mr. John Dacre, 14, Eaton-crescent, Clifton, Bristol, before June 20, and a brief description of each exhibit for insertion in the Museum Catalogue must be in the hands of the respective Secretaries before July 1.

At the meeting of the French Meteorological Society on April 12, M. Renou, President, made some interesting remarks upon thunderstorms. He said that they occurred in some parts of France every day of the year, and during six or seven months in 1892 as many as 328 were counted. He remarked that they were more frequent in Europe than in equatorial regions; at Sumatra, for instance, storms occur during the six months of the south-east monsoon, but thunder is never heard. In France they generally traverse a narrow tract from south-west to north-east, but in the hot regions of the globe, on the contrary, the storms are nearly stationary. They are very exceptional in Peru, occurring only once or twice in a century; there was one in January 1877, but none had occurred previously since 1803.

Reports of cuckoos being seen and heard long before the usual date of the arrival of the bird are made every year. Generally the reports cannot be relied upon, but a circumstantial account by Dr. A. J. Fleming, in the *Zoologist* for April, goes to show that he really saw a cuckoo on March 5 of this year. The accuracy of his observations, however, is questioned in the current number of the journal by several naturalists, most of whom assert that March cuckoos do not exist. Mr. J. E. Harting remarks:—"From numerous observations made by competent naturalists in different localities it appears that the usual time of arrival of the cuckoo in this country is between the 20th and 27th April, and the average date of its appearance may be said to be on the 23rd of that month, St. George's Day. In no instance, so far as I am aware, has the bird been heard or seen (by any competent observer) before the 6th of April. It is surprising how few people are to be trusted, either in matter of *eye* or *ear*, in regard to the cuckoo. Many cannot know a cuckoo on the wing from a male sparrow-hawk, and others convince themselves that they have heard this bird's notes when they have been listening to a clever imitation by some village bird-nesting boy, or to the still more deceptive notes of a cuckoo-clock in a neighbouring cottage."

Lieut.-Colonel Sawyer read a paper to the Royal Geographical Society, at its last meeting, on the Bakhtiari Mountains and Upper Elam, a part of Persia which his surveys in 1890 have made it possible to map correctly. In the practical work of the survey he was assisted by the Indian surveyor Imam Sharif, who subsequently accompanied Mr. Bent's expedition to Hadramaut. The country is practically the continuation of the classical Zagros mountains, and the portion surveyed is a tract 30 miles wide between the bordering mountain ridges, and 300 miles in length from north-west to south-east. In the centre the mountains culminate in the mass of Kuh-i-rang, 12,800 feet above the sea, whence flow the chief rivers of Persia, the Zainderud, the Ab-i-diz and the Karun, the upper courses of which have been mapped correctly for the first time. This central mass not only separates two distinct drainage areas, it divides two entirely different ethnographical regions—the country of the Bakhtiari lies to the east, and Upper Elam to the west. Upper Elam is peculiarly rich in ancient remains, few of which have yet been examined, and many of them reach back to a very high antiquity. The expedition, though primarily for the purpose of surveying, did not fail to take account of more specially scientific matters, and although little was said about the geology of the mountains, their flora seems to have been pretty fully studied, as 350 species of plants were collected, of which seventeen at least were new to science. The people, who have been described from observations on this expedition by Mrs. Bishop, struck Colonel Sawyer as proud and warlike, and although warped in character by their isolated habitat, they yet remain possessed of many fine characteristics, physical and mental.

The May number of the *Scottish Geographical Magazine* contains several interesting papers. One on the geographical unity of the British Empire should strictly be entitled the economic unity, as the bond cannot without much straining be called a geographical one. Herr Victor Dingelstedt gives an account of the isolated valley of the Vièze, at the foot of the Dent du Midi, showing how isolation and the physical conditions of configuration, climate, and vegetation have combined to keep the people in a remarkably backward and primitive state. Mr. Stuart-Glennie gives in very brief abstract an outline of his travels on the border-land between Turkey and Greece in an article on "Dodona, Olympos, and Samothrace," which would have been more valuable if the date of his visit had been indicated. He promises to complete the account of the ethnography of the region in a forthcoming work, under the title of "Ancient Hellas."

The *Journal* of the Tyneside Geographical Society is rapidly approaching the form of a well-to-do geographical monthly; and although still relying to a considerable extent on articles reprinted from other publications, the May number includes two original lectures, one by Mr. Clements R. Markham, F.R.S., on Peru, and the other by Lord Roberts, on Delhi and its siege in 1857.

The first part for 1894 of the *Records* of the Geological Survey of India contains a report on the Bhaganwala Coal-field of the Salt Range, by T. D. la Touche. This coal-field was first made known in 1853; reports on it have appeared by Dr. Oldham (1864) and Mr. Wynne (1878). Estimates of its value have recently been published, which Dr. King, the Director of the Survey, believes to be greatly exaggerated; hence the present report. The coal is of Nummulitic age: the seam varies much in thickness, and is irregular in its mode of occurrence. Estimates based on a thickness of from $3\frac{1}{2}$ to 5 feet, and a maximum depth of 2000 feet, give one million tons as the probable quantity available.

THE Director's tri-monthly notes in the same number of the *Records* contain a full account of the gigantic landslip in Garhwal, noticed previously in NATURE (vol. xlix. p. 438). The fall of rock took place last September, and dammed up the valley of the Bihri Ganga by a wall 900 feet high. The water has steadily accumulated behind the dam, and is now daily expected to overflow. The first rush of water will be severe, and probably about 250 feet of the dam will be carried away; after that there may be a permanent lake established with a natural outfall. An investigation of this interesting landslip is in progress by Mr. Holland.

DR. J. W. GREGORY describes the Echinoidea of Cutch in the "Palæontologica Indica" (ser. ix. vol. ii. part 1, 1893). The Echinoids are few and small; they lived probably on sand and in rock-pools in a somewhat rough sea around a series of coral-reefs. More light on the geology of the area may be expected from the large collection of corals. The fauna seems to be homotaxial with the Callovian of Europe.

A RECENT number of the *Comptes Rendus* contains a note by M. E. Bouty on the capacity of a polarised surface of mercury and other substances. By means of the principles of thermodynamics, Lippmann has shown that the polarisation capacity of unit surface of mercury, the surface being kept constant, is equal to $-\frac{d^2A}{de^2}$ where A is the surface tension and e the counter electromotive force of polarisation. M. Lippmann has also calculated the value of this expression for mercury in contact with acidulated water, and found that, at any rate within wide limits, the value is independent of e. On the other hand, the author, as well as Blondlot, finds that in the case of platinum electrodes in different electrolytes, even when the time of charge is evanescent, the capacity increases rapidly with the increase of e. The author has shown that this increase does not take place if we consider that part of the capacity which is capable of producing a discharge current in an external circuit, and that polarisation phenomena are in part irreversible, except for infinitely small values of the electromotive force and the time. The experiments thus show that, if the irreversible parts of the phenomena are omitted, the capacity of platinum is independent of e, just as is the case with mercury. With platinum electrodes and a solution of sodium nitrate the author has found values for the capacity of a square centimetre of the electrode at temperatures between 21° and 25° of from 17·72 microfarads for a solution containing two equivalents of the salt per litre to 9·32 microfarads for a solution of 0·0001 equivalents per litre. In the case of distilled water (platinum electrodes) he finds the capacity per square centimetre to be 8·27 microfarads.

IN a paper read at the Botanical Congress at Genoa, last year, Prof. Saccardo calculates the number of species of plants at present known as 173,706, distributed as follows:—Flowering plants, 105,231; Ferns, 2819; other Vascular Cryptogams, 565; Mosses, 4609; Hepaticæ, 3041; Lichens, 5600; Fungi, 39,603; Algæ, 12,178. Prof. Saccardo thinks it probable that the total number of existing species of Fungi may amount to 250,000, and of all other plants to 135,000.

A SET of simple and instructive heat experiments, illustrating the laws of expansion, radiation, and convection, are described by Dr. V. Dvorák in the *Zeitschrift für Physikalischen Unterricht*. To show the expansion of a solid by heat, a brass wire, 1·5m. long, is suspended horizontally by two clamps. A weight of about 5 gr. is suspended at the middle of the wire, and a small wooden block is placed below it. The expansion produced by passing a lighted match along the wire produces a perceptible lowering of the weight. To prove that emissive power is proportional to the power of absorbing radiant heat, Dr. Dvorák constructs a special thermo-couple, consisting of a disc of thin German silver, to the back of which a thin steel wire is soldered. Both are connected with a delicate galvanometer. When the disc is lamp-blacked and exposed to radiation, a larger deflection is obtained than after the lamp-black has been wiped off. A still larger deflection is obtained when the lamp-black is moistened with olive oil. A comparison of these indications with the deflections obtained from the radiation of a Leslie cube with the corresponding surfaces proves the law referred to. To exhibit the phenomenon of latent heat, a plate of copper foil mounted on a wooden ring is soldered to a German silver wire, and both copper and wire are provided with binding screws, and connected with a galvanometer. By depressing the copper foil into the ring a shallow dish is obtained, in which liquids may be evaporated. The galvanometer shows the loss of heat attending evaporation, the amount of latent heat differing with the liquid used. Convection currents in air and water are, according to Dr. Dvorák, well shown by introducing the liquid or gas between a screen and a point of light. The latter may be produced by placing a screen with a small hole at the principal focus of a lens receiving the sun's rays. A Bunsen burner with a small flame, a glowing match, water containing a wire heated by an electric current, or water cooled by a fragment of ice or salt at the surface, show beautiful ascending or descending clouds on the screen.

WE welcome the May number of "The Country Month by Month," by Mrs. J. A. Owen and Prof. Boulger. What has been said of previous issues applies to this. The book is a chatty and bright companion for country rambles.

PROF. W. R. FISHER wishes us to state that he was not present at the evening meeting of the Essex Field Club at Chingford, reported in our last issue (p. 12).

THE quarterly *Journal* of the Geological Society, No. 198, which has just been published, contains, in addition to the papers read before the Society from November 1893 to February 1894, inclusive, the anniversary address of the President, "On some Recent Work of the Geological Society," part ii. The *Journal* reaches its jubilee this year, and a suitable index to the contents is being prepared to commemorate the occurrence.

MESSRS. HACHETTE AND CO., of Paris, have begun to publish, in parts, a work by M. Maspero, entitled "L'Histoire Ancienne des Peuples de l'Orient." Maspero's book, published under the same title nearly twenty years ago, has become classical. That of which the publication has just been commenced, however, will only be like its predecessor in name and general outline; for the text will be new, and it is to be richly illustrated. It will be divided into three volumes, issued in about 150 separate parts of sixteen pages each. Oriental history will be scientifically treated, and the work will appeal to all who are interested in the discoveries that have been made in Egypt, Assyria, Chaldea, and Asia Minor during the last thirty years.

THE March number of *Modern Medicine and Bacteriological Review* contains a reminiscence of Sir Andrew Clark from the pen of Miss Frances E. Willard. The little article is not only interesting but useful, containing an exact account of general and most simple instructions recommended by Sir Andrew Clark for the maintenance of health, which admit of wide application. Amongst the bacteriological notes, we find a reference to a paper by E. Fraenkel, published in the *Deutsche Medicinische Wochenschrift*, on the treatment of fifty-seven cases of typhoid fever by injection of a sterilised culture of typhoid bacilli. Fraenkel states that the results obtainable by this method of treatment are superior to those of any other method which has been previously employed. The earlier the treatment commences the more successful are the results obtained. The injections are said to be perfectly harmless when made into the muscle, but cause much pain when introduced subcutaneously. Dr. Kellogg contributes an article on the "Relation of Modern Physiological Chemistry to Vegetarianism," which is to be continued. The other longer papers are chiefly of medical interest.

THE explosive halogen compounds of nitrogen form the subject of a memoir contributed to the current number of the *Berichte* by Dr. Seliwanow, of St. Petersburg. Pure trichloride of nitrogen, NCl_3, was prepared for the first time in a state of purity in the year 1888, by Dr. Gattermann, in Prof. Victor Meyer's laboratory at Göttingen. It was shown to be an oily liquid of so unstable a character that strong sunlight, or the light waves emanating from a powerful artificial source such as burning magnesium, instantly provoke its extremely violent explosive decomposition. By working in a dull light, however, Dr. Gattermann succeeded in weighing a quantity of the liquid and analysing it. He showed, moreover, that the crude liquid substance obtained by the action of chlorine on ammonium chloride is a mixture of two or perhaps three different chlorides of nitrogen, and that the pure trichloride is only to be obtained by subjecting this product, after removal of all sal-ammoniac by washing and subsequently draining from water, to the action of a rapid stream of chlorine. Iodide of nitrogen has frequently formed the subject of investigation, and last year Dr. Szuhay, of Buda-Pesth, showed that the substance obtained by adding excess of ammonia to a solution of iodine in potassium iodide consists largely of the compound, NHI_2. The existence of an iodide containing hydrogen had previously been indicated by Dr. Gladstone and M. Bineau, but it appears probable that in presence of excess of iodine, the tri-iodide NI_3 is also produced in large quantity. That halogen compounds of nitrogen containing likewise hydrogen are capable of existence would appear, therefore, to be fully proved by the work of Drs. Gattermann and Szuhay, and the latter chemist actually succeeded in preparing a silver derivative $NAgI_2$, a substance as explosive as the iodide of nitrogen itself. Dr. Seliwanow now brings forward evidence to show that the formation of chloride or iodide of nitrogen by the action of the halogens upon ammonia occurs in two stages, hypochlorous or hypo-iodous acid being first produced. When a dilute instead of a concentrated solution of iodine is employed, no separation of iodide of nitrogen occurs, and the solution is found to contain both ammonium iodide and hypo-iodous acid HOI; the latter is readily detected by means of a reaction with potassium iodide in which iodine is liberated, which Dr. Seliwanow has recently discovered during the course of his work on certain organic derivatives of this acid. Upon increasing the strength of the solution of iodine, iodide of nitrogen at length commences to be deposited, and this is found to occur at the expense of the hypo-iodous acid. Hence iodide of nitrogen appears to be formed directly by the action of ammonia upon the unstable hypo-iodous acid produced in the first stage of the reaction. A similar explanation is also shown to hold with respect to the formation of chloride of nitrogen. It is interesting to observe that Dr. Seliwanow actually proves the existence of hypo-iodous acid in a solution of ammonia, a fact which may perhaps be accounted for by the recent remarkable discovery of Prof. Victor Meyer that this so-called acid is really endowed with basic properties. When it does react with ammonia, the chief product, as above shown, is iodide of nitrogen. The two equations for the formation of the latter are formulated by Dr. Seliwanow as follows:—

$$NH_3 + I_2 + H_2O = NH_4I + HOI.$$
$$NH_3 + 3HOI = NI_3 + 3H_2O.$$

THE additions to the Zoological Society's Gardens during the past week include a De Filippi's Meadow Starling (*Sturnella de filippi*) from La Plata, presented by Sir Harry B. Lumsden, C.B.; two Common Peafowls (*Pavo cristatus*, ♀ ♀) from India, presented by Mr. Richard Hunter; a Chicken Snake (*Coluber quadrivittatus*) from Florida, U.S.A., presented by Master James W. Philips; a Common Boa (*Boa constrictor*), two Tree Boas (*Corallus hortulanus*), a Thick-necked Tree Boa (*Epicrates cenchris*), a Carinated Snake (*Herpetodryas carinatus*) from Trinidad, presented by Messrs. Mole and Urich; a Ring-hals Snake (*Sepedon hæmachates*), two Cape Vipers (*Causus rhombeatus*) from South Africa, presented by Mr. J. E. Matcham; a Jaguar (*Felis onça*, ♂) from South America, two Plumed Ground Doves (*Geopelia plumifera*), two White Storks (*Ciconia alba*), two Vivacious Snakes (*Tachymenis vivax*), two Four-lined Snakes (*Coluber quadrilineatus*), four Green Lizards (*Lacerta viridis*) European, four Dark Green Snakes (*Zamenis atrovirens*), two Glass Snakes (*Pseudopus pallasi*) from Dalmatia, purchased; two Senegal Touracons (*Corythaix persa*) from West Africa, received in exchange; two Barbary Wild Sheep (*Ovis tragelaphus*, ♀ ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE MOON'S APPARENT DIAMETER.—A recent number of *Ciel et Terre* (April 2) contains an article on the moon's angular diameter, by M. P. Stroobant, of which a translation, with copious notes, appears in the *Observatory* for May. The methods employed in the determination of the apparent diameter of our satellite are (1) micrometer measures, (2) meridian passages, (3) heliometer measures, (4) photography, (5) occultation of stars by the moon, (6) eclipses. A comparison of the principal results obtained during the present century by these various methods indicates that occultations give the most accordant values, and M. Stroobant remarks that the method of occultation is the only one in which the apparent diameter of the moon is not augmented by physical or physiological causes. Accurate observations of occultations indicate that the lunar diameter has a value lying between 31′ 5″ and 31′ 6″, but M. Stroobant urges that this approximation is not sufficient. He concludes by saying:—"The application of photography to the determination of the exact instant of disappearance or of reappearance of a star would permit, without doubt, the attainment of great precision, especially when these phenomena occur at the dark limb of the moon, or during eclipses, when a number of small stars can be observed. . . . About every nineteen years the moon passes over the Pleiades in conditions more or less advantageous for observation; this phenomenon will occur next year. Might not the occasion be profitably used in securing a number of photographs at various observations? If these are sufficiently separated from one another, it would be possible to deduce a new value for the parallax of the moon."

GALE'S COMET.—This comet, for which we gave an ephemeris last week, is now very favourably placed for observation in the northern hemisphere. Its track lies from a point near ζ Hydræ (May 7) to near ζ Leonis (May 15). From South Kensington we have received the following report:—"The comet has been clearly visible to the naked eye for some days past, and when viewed with an opera-glass is quite a conspicuous object. Observed with the telescope it appears as a large slightly elongated nebulous mass with a central condensation, but with no obvious tail. The spectrum of the comet was observed by Mr. Fowler on May 7, and was seen to consist of the three carbon bands which have so frequently been recorded in other comets. The bands were found to be coincident with the corresponding bands seen in the spectrum of the blue base of a candle flame, at approximate wave-lengths 4736, 5165, and 5635. There was also a fairly bright continuous spectrum from the nucleus."

DENNING'S COMET.—M. L. Schulhof (*Astr. Nach.* 3227) has computed an elliptic orbit for the comet found by Mr. Denning on March 26, as the parabolic elements previously determined did not satisfy the observations. The period of the comet appears to be 6·745 years. According to the criterion published by M. Tisserand some time ago, the comet is identical with either Grischow's comet (1743 I.) or Blanpain's (1819 IV.), or it may be with both, for the identity of these two objects is admitted by some astronomers. M. Schulhof points out that it is desirable that Denning's comet, which is fading rapidly, should be followed so long as possible with large telescopes. Periodic comets can only throw light upon some obscure points in celestial mechanics and cosmogony when they have been observed during several apparitions. An ephemeris extending to May 15 will be found in NATURE, vol. xlix. p. 586.

STARS HAVING PECULIAR SPECTRA.—In *Astronomische Nachrichten*, No. 3227, Mrs. Fleming gives a list of five faint objects having spectra of Type V., that is, of bright lines, discovered from an examination of photographs of stellar spectra, taken at the Peruvian Station of the Harvard College Observatory, under the direction of Prof. S. J. Bailey. This brings the list of bright-line stars up to sixty. Two new nebulæ have also been found by means of the photographs of their spectra. The positions and descriptions of the objects are stated as follows:—

R.A. 1900. h. m.	Decl. 1900.	Description.
13 46·5	−66·1	Type V.
15 10·0	−45·17	,,
17 11·8	−34·18	,,
17 18·2	−43·24	,,
17 38·2	−46·3	Gaseous nebula.
18 39·3	−33·27	Type V.
19 10·5	−39·47	Gaseous nebula.

THE IRON AND STEEL INSTITUTE.

ON Wednesday and Thursday of last week, the 2nd and 3rd insts., the annual spring meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers; the President, Mr. E. Windsor Richards, occupied the chair. The following is a list of the papers set down for reading and discussion:—

"On the Physical Influence of certain Elements upon Iron." By Prof. A. O. Arnold.

"On the Capacity and Form of Blast Furnaces." By William Hawdon.

"On Scandinavia as a Source of Iron Ore Supply." By Jeremiah Head.

"On the Walrand Process." By G. J. Snelus.

"On the Results of Heat Treatment on Manganese Steel and their Bearing upon Carbon Steel." By R. A. Hadfield.

"On the Analysis of Steel." By H. K. Bamber.

"On the Application of Electricity as a Motive Power in the Iron and Steel Industries." By D. Selby-Bigge.

"On Methods of Preparing Surfaces of Iron and Steel for Microscopic Examination." By J. E. Stead.

"On the Relations between the Chemical Constitution and Ultimate Strength of Steel." By W. R. Webster.

The last four were taken as read. The usual formal proceedings having been transacted, the Bessemer gold medal for 1894 was presented to Mr. John Gjers, of Middlesborough, in recognition of his great services to the iron and steel industry.

The President then proceeded to deliver his address, which dealt chiefly with the economic side of iron and steel production. This industry appears to be passing through a period of extreme depression, more pronounced even than that of 1885. In the latter year the production of Bessemer steel rails was 706,583 tons. That year was designated at the time as a period of great depression, but in 1893 the production of rails was but 579,386 tons, whilst in 1892 the output was 43,550 tons lower even than in 1893. The price of these rails, which in 1886 was £4 13s. 10d. per ton, fell as low as £3 12s. in 1893. The question arose, the President said, whether this diminished demand was due to any falling off in quality of material, excellency in finished products, or increased cost of manufacture. From careful observations which he had made, Mr. Windsor Richards was convinced that our metallurgists and manufacturers still keep a foremost position. The loss of the continental trade was due solely to protective tariffs, and even the importation of continental rails was to be attributed to the same source, strange as it might seem. The reason for this is that to produce steel economically, it is necessary that it should be made in large quantities; in consequence of the protective tariff the continental manufacturer is freed from foreign competition at home, and can therefore obtain an exorbitant price for his goods. This enabled him to sell in foreign markets, where he had to meet competition, at a lower price than those who had not the same lucrative home market. In fact it was necessary to produce largely, and the surplus quantity could in this way be sold at what would otherwise be a loss. In face of these facts, the President said it was useless to expect relief by resource to labour-saving machinery and other methods of cheapening cost, and it was to be remembered that the foreign manufacturers could take these up as readily as we could. Technical education, he also seemed to think, would be powerless to avail us against the conditions he had pointed out. "Never," said the address, "since the organisation of this Institute (a period it may be mentioned of over twenty-five years) has the metallurgist experienced a more difficult time than the depression we are now passing through. Added to his commercial troubles were constant demands from the workmen for either higher wages or fewer hours of work. We may well anxiously look round to see where markets for our products, and employment for our workmen and capital are to come from." Some English steel makers have been building hopes on the relaxation of the American tariff, but these hopes the President looked on as fallacious, and indeed the United States steel makers have been passing through a period of greater depression than even we ourselves in this country. It is to our colonies, therefore, that Mr. Richards tells us we must look for relief, and he points out the vast field there is for the further development of rails in India, Australia, and Africa. The introduction of steel for rails has not proved an unmixed blessing for the iron and steel manufacturer. The President quoted an instance in which Goliath rails of 105 lbs. per yard had been laid down five years ago on a continental railway, and it was shown that on the basis of the wear already observed during those five years, such rails would last a century. The carbon in the steel was from ·4 to ·5. Rails are being laid down even harder than this, containing from ·6 to ·7 carbon. The extreme hardness obtained in this way entailed, the President said, an unnecessary risk. The address next went on to speak of the uncertainty of phosphorus analyses, and to the desirability of dealing with steel in large masses, in the ingot. He stated that Messrs. John Brown and Co., Sheffield, are having constructed a forging press for steel ingots, which will exert a force of 1000 tons, whilst ingots 6 ft. 9 in. square, and weighing up to 70 tons, are being dealt with by the forging press, the appliance used in handling them having a capacity of 100 tons.

The first paper read was by Mr. G. J. Snelus, and was on the Walrand-Legénisel process for steel castings. This process consists of adding to the metal in the converter at the end of the ordinary blow a definite quantity of melted ferro-silicon, then making the after-blow, turning down when the extra silicon has been burned out, and adding the ordinary final additions of ferro-manganese, &c., as circumstances required. The advantages of this process are that firstly an ordinary Bessemer pig can be used with 2 to 3 per cent. silicon, thus insuring a steel perfectly free from carbon; secondly, the combustion of the added silicon produces such a large amount of heat at the right time, and so rapidly that the metal becomes very fluid; the third advantage claimed is that as the silicon burns to a solid, it leaves the metal perfectly free from gas, and the steel is sound and free from gas cavities; fourth, that in consequence of the metal being so fluid and already free from oxide of iron, the ferro-manganese or other substances added, such as aluminium, are more effective and remain in the final steel. Another advantage secured by this process is that in consequence of the fluidity of the metal much more time and facility is given for casting operations. The author gave detailed descriptions of experiments he had seen made with this process, and quoted figures in support of his contentions. The system of casting is, however, confessedly expensive, and it would seem to be more especially suitable for those engineering works where it is desirable to have a steel foundry attached, and in which the demand would naturally not be so continuous as in the case of an establishment devoted entirely to the production of steel castings. It may be stated that the price of steel as it stands in the ladle is given as 4s. 6d. per cwt., whilst the cost of a complete installation of moderate size would be about £3500. In calculating the cost of the steel in the ladle, the author appears to leave out the fixed expenses. It is doubtless a tempting thing to the managers of engineering workshops to have their own steel foundry, especially as it is often difficult to obtain castings with promptness and punctuality, the advantage of producing all parts required at home, and thus having control of delivery, is apparent. It is very easy, however, to carry this principle too far. The time of a works manager is limited, and without the master's eye there is likely to be much leakage in a department. Manufacturing establishments may be too self-contained, and there are many unfortunate instances of works producing everything required, excepting dividends.

A short discussion followed the reading of this paper, those who spoke being altogether favourable to the process. Unfortunately the large number of papers that were on the list made the President fearful that the whole programme would not be carried through in the two days, and he therefore closed this first discussion very abruptly. Had he not done so we believe that the discussion would not have been throughout of so flattering a description.

The next paper read was a contribution by Mr. Jeremiah Head, entitled "Scandinavia as a Source of Iron Ore Supply." Mr. Head has recently made a tour through Norway and Sweden, going to the extreme north of the Scandinavian Peninsula, and in his paper he discussed the iron-producing capabilities of these countries, of which he appears to take a somewhat sanguine view. He pointed out that in the case of export duty being placed on iron ore by the Spanish Government, the steel makers of this country might be put in an awkward position, depending as they did so largely on Bilbao ore. Some of the experienced steel makers present, however, by no means agreed with Mr. Head in his estimate of the value of Scandinavian ore. It would appear that until a railway is constructed to the Norwegian coast, which, unlike the Baltic, is free from ice at all times of the year, there is not much prospect of a continuous supply of ore being obtained from northern Scandinavia. The objection that for half a year there is almost continual night in this district, was, Mr. Head said, an imaginary one, the fact being that the Scandinavians carry on their business all through the year without trouble. The brilliant moonlight, the Northern Lights, and the twilight that exists, aided by the reflection from the snow-covered country, enables work to be transacted. Mr. Head's paper contained a great deal of useful information on the subject, analyses of the ores being given, and figures as to the cost, &c.

On the second day of the meeting the proceedings were opened with a paper by Mr. William Hawdon, on "The Capacity and Form of Blast Furnaces." The author commenced with some interesting figures on the increase in capacity of blast furnaces; in Cleveland during recent years the content has risen from about 6,000 cubic feet to as much as 30,000 cubic feet, with the result of increased economy and larger output. In discussing the proportions of furnaces, he pointed out that the crucible or well of the furnace, that is the part immediately above the hearth, has its diameter governed by two considerations: if it be too large, a pillar of perfectly cold material may be formed in the centre of the mass of ore, fuel, &c., contained in the furnace; whilst if the diameter were too small, there would not be sufficient space to give the required volume for combustion in order to obtain a given output. The melting zone above the crucible must also be designed so as to allow an easy penetration of the blast through the materials. When air is blown into a furnace it has to be expanded by the expenditure of heat, but if air be introduced at a high temperature and already in an expanded state, a more rapid combustion is obtained with a saving of fuel in the furnace. In the case of cold blast being used, intensity of combustion does not spread over a large space, and therefore a smaller well suffices. High temperature of blast requires a larger area in the neighbourhood of the tuyeres, through which it is admitted. It is necessary that the furnace materials should come down from the upper reaches thoroughly heated and reduced, and in as level a manner as possible over the entire area. In order to obtain capacity and to support the material, and also to prevent too dense packing near the tuyeres at the zone of fusion, the blast furnace is made with boshes; that is to say, the interior space enlarges suddenly, the walls taking a slope of 60° to 80, the angle of repose for dry materials being about 45. But when the minerals become plastic, the angle of the bosh requires to be more steep. Above the slope of the boshes there is the maximum diameter of the barrel of the furnace. When, owing to the relative sizes of the wall and the barrel the bosh occupies a large vertical space, thus retiring a long way back, the materials at the sides are too far removed from the ascending current of gas, and will come down in a perfectly raw state. The author gave an amusing example of this error in furnace construction. In one case, after a few months' working it was discovered that some wooden sleepers that were originally placed in to light up the furnace, had not been consumed, and were in fact found only charred on the surface, resting near the top of the bosh of the furnace. In order to get over the somewhat conflicting conditions we have here referred to, Mr. Hawdon and his friend Mr. Howson had designed a furnace of comparatively narrow dimensions, but enlarged at the upper part, thus giving, as it were, a second bosh. In this way in the higher region where the charge is in a dry and porous state and not subject to extreme pressure, capacity is obtained, whilst the direct weight upon the lower portions of the materials is reduced. With a furnace of this nature, which has been in work some short time at the Newport Iron Works, the author obtained in smelting hematite a fuel economy of 15 cwts. of fixed carbon per ton of iron, the weekly output being 932 tons, the ore being 50 per cent. One great advantage in the use of this form of furnace would appear to be regularity of the product, freedom being obtained from that uncertain recurrence of white iron which is so often a trouble to the blast furnace manager. It should be remembered that the furnace had not been in work for any considerable time, and new furnaces nearly always work better than when they have been in blast a few years. On the whole, however, it would seem that Mr. Hawdon has made out a very good case for his new form of furnace, and indeed the promises are so good that doubtless many more will be erected on these lines.

The remaining paper read at the meeting was by Prof. J. O. Arnold, of Sheffield, and was entitled "The Physical Influence of Elements on Iron." We approach this paper with despair. In the first place, it was one of extreme length and is full of facts from cover to cover. In the second place, the discussion which followed its reading was of such a nature that many of the speeches which had been prepared beforehand, and were read by their authors, were really of the nature of papers in themselves. Indeed one speaker, Mr. Hadfield, of Sheffield, had prepared a paper of some length which had been called forth by Mr. Arnold's monograph, and extracts from this were read by the author during the discussion. M. Osmond, Prof. Roberts-Austen, Sir Lothian Bell, and Mr. Gowland had also prepared what in effect were separate monographs on the subject; whilst Mr. Stead, of Middlesborough, spoke at considerable length. In addition to these there were several other speakers. We could not abstract Prof. Arnold's paper in anything approaching the space we have at our disposal here, important and interesting as the subject is; and even could we do so, it would be hardly fair to those who took opposite views to him, as we cannot reproduce their arguments. Under these circumstances we must content ourselves with giving the very briefest idea of the subject, referring our readers to the *Transactions* of the Institute for full information. It will be remembered that at a meeting of the Institute of Mechanical Engineers, Prof. Arnold made a very strong attack upon the report presented by Prof. Roberts-Austen as chairman of the Alloys Research Committee of that Institution. Prof. Roberts-Austen in his report adopted the theories brought forward by M. Osmond in regard to the critical points, or evolutions of heat during the cooling of mild steel, from a temperature of 1000° C. These critical points were: firstly, the slight evolution of heat at 850° C. This point is known as Ar_3. Secondly, a faint disengagement of heat at about 750° C., the point Ar_2, the third point Ar_1, is at about 650; the latter is almost absent in very mild steel, but becomes highly accentuated in steels high in carbon, and was therefore due to a combination of iron and carbon to form the definite carbide Fe_3C. M. Osmond maintained, what Prof. Arnold designated the "startling theory," that the point Ar_3 marked the vital change of the passage into ordinary soft iron of an allotropic modification of iron (existing at temperatures above the critical point) of adamantine hardness. This allotropic form M. Osmond named β iron to distinguish it from α or soft iron. He further stated that the hardness conferred upon tool steel when plunged at a good red heat into cold water was due, not to carbon, but to the presence of β iron, rendered stable at low temperatures on being suddenly chilled in the presence of carbon, the last-named element, as such, possessing a comparatively insignificant hardening influence. M. Osmond also said that an investigation made on a series of alloys had verified Prof. Roberts-Austen's law that the influence of elements on iron is in accordance with the periodic law. These, briefly, are the points on which Prof. Arnold joined issue ; and in order to support his contention, he has made a vast number of experiments which he claims, if we understood him correctly, entirely upset the theories of M. Osmond and Prof. Roberts-Austen.

The paper by Mr. Hadfield, to which we have referred, is entitled "The Results of Heat Treatment on Manganese Steel and their Bearing upon Carbon Steel." Mr. Hadfield's connection with that remarkable alloy of iron known as manganese steel is well known, and the great difficulty with which it is magnetised renders it especially interesting in connection with this subject. During the discussion Mr. Hadfield showed that manganese steel may be made magnetic ; in fact he produced a bar which was distinctly affected by the magnet at one end, whilst at the other end there were no magnetic properties. We must, however, refer our readers to the *Transactions* for the many interesting details contained in this paper. The meeting terminated with the usual votes of thanks.

The summer meeting this year will be held in Belgium, commencing on Monday, the 20th August, when members will assemble in Brussels. The meeting will extend until the following Friday, so as to give members an opportunity to travel home on the Saturday.

THE ROYAL SOCIETY'S CONVERSAZIONE.

THE first (or gentlemen's) soirée of the Royal Society took place on the evening of May 2, in the Society's rooms at Burlington House. There were numerous exhibits, and it will be seen from the following summary that most branches of science contributed evidences of progress.

Prof. Hunter Stewart and Mr. Henry Cunynghame exhibited apparatus for micro-photography.

Experiments in persistence of vision were shown by Mr. Eric S. Bruce.

Mr. J. Theodore Bent exhibited antiquities and anthropological objects from the Hadramoot, Southern Arabia.

Two models of the South Lodge Camp, Rushmore Park, Wiltshire, an entrenchment of the Bronze age, before and after excavation, with the relics therefrom, were shown by General Pitt-Rivers ; and also two models of the Handley Hill entrenchment before and after excavation, on the same scale as the South Lodge Camp, with the relics therefrom.

New Dicynodont reptiles from South Africa were exhibited by Prof. H. G. Seeley ; and a skull of Deuterosaurus.

Mr. Richard Kerr showed an ovate palæolithic implement and two molar teeth of *Rhinoceros tichorhinus*, found by him in brick-earth at St. John's-road, Radnor Park, Folkestone, in August 1893.

Chemistry was represented by Dr. J. H. Gladstone's exhibit of early specimens of partly soluble cotton xyloidin, and of Austrian gun-cotton for military purposes. In 1847 the exhibitor prepared xyloidin from starch and from cotton. His specimens have all spontaneously decomposed, except those shown, which are mixtures of the soluble cotton xyloidin and ordinary gun-cotton.

Some maps and plans which accompany the Report on Nile Reservoirs, recently published by the Egyptian Government, were exhibited by Prof. J. Norman Lockyer.

Mr. J. Wimshurst exhibited models showing an improved method of communication between shore stations and light-ships, or other like purposes.

Mr. R. E. Crompton showed an electrically heated altar and electrically heated soldering bits for soldering and brazing ; and a potentiometer, to measure electromotive forces, from ·0001 to 1500 volts, correctly to 1/2000 ; and Sir David Salomons showed some new phenomena in "vacuum tubes."

Mr. Owen Glynne Jones exhibited his absolute and relative viscosimeters.

Prof. Roberts-Austen's exhibit comprised an ink-recording pyrometer, consisting of a thermo-junction of platinum and platinum iridium attached to a dead beat galvanometer, and a series of pyrometric curves obtained by photographic recorders in different iron works, and showing the temperature of the hot blast used in smelting iron.

Mr. A. E. Tutton exhibited an instrument of precision for producing monochromatic light of any desired wave-length, and an instrument for grinding section-plates and prisms of crystals of artificial preparations accurately in the desired directions. (Both these instruments are described in NATURE, vol. xlix. p. 377.)

Dr. Karl Grossmann and Mr. J. Lomas exhibited crystals of ice (hexagonal hopper) and photographs.

Dr. Karl Grossmann showed some specimens of Obsidian from Iceland. The specimens were brought by the exhibitor from the Hrafntinnuhryggur in Iceland (N.E.) The large specimen showed *conchoidal fracture*, evidently produced on falling from a cliff. The smaller specimen shows *flow structure*.

A twin-elliptic pendulum and pendulum figures were exhibited by Mr. Joseph Goold ; and a glass model, showing a method of transmitting force by spheres or discs, by Mr. Killingworth Hedges.

An exhibit which attracted much attention was M. Moissan's electric furnace, and specimens of chemical elements obtained by means of it : vanadium, chromium, molybdenum, tungsten, uranium. The furnace consists of a parallelopiped of limestone, having a cavity of similar shape cut in it. This cavity holds a small crucible, composed of a mixture of carbon and magnesia. The electrodes are made of hard carbon, and pass through holes cut on either side of the furnace, meeting within the cavity. For the purpose of certain experiments a carbon tube was fixed in the furnace at right angles to the electrodes, and so arranged as to be 10 mm. below the arc, and about the same distance from the bottom of the cavity. This tube contains the material to be heated, and by inclining it at an angle of about 30° the furnace may be made to work continuously, the material being introduced at one end of the tube and drawn off at the other. A temperature of about 3500° C. is produced. The metals are reduced by heating a mixture of their oxides with finely divided carbon, and for this purpose a current of about 600 ampères and 60 volts is employed. M. Moissan has not only succeeded in reducing the most refractory metals, but has fused and volatilised both lime and magnesia. Nearly all the metals, including iron, manganese, and copper, have also been vapourised, whilst by fusing iron with an excess of carbon, and then quickly cooling the vessel containing the solution of carbon in molten iron by suddenly plunging it into cold water, or better into a bath of molten lead, he has been successful in producing small colourless crystals of carbon, identical in their properties with natural diamonds.

A new harmonic analyser was exhibited by Prof. Henrici. This analyser differs from that shown last year by an improved integrating apparatus. The maker, Herr G. Coradi, of Zürich, has introduced a glass-sphere, whereby all *slipping* has been avoided, and greater compactness has been obtained. The instrument exhibited gives only one term (two coefficients) in Fourier's expansion at a time, but on going six times over the curve to be analysed as many terms can be obtained. There is no difficulty in introducing more integrators in the same instrument, and one has been made which gives five terms on going once over the curve, and ten in going twice over it.

Callendar and Griffiths' long distance direct-reading electrical thermometers and pyrometers were shown by Mr. E. H. Griffiths ; and a torsional ergometer or work-measuring machine, used in connection with a mechanical integrator and as an electrical governor, by the Rev. F. J. Smith.

Mr. Henry Wilde showed his magnetarium for reproducing the phenomena of terrestrial magnetism and the secular changes in its horizontal and vertical components, and a magnetometer for showing the influence of temperature on the magnetisation of iron and other magnetic substances.

Polyphase electric currents were illustrated by Prof. Silvanus P. Thompson, with models and experiments.

The Marine Biological Association contributed living pelagic larvæ, &c., from Plymouth, examples of the echinoderm fauna of Plymouth, and a hybrid between brill and turbot.

Mr. Henry A. Fleuss showed a mechanical pump for the rapid production of very high vacua, and vacuum tubes exhausted by it; and Mr. H. N. Dickson his charts and sections showing the temperature of the water in the northern and western parts of the North Sea and the Faroe-Shetland Channel at all depths, August 1893.

Dr. H. R. Mill and Mr. Edward Heawood exhibited bathymetrical maps of Windermere, Ullswater, Coniston Water, Derwentwater and Bassenthwaite, Buttermere and Crummock, Ennerdale Water, Wastwater and Haweswater. Contour lines at each 25-feet of depth beneath the surface were shown, and the configuration of the basins was thus for the first time accurately delineated.

Prof. J. Norman Lockyer exhibited photographs of stellar spectra taken with a 6-inch objective prism of 45°, and photographs of the great sun-spot of February 1894, taken at Dehra Dun.

Living larvæ influenced by the colours of their surroundings were exhibited by Prof. E. B. Poulton; and microscopic slides illustrating the behaviour of the nucleus during spore formation in the hepaticæ, by Prof. J. B. Farmer.

Photographs of diffraction and allied phenomena were exhibited by Mr. W. B. Croft. The photographs showed Newton's rings, reflected and transmitted; Grimaldi's fringes; Fresnel's interference from a bi-prism; Arago's shifting of bands towards the denser medium; Talbot's bands. The shadows of needles, wire gauze, perforated zinc, a screen with circular holes, opaque circular screens with Arago's bright centre. A comparison of the diffraction of Fresnel with that of Fraunhofer and Schwerd; the diffracting object consists of groups of small circles of light. Uniaxal and biaxal crystals; conical refraction.

Specimens demonstrating some phenomena of chemiotaxis in inflammation were exhibited by Mr. W. B. Hardy and Dr. A. A. Kanthack.

Prof. Marshall Ward showed apparatus employed for observing and measuring the growth of bacteria, fungi, and other micro-organisms under different conditions under the microscope. The essential feature is the culture-cell. It has a quartz floor, and is capable of holding large quantities of water, and thus while letting the light-rays pass does not rapidly vary in temperature. By the side of the culture-cell containing the hanging-drop in which is the organism under observation, is an exactly similar cell, but with a small thermometer in it, the blackened bulb of which is in the cell, and gives the temperature *inside* the latter. The rest of the apparatus consists in the measuring eye-piece; the screens of coloured glass, various liquids, &c., for growth in different kinds of light; and a warm chamber in which the whole microscope can be enclosed and kept at known temperature.

A demonstration of the trails of Oscillatoriæ formed the exhibit of Mr. J. G. Grenfell.

Prof. E. Waymouth Reid exhibited microscopic specimens illustrative of the process of secretion in the skin of the eel. The chief point of general interest in the process is the peculiar manner in which the surface of the skin is cast off when the animal is stimulated.

Prof. G. B. Howes exhibited eggs and young of *Ceratodus Forsteri*, and a male of *Lepidosiren paradoxa*.

Mr. E. J. Allen showed nerve elements from the ganglia of lobster embryos; and Dr. D. Sharp a collection of white ants (*Termitidæ*).

A specimen and drawing of the South American mud-fish, *Lepidosiren paradoxa*, was exhibited by Prof. E. Ray Lankester. See NATURE, vol. xlix. p. 555.

Dr. Alexander Muirhead exhibited a new form of Lord Kelvin's siphon recorder, Muirhead's artificial cable, and Muirhead's automatic curb transmitter. Lord Kelvin's siphon recorder and Muirhead's automatic curb transmitter were shown in operation in connection with an artificial cable of the same capacity and conductor resistance as the Atlantic cable, which is to be laid next July by the Anglo-American Telegraph Company. Capacity of artificial cable 800 microfarads; resistance of conductor 3350 B.A. units.

Demonstrations by means of the electric lantern took place during the evening, Dr. D. H. Scott showing photographs from sections in Dr. W. C. Williamson's collection, illustrating the microscopic structure of fossil plants from the coal-measures. The lantern was also used by Prof. E. B. Poulton, who exhibited illustrations of recent work upon the influence of environment upon the colours of certain Lepidopterous larvæ. Variously coloured twigs and shoots, such as occur in nature, have been shown to influence the appearance of many twig-like larvæ in such a manner as to conceal them. During the summer of 1893 certain larvæ of two species (*Gastropacha quercifolia* and *Otontoptera bidentata*) were surrounded, during their growth, with lichen-covered twigs. Larvæ thus treated developed lichen-like marks upon the body.

THE RELATIVE SENSITIVITY OF MEN AND WOMEN AT THE NAPE OF THE NECK (BY WEBER'S TEST).

THE difference in the sensitivity of the two sexes has been discussed often and from various points of view, but still, as it would seem, upon insufficient data. More observations being wanted, I submit the following, partly for such value as they have in themselves, partly to show an easy method of observation which others may pursue with advantage, and partly as a good illustration of the method of percentiles, or centiles.

The test employed is one of a familiar kind, made with the points of a pair of compasses, and usually associated with the name of Weber. If one person becomes just conscious of the doubleness of the pricks when the distance between the points is a, and another person does so when the interval is b, then the ratio of a to b may fairly be taken to express the relative obtuseness of the two persons, so far as concerns the form of sensitivity tested, and the inverse ratio of b to a to represent its relative delicacy. The particular test used was one that has three especial merits: it requires no minuteness of measurement, no uncovering, and the person tested is unable to see the operation. It consists in pressing the points of the compasses against the nape of the neck and across the line of the spine, while the experimentee sits with his or her head bowed forward. The just-perceptible interval at the nape of the neck averages as much as half an inch or thereabouts, while its variation in different persons is large. Consequently there is no need for extreme delicacy of measurement, neither does the varying thickness of cuticle caused by various degrees of usage, interfere materially with the results, as it does when like experiments are made, as is usual, on the finger-tips. The varying delicacy of perception due to differing amounts of practice is here entirely eliminated, because all persons are equally unpractised, no one occupying himself or herself in attempts to discriminate between two simultaneous pressures on the nape of his or her neck, while everybody has life-long practice in discriminating roughnesses, though in various and unascertainable degrees, with his or her finger-tips. There are parts of the body, such as the back, which are still less discriminative than the nape of the neck, but there is no other equally suitable part that is so get-at-able, in respect to the the ordinary dress of man or woman. Lastly, the attitude of the person who is being tested, entirely precludes him from watching the operator, and guessing from the hands or movements of the latter, whether he is applying two points, or only one, at the moment when he asks what is felt. The observations were all made by Sergeant Randall, who superintends my laboratory; he employed the two points of a Flower's craniometer, which was handy for use, as it was wanted to make other measurements of the same persons. The observations were carried on for some months, until a sufficient number had accumulated to justify discussion. Stature was included among them, but, failing on examination to trace any notable relation between stature and the just-perceptible interval on the nape of the neck, I have disregarded stature altogether in the following summary, and age too, so far that the person tested was often not fully grown.

The observations made on males and females, respectively, are summarised in the first and third lines of Table I. Their sums, reckoned in each case from the beginning of the series, are entered in lines 2 and 4, while the percentages of those sums are given in lines 3 and 6, but solely for the purpose of graphic projection in the form of dots, in Fig. 1. Those dots are joined by straight lines, forming traces for the males and females respectively. The lengths of the ordinates to the traces, which are drawn at the 10th, 20th, &c. divisions of the base, are the 10th, 20th, &c. percentiles, or centiles; or, in still briefer language, the 1st, 2nd, &c. "deciles." Their values, obtained by simple interpolation from the entries in lines

1 and 2 of Table I., are entered in Fig. 1. Thus 13·8 millimetres is the just-perceptible interval of the median man, and 11·8 that of the median female. In one sense, but only in an imperfect one, the relative sensitivity of the two sexes is given by these figures as being about 7 to 6. Much more has, however, to be specified before the relation can be adequately expressed, because it is obvious from the diagram, that what is true for persons having medium sensitivity, is not true for those having high, and still less for those having low, sensitivity. We are, however, able to specify what is wanted very compendiously, because both of the traces conform fairly well to the law of frequency of error, at least between the limits of the 1st and the 9th decile. In the case of males, the median is taken at 3·50 millimetres, and the q (= half the difference between the two quartiles, a value which is identical with that of the ± *probable error* of a single observation) at 3·25; in females, the corresponding values are 2·00 and 3·70. A somewhat nearer approximation to the observed values could be obtained by closer attention to the second decimals, but such minuteness is uncalled for in a case like this. It will be seen from columns B, C, and *b*, *c*, in Table II., that the sums of the observed and calculated deciles closely accord, and that the differences between the several pairs of them, headed B—C and *b*—*c*, are as nearly alike as we have a right to expect. The calculated deciles, and the curves drawn through them, in Fig. 2, may therefore be accepted as a just rendering of what is more roughly indicated by the observations in Table I. and Fig. 1. In the following remarks reference will be made almost exclusively to the calculated values, but the results can and will usually be checked by reference to the observed ones, with which they tally sufficiently well.

TABLE I.

Summary of Observations of 932 Males and 377 Females, showing the number in whom a just-perceptible feeling of doubleness was given by the pressure of two points across the nape of the neck, and separated by the various intervals, as below.

—	5 and under.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25 and above.	Total observed.
	Length of the just-perceptible interval in millimetres																					
Number of Males . . .	32	19	23	41	49	84	56	58	46	71	116	67	65	44	32	35	26	23	10	6	29	932
Sums from beginning . .	32	51	74	115	164	248	304	362	408	479	595	662	727	771	803	838	864	887	897	903	932	
Reduced to per-cents. . .	3	5	8	12	18	27	33	39	44	51	64	71	78	82	87	90*	93	95	96	97	100	
Number of Females . .	23	15	23	23	32	30	24	23	19	27	28	23	15	5	16	18	7	7	5	4	10	377
Sums from beginning . .	23	38	61	84	116	146	170	193	212	239	267	290	305	310	326	344	351	358	362	367	377	
Reduced to per-cents. . .	6	10	16	22	31	39	45	51	56	63	71	77	81	82	87	91*	93	95	96	98	100	

* These figures are protracted in both cases as 90·5, inasmuch as the accordance of the two preceding and of the four subsequent entries make the correction reasonable as well as convenient.

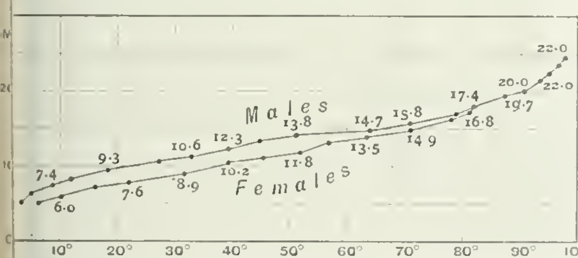

FIG. 1.—Traces and deciles from observations. The dots refer to the observed values as given in the 3rd and 6th lines of the table. They are connected by straight lines. The figures are the values of the corresponding deciles—that is, of the ordinates to the traces erected at each successive tenth part of the base.

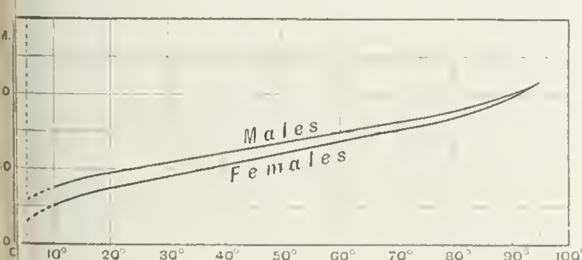

FIG. 2.—Deciles and curves by calculation.
Data for males: median = 13·50, q = 3·25 mm.
Data for females: median = 12·00, q = 3·70 mm.

TABLE II.

Grade or rank in a series of 100.	MALES. Rank in a series of 932.	MALES. Deciles. By observation.	MALES. Deciles. By calculation from median = 13·50, quartile = 3·25.	MALES. Differences between observation and calculation.	FEMALES. Rank in a series of 377	FEMALES. Deciles. By observation.	FEMALES. Deciles. By calculation from median = 12·00, quartile = 3·70.	FEMALES. Differences between observation and calculation.
	A.	B.	C.	B—C.	*a*.	*b*.	*c*.	*b*—*c*.
°		m.m.	m.			m.m.	m.	
10	93	7·4	7·3	+0·1	38	6·0	5·0	+1·0
20	186	9·3	9·4	−0·1	75	7·6	7·4	+0·2
30	280	10·6	10·9	−0·3	113	8·9	9·1	−0·2
40	373	12·3	12·2	+0·1	151	10·2	10·6	−0·4
50	466	13·8	13·5	+0·3	189	11·8	12·0	−0·2
60	559	14·7	14·8	−0·1	226	13·5	13·4	+0·1
70	652	15·8	16·1	−0·3	264	14·9	14·9	0·0
80	746	17·4	17·6	−0·2	302	16·8	16·7	+0·1
90	839	20·0	19·7	+0·3	339	19·7	19·0	−0·7
Sums	—	121·3	121·5	—	—	109·4	108·1	—

The average ratio between the sensitivities of the females and males is the same as that between the sums (or means) of columns C and *c* in Table II., namely as 125·5 to 108·1; or to speak more modestly, as no trust can be reposed on the minute precision of such values as these, the average delicacy of female discrimination between the two points is to that of the male, in a ratio that lies somewhere between 7 to 6 and 8 to 7, or thereabouts. It will be recollected that the former ratio was that between the median female and the median male.

The *variability* of the discriminative power appears from the observations to be distinctly higher among females than among males. Measuring it in the usual way, by the half difference between the two quartiles, which is the same thing as the *probable error* of a single observation, or else by any multiple of this, as by the *mean* error, we find that the variability among females is to that among males as 3·70 to 3·25, say as 8 to 7. It is in consequence of this that so large a difference is shown between the relative sensitivity of the two sexes, at the right and left extremes of their respective curves in Fig. 2. We find from Table II. that the value of C—*c* at the 1st decile is 2·3 millimetres, and at the 9th decile it is only 0·7, the differences between the intermediate pairs decreasing regularly. The regularity of the decrease is not apparent in the actual observations, as shown in Fig. 1, nor in Table I., still there is nothing in what we see there that is incompatible with Fig. 2, while the fact of the difference between the right ends of the traces being much less than that between the left, is conspicuous.

Is it, however, a physiological fact that women are more variable than males in respect to discriminative touch, or are the observations affected by any extraneous cause of variability? I think that the recorded variability may in a very small part be accounted for by the fact that women vary much more than men in the exercise of sustained attention. Carelessness would affect the results in the same direction as diminished sensitivity. Thus suppose one part of a large number of persons who were all really alike in sensitivity, to be very careless, and the remainder to be scrupulously careful; the minds of the careless would be apt to wander; they would then fail to notice the first just-perceptible sense of doubleness, and would appear, in consequence, to be more obtuse than the careful ones. Though the range of variability was in reality *nil*, the existence of carelessness would introduce variability into the records. Some women are religiously painstaking, as much so as any men; but the frivolity of numerous girls, and their incapacity of, or unwillingness to give, serious attention, is certainly more marked than among men of similar ages. Women may, however, be really more variable than men in respect to sensitivity, because they seem more variable in a few other respects, such as in stature and obesity. Many more very tall girls are to be seen now-a-days among the upper classes than formerly, but the run of the statures among men has not altered quite so much. The multitude of extraordinarily obese women who used to frequent Vichy for the cure of fatness, were wonderful to behold; but they are no longer to be seen in their former abundance, as the fashion of treatment has changed within recent years. Again, it appears that women vary much more widely than men in respect of their morality; to which assertion I would quote Tennyson as a corroborative witness, who writes as follows, in Merlin's soliloquy on the character of Vivien:

> "For men at most differ as heaven and earth,
> But women best and worst as heaven and hell."

Since Fig. 2 is true to scale, it is easy to utilise it for ascertaining the class-place of any man or woman in respect to the form of sensitivity now in question. The whole process would be as follows:—Take a pair of compasses, and find with them by experiment the just-perceptible interval across on the nape of the neck of the person tested; then apply the compasses, to Fig. 2, keeping one (the lower) of its points always on the base line of the Fig., and holding the compasses so that the line joining its points shall be perpendicular to that base line. Slide the lower point of the compasses along the base line until the upper point touches the male or female trace, as the case may be; then read off the grade at which the lower point stands on the base line. Suppose it to be 35; we thereby learn that 35 per cent. of the same sex have more sensitivity than the person tested, and that 65 per cent. have less. Similarly for any other value.

It would, I think, be well worth the while of an inquirer to repeat these tests, to revise my results, and to pursue the subject much further. If any one should feel disposed to do so, I would suggest that he should make his measurements with the cheap form of bow compasses, in common use by carpenters. The legs are connected not by a joint, but by a spring which tends to separate them, and they are brought together to any desired interval by turning a screw with the finger and thumb, which overcomes the spring. The interval between the points could easily be measured on a separate scale; all the more easily, if there were a slight depression at the zero point of the scale, in which one leg might be securely rested.

FRANCIS GALTON.

THE RELATION OF MATHEMATICS TO ENGINEERING.[1]

MATHEMATICS has been described in this room as a good servant but a bad master. It will be my duty this evening to prove by suitable illustration the first half of the proposition, and to show the service mathematics has rendered and can render to engineers and engineering.

In our charter the Institution of Civil Engineers is defined as "A society for the general advancement of Mechanical Science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a Civil Engineer, being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange, and in the construction of ports, harbours, moles, breakwaters and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns." No better definition can, I think, be found for our profession than that it is the art of directing the great sources of power in nature for the use and convenience of man. It covers all that the widest view of our work can include, and it excludes those applied sciences, such as medicine, which deal with organised beings. Mathematics has to deal with all questions into which measurement of relative magnitude enters, with all questions of position in space, and of accurate determination of shape. Engineering is a mathematical science in a peculiar sense. Medicine, the other great profession of applied science, has but little to do with questions of measurement of magnitudes, or of geometry; but the engineer finds them enter into everything with which he has to deal, and enter in the most diverse ways. The thing he has to determine is that the means he employs is enough and not unnecessarily more than enough to attain the end in view. For this he must numerically measure the end and the means and see that they are justly proportioned to each other. It is useless this evening to waste time proving, what all will admit, that no one can be even the humblest engineer without a knowledge of arithmetic and enough of geometry to enable him to read a drawing, that some trigonometry, some rational mechanics and a knowledge of projections, is a very useful part of the mental equipment of a draughtsman. It is hardly necessary to call attention to the great economy in the labour of calculations effected by the use of logarithms, a mathematical instrument for which we are indebted to Napier. We may with more profit examine what use the higher mathematics can be to the practical engineer, and what has been done in the past for engineering by its aid.

Judging from etymology, mathematics must have been begun by engineers; for surely geometry is the work of the earth measurer or land surveyor. But since the prehistoric times when geometry was initiated, engineers have not added much that is new to mathematics. They have rather sought amidst the stores of the mathematician and selected the handiest mathematical tool they could find for the particular purpose of the moment, but have done little or nothing in return in the way of improving the tools which they borrow. In this respect the relation of engineering to mathematics differs much from its relation to experimental physics. In electricity, magnetism and heat, engineers have from their practical experience repeatedly corrected the ideas of the theorists, and have started the science on more accurate lines. If our subject to-night had been the use of the practical applied science of engineering in promoting the development of pure mathematics, we should speedily find that there was hardly any material for discussion. The account being all on one side, let us see to what the debt of the engineer to the mathematician amounts.

There is no department of practical engineering in which the

[1] The "James Forrest" Lecture, delivered at the Institution of Civil Engineers, by Dr. John Hopkinson, F.R.S., on May 3.

application of mathematics is more familiar than in that which relates to the calculation of the strength and rigidity of structures of various kinds. It is impossible to take up any book dealing with the subject without finding that it is crammed either with mathematical formulæ, or with geometrical figures. The question is not whether mathematics is necessary to an adequate comprehension of the subject, but whether analytical or purely geometrical methods are more convenient. Of course one might occupy many lectures in discussing the practical application of mathematics to the question of bridge building, roofs, guns, shafting, and the like. Our object must be to illustrate by various examples rather than to attempt anything like a complete discussion.

Consider the case of a long strut, so long that its transverse dimensions can be regarded as insignificant in comparison with its length. Whilst the strut remains perfectly symmetrical about its middle line, its strength will depend only upon the resistance of the material to crushing. Everyone knows that this would be an inadequate conclusion; we have to consider another element, namely, its stability, that is, we must examine what will happen to the strut if from any cause it is displaced somewhat from the direct line between its extremities. A mathematical discussion of the question results in a differential equation of the second order with one independent variable. Upon consideration of this we are enabled to see that if the thrust upon the strut be less than a certain critical value, a slightly bent strut will tend to return to its straight condition; but that if the thrust upon the strut be greater than this critical value the displacement will tend to increase, and the strut will give way. Further, that the critical value will depend upon whether one or both of the two extremities of the strut are held free, or whether they are rigidly attached by flanges or otherwise, so that the direction of the axis of the strut at this point must remain unaltered. Again, we infer that if the ends are held rigidly fixed, the length of the strut may be twice as great for a given critical value of the thrust as if the two ends are free to turn. We can also infer what the critical value will be for struts of various lengths and of varying cross sections. This critical value depends not upon the resistance of the material to crushing, but upon its rigidity.

Another example, having a certain degree of similarity with the case of struts, is that of a shaft running at a high number of revolutions per minute, and with a substantial distance between its bearings; for simplicity, we will suppose that there are no additional weights, such as pulleys, upon the shaft. How will the shaft behave itself in regard to centrifugal force as the speed increases? In this case, so long as the shaft remains absolutely straight it will not tend to be in any way affected by the centrifugal force, but suppose the shaft becomes slightly bent, it is obvious to anyone that if the speed be enormously high this bending will increase, and go on increasing until the shaft breaks. In this case also we may use mathematical treatment; we find that the condition of the shaft is expressed by a differential equation of the fourth order, and from consideration of the solution of this equation we can say that if the speed of any particular shaft be less than a certain critical speed, the shaft will tend to straighten itself if it be momentarily bent, but that, on the other hand, if the speed exceeds this critical value, the bending will tend to increase with the probable destruction of the shaft. I do not know that either of these two questions can be properly understood without some knowledge of differential equations.

A problem having a certain analogy to those to which I have just referred is that of hollow cylinders under compression from without, such as boiler tubes. Whether the tubes be thick or thin, so long as they are perfect circular cylinders, they should stand until the material was crushed. But if the tubes are thin, what will happen if the tube from any cause deviate ever so little from the cylindrical form? The solution cannot be obtained without a substantial quantity of mathematics.

The next illustration shows how a mathematical conclusion, correct within the limits to which it applies, may mislead if applied beyond those limits, and how a more thorough mathematical discussion will give a correct result. Considering a case of shafting in torsion it was shown by Coulomb that the stiffness and strength of a shaft having the form of a complete circular cylinder could be readily calculated if the transverse elasticity of the material and its resistance to shearing were known. From the complete symmetry about the axis it is evident that points which lie in a plane perpendicular to the axis before twisting will still be in that plane when the shaft is twisted; it is also clear that the angle through which all points in the same plane move will be the same; hence the problem was as simple as problem could be. But many who had occasion to make use of Coulomb's results gave them an application which was wholly unwarranted. They assumed that they were equally applicable to other cases than complete circular cylinders; they assumed in fact that every point of the material which lay in a plane perpendicular to the axis would remain in that plane when the shaft was twisted, whether the shaft was symmetrical about its axis or not, and they consequently arrived at very erroneous results. That the assumption was erroneous is obvious enough from a consideration of an extreme case. In Fig. 1 is shown in cross-section a hollow cylindrical shaft, which is not complete, but divided by a plane passing through its axis. In this case the shaft when twisted will be as illustrated in the side elevation; two points, A and B, were in one plane perpendicular to the axis when the shaft was free from twist; they cease to be in one plane when the shaft is twisted. St. Venant[1] in 1855 investigated the question of shafts without making incorrect assumptions; he expressed the condition of the material by a partial differential equation of the second order, and gave suitable surface conditions. A general solution of the problem for all forms of shafts has not been obtained, but St. Venant gives a number of solutions for particular forms, and he obtains some general results of interest. In all cases the stiffness of the shaft is less than would be inferred from an erroneous application of Coulomb's theory. Fig. 2 shows diagrammatically the strain in a shaft of triangular section; the full lines indicate that the parts of the shaft which lay in one

FIG. 1.

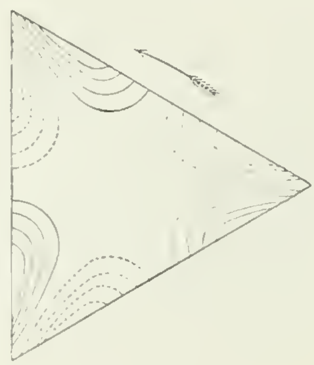

FIG. 2.

plane before twisting when twisted rise above the plane; the dotted lines indicate that they lie behind the plane of the paper. The shearing stress is least at the angles of the triangle, and is greatest at the middles of the sides. At this point then the shaft will begin to break under torsion. The fact is probably well known to men of practical experience, but it is directly contradictory to the conclusion at which one would arrive by a careless use of Coulomb's theory beyond the narrow limits within which it is applicable. The longitudinal ribs which one often sees on old cast-iron shafts are useful enough to give stiffness to the shafts against bending, but are good for very little if torsional stiffness or torsional strength is desired.

Another application of mathematical theory which has been carried somewhat further than the premises warrant is found in the case of girders. It is almost invariably customary to treat a girder as though the sections retain when the girder is bent the form and size which they had before bending. Making this assumption, it is very easy to calculate the strength and stiffness of a girder of any section. Unfortunately, the assumption is untrue; but, fortunately, it is approximately true in the case of most girders with which engineers in practice have to deal. That it is untrue can be readily seen from consideration of a girder of exaggerated form, the section of which is shown in Fig. 3. Any practical man would at once see that the outer parts of the flanges would add little to the strength of the girder, but according to the usual mathematical theory the outer parts of this flange should be as useful as the parts which are nearer to

1 "Memoires des Savants Étrangers," 1855; and Thomson and Tait, "Treatise on Natural Philosophy."

the web. This problem St. Venant also deals with in a rigid mathematical manner. Amongst other things, he showed that a girder of rectangular section, such as shown in Fig. 4, would, when bent, take the form shown by the curved lines in the same Fig. The last two examples show how a little knowledge may be a dangerous thing and how easy it is for anyone who attempts to apply mathematics without adequate mathematical knowledge to be misled.

The theory of thick cylinders under bursting stress from within has many important practical applications to hydraulic presses and to guns. It has been discussed more than once in this room. As usual in considering these cases we are immediately led to differential equations which here are fortunately solved without serious difficulty, and the solution tells us the whole story. We learn that doubling the thickness by no means doubles the strength of the cylinder. And as a converse, that doubling the

Fig. 3.

strength of the material will permit the thickness to be diminished to much less than one-half. Twenty-five years ago hydraulic presses were mostly made of cast-iron. Many people were not a little astonished at the great reduction in thickness and weight which became possible when steel was substituted for the weaker material. In the case of guns it is well known that greater strength can be obtained if the outer hoops are shrunk on to the inner ones.[1] Mathematical theory tells us what amount of shrinkage should give the best results. It may possibly not be worth while to follow the results of theory precisely, but without the guidance of theory it would not be unnatural to give so great a shrinkage that the gun would be weaker than if no shrinkage were used.

The rolling of ships in a seaway gives an illustration of a principle which has very varied application in many branches of physics. Suppose a body is capable of oscillating in a certain periodic time, and that it is submitted to a disturbing force of

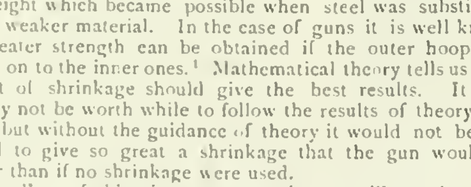

Fig. 4.

given period, the equation of motion easily shows that the resulting disturbance will be great if the two periods are equal or nearly equal. We meet with the principle in acoustics as resonance. If two tuning-forks are tuned to the same pitch, and one is sounded in the neighbourhood of the other, that other will presently be thrown into vibration by the waves transmitted through the air from the first. You may try a similar experiment at any time on any piano. Strike the higher G in the treble, the sound ceases on raising the finger. Now hold down the middle C, and again strike G; the C string at once takes up the note sounded, and can be heard after the exciting string has been silenced by damping. The same fundamental idea is found in the lunar theory in the term in the equation known as the evection, and again in the theory of Jupiter's satellites. The reason why the metals present in the solar atmosphere give black lines in the spectrum by absorption, corresponding in position with the bright lines in the spectrum which the same metals give when incandescent, is again the same. Gas will absorb or take in from the ether waves of the exact period which it is capable of giving to the ether. The general explanation of all these phenomena is easy. Imagine a pendulum, and suppose it experiences a periodic disturbing force, the first impulse of the disturbing force gives the pendulum a slight swing; the effect of the second impulse depends entirely on when it occurs; it may occur so as to neutralise the effect of the first, or it may occur so as to increase it. If the period of the force is the same as the natural period of the pendulum, the effect of the second, third, and later impulses will be added to the effect of the first, and the final disturbance will be great, even though the individual impulses be minute. But the mathematical theory tells us much more than any general explanation can do. It tells us exactly what the character of the effect will be, and its amount if the periods are nearly but not exactly the same. It tells us, too, exactly how friction affects the results. And the beauty of it is that the mathematical theory is much the same in all cases, so that having learned to deal with one case we are enlightened as to a host of others. The oscillating body may be an iron-clad, or it may be an atom of hydrogen; the disturbing periodic force may be the waves of the Atlantic, or it may be the waves in the ether occurring five hundred millions of millions of times in a second; it is all one to the mathematician; the treatment is substantially the same.

The question of the speed of ships and the power to propel them is probably more effectually treated by experiment on models, as was done by the late Mr. Froude, than by mathematics alone; but in order to learn from the experiments all they are capable of teaching, a mathematical understanding is needed. Given that we know by experiment all about a given model, that we know what force is needed to propel it at every speed, we want to know from these experiments how a great ship, 100 times as big, but similar in form in every respect, will behave; and here mathematics come in to aid us in making the inference.

The construction of ships at once leads us on to the methods of navigating them. In navigation I should find much material for my purpose, but navigation is not usually included in engineering, but many of the implements of navigation undoubtedly are. The mariners' compass has for ages been the mainstay of the navigator, and a simple enough instrument it was till it was disturbed by the iron of which ships came to be built. The disturbance of the compass by the iron of the ship was first seriously attacked by two senior wranglers, Sir G. Airy and Mr. Archibald Smith. The disturbance may be divided into two parts, the first due to the permanent magnetism of the ship, the second to the temporary magnetism induced by the earth's inductive action on the iron of the ship—the first causes the semicircular, the second the quadrantal, error. One has only to open the "Admiralty Manual of Deviations of the Compass" to see how the mathematics of Archibald Smith have accomplished a proper understanding of the subject. The errors of the compass are dealt with in two ways: they are compensated by soft iron correctors, and by permanent magnets so placed as to have an effect equal and opposite to the effect of the temporary and permanent magnetism of the ship. Or they are dealt with by formulæ of correction which enable the error to be calculated when the course of the ship and the conditions of the earth's magnetism are given, or a combination of the two methods is used. Either method is based on Archibald Smith's theory. It is not possible to leave the subject of the mariners' compass without referring to the great improvements of Lord Kelvin. The improvements relate to every part of the instrument, and I venture to say that none of them could have been made by anyone but a mathematician. In order to get his card steady he knew that its period must be different to any possible period of the waves, or he would have the resonance to which I have just referred coming in, so he gave his card a considerable moment of inertia; but this was managed with a light card so that small needles could be used. If the needles are small the correction by soft iron masses and by permanent magnets is easier and more accurate. Then the bowl of the compass had to be suitably carried so that it would not be unduly disturbed by shock, and provision had to be made for damping by fluid friction the oscillations of the bowl if they occurred. Lastly, a most beautiful method of correcting the compass, without taking a sight, was discovered. In every detailed improvement one can detect that the inventing mind was that of a most able and trained mathematician.

An essential of safe navigation is an efficient system of light-

[1] Lamé, "Leçons sur la Théorie Mathématique de l'Élasticité des corps solides," 14th Leçon.

houses. The optical problem of the lighthouse engineer is to construct apparatus which shall usefully direct all the light produced. The present forms of apparatus are in their leading features due to Fresnel, the able mathematician, who established on an absolutely firm foundation the undulatory theory of light. To properly design an optical apparatus formulæ must be used, and the advantage is great if the designer can with ease manufacture the formulæ he requires.

Submarine telegraphy yields some interesting examples of the application of the higher mathematics. When a cable across the Atlantic was first seriously entertained, the first point to be settled was, how many words a minute could be sent through such a cable. This was the most practical question possible. Upon the answer depended the prospect of the cable paying commercially if successfully laid. The matter was dealt with by Prof. Thomson,[1] of Glasgow, now Lord Kelvin. He showed that the propagation of an electric disturbance in a cable could be expressed by a partial differential equation, and that the solution of this equation under certain conditions applicable to practice could be expressed either by a definite integral or by an infinite series. The values of these were calculated, and hence before an Atlantic cable was laid at all it was known how long it would take a signal to reach the opposite shore, and how much its intensity would be diminished in transmission. Referring to Fig. 5, abscissæ represent time, reckoned from the time of making contact at the sending end of the cable, ordinates the currents at the receiving ends, curve (1) gives these currents when the contact at the receiving end, after being made, is continuously maintained. It will be observed that for a time a there is hardly any current at the receiving end, that then the current rapidly increases and attains to half its final value after a time equal to about $5a$. Curves (1) . . . . (7) show the currents at the receiving ends when the contact is made at the sending end maintained for times a, $2a$ . . . $7a$ respectively, and then broken. Looking at curve (1) one sees how small is the amount of current and how long it lasts compared with the time during which contact is made. The time a depends on the length and character of the cable; it is equal to $k c l^2 \log_e \frac{4}{3}/\pi^2$, where k is the resistance per unit length, c the capacity per unit length, and l the length of the cable. The knowledge of what is the commercial value of a cable depends on a knowledge of the value of a, and this cannot be obtained without knowing the differential equation $c\,k\,\frac{dv}{dt} = \frac{d^2v}{dx^2}$,[2] to which I have referred, and its by no means simple solution either as a definite integral or as an infinite series. So far as I know, this piece of higher mathematics cannot be evaded by any mere elementary treatment. The transmission of disturbance in a cable is quite different from the transmission of sound waves in air, which move with constant velocity. If the cable be doubled in length, it takes four times as long for the signal to pass through it instead of just twice as long, as would be the case if it were a proper wave motion. In fact the time of passage between the making of contact at the sending end of the cable and the beginning of the resulting disturbance at the receiving end, varies as the square of the length of the cable. The mathematical theory is exactly the same as that of the transmission of heat in a plate, one surface of which is suddenly exposed to a temperature different to the temperature of the plate. This is constantly occurring in the application of mathematics—one piece of mathematical work serves for many physical problems having apparently little in common. Fourier long ago discussed the heat problem, little dreaming that his analysis would be just what was wanted for ascertaining how fast signals could be sent across the Atlantic by a system of telegraphy which in his days had not even been projected in its simplest form. The same differential equation also gives the theory of the transmission of telephonic messages through cables; but the solution is then easier, and tells us exactly why it is so much more difficult to speak through 100 miles of cable than through 1000 miles of overhead line. As I have just stated, the differential equation of the disturbance in the cable is $c\,k\,\frac{dv}{dt} = \frac{d^2v}{dx^2}$. A musical note of period T spoken into the cable through a telephone is properly represented by $A \sin \frac{2\pi t}{T}$; the disturbance in the cable will be—

$$v = A\, e^{-x\sqrt{k c \pi / T}} \sin\left(\frac{2\pi t}{T} - x\sqrt{k c \pi / T}\right),$$

as may be easily verified by differentiating. This equation tells us everything. It tells us the rate at which the waves diminish with the distance. This rate increases with the resistance, with the capacity and with the frequency. If the capacity is at all considerable the diminution is rapid. The velocity of the waves is not the same for all frequencies, as is the case with waves in air, but varies as the square root of the period, so that if two notes were sounded the high note would arrive after the low notes, and the resultant effect would be entirely destroyed. Here, again, it is difficult to see how the differential equation and its solution can be evaded.

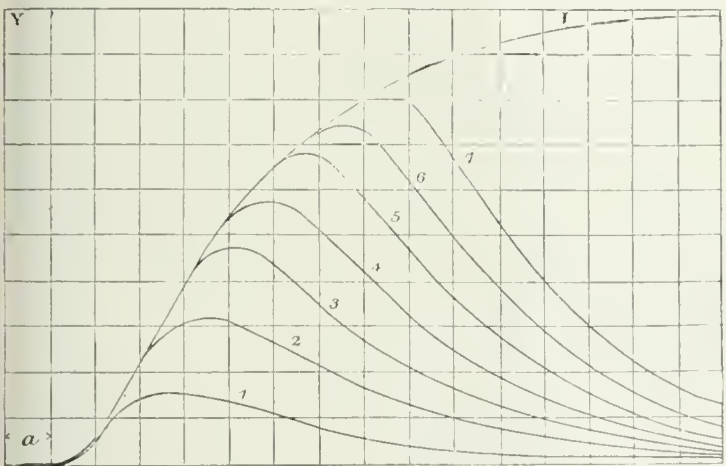

Fig. 5.

Though the history of the telegraph dates only from a little more than fifty years ago, it is ancient in comparison with the other great applications of electrical science, which have received their development during the last fifteen years. Here again mathematics which are not quite elementary have played their part. In the theory of transformers we find another illustration of the need of knowing how formulæ are obtained if they are to be correctly applied. The early transformers were made with unclosed magnetic circuits; there was an iron core, but the lines of magnetic force passed through air for a considerable part of their path. In this case a complete mathematical theory was not very difficult. But speedily closed magnetic circuits were found to be better, and the relation of magnetic induction and magnetic force became all important. If anyone were to apply mathematical formulæ, which were true for the earlier transformers, to the later ones, his results would be inaccurate. Indeed a wholly different method of attack on the problem was needed, taking account of the facts as they are, and not applying results which were true of older apparatus to cases essentially distinct.[1]

The employment of alternating currents has brought into use, as a necessity for understanding the actually observed phenomena, a great deal of mathematics. Why is the apparent resistance of a conductor greater for an alternating current than for a direct current? And by resistance I do not mean the quasi-resistance due to self-induction.[2] The mathematical electrical theory is ready with an answer; it is ready, too, to tell us how the difference depends upon the frequency of the current and on the size of the conductor. In the case of a cylindrical conductor

[1] "Mathematical and Physical Papers," vol ii. p. 61. Sir W. Thomson.
[2] v is the potential, t the time, and x the distance from the sending end of the cable.

[1] *Proceedings* of Royal Society, February 17, 1887.
[2] Lord Rayleigh, *Phil. Mag.*, vol. xxi. p. 381.

the solution involves a knowledge of Bessel's functions. We learn that if the current has a high frequency, or if the conductor be large, there will be very little current in the centre of the cylinder, and that therefore for any practical purpose the centre of the cylinder might just as well not be there; the current is largely confined to the part of the conductor near to its surface. The currents at different depths in the conductor attain to their maximum values at different times; those near the surface of the cylinder occur before those at some distance from the surface. The mathematical conditions are expressed by the same equation as is used to express the disposition of heat in a cylinder the surface of which is submitted to a periodic variation of temperature. Anyone who had thoroughly mastered the heat problem would be quite prepared to deal with the problem of currents in a conductor. It cannot be too often repeated, any piece of pure mathematics which finds one application to a physical problem is almost sure to find, in exactly the same form, applications to other problems which superficially are absolutely distinct. The differential equation in this case is $kc\frac{dv}{dt} = \left(\frac{d^2v}{dr^2} + \frac{1}{r}\frac{dv}{dr}\right)$, the similarity of physical condition to the problem of linear propagation of heat is close, but the mathematics differ materially owing to the presence of the term $\frac{1}{r}\frac{dv}{dr}$ in the equation. Mathematics deals with the relation of quantities to each other without troubling as to what the physical meaning of the quantities may be. Hence it is that the mathematical treatment of two such problems as the distribution of currents in a cylindrical conductor and of heat in a cylinder is identical, whereas the treatment of the distribution of heat in a cylinder is quite distinct from the treatment of the distribution of heat in a sphere or in a solid bounded by two parallel planes.

A curious phenomenon was observed in the large alternate-current machines at Deptford when connected to the long cables intended to take the current to London. The pressure at the machines when connected to the conductors was, under certain conditions, actually greater than when not so connected. The phenomenon is one of resonance very analogous to the heavy rolling of ships when the natural period of roll is about the same as the period of the waves.[1] The period of the alternating current corresponds to the period of the waves, the self-induction of the machine to the moment of inertia of the ship, the reciprocal of the capacity to the stiffness of the ship, and the electrical resistance of the conductors to the frictional resistance to rolling. The mathematics in the two cases is then the same. The effect was predicted long before it was observed in a form calculated to cause trouble.

A problem which is still agitating electrical engineers is that of running more than one alternate-circuit dynamo machine connected to the same system of mains. Before the matter became one of practical concern, it was considered in this room, and it was shown mathematically that it was possible to run independently-driven alternators in parallel but impossible to run them in series. That is to say, that if two alternators were connected to the same mains they would tend to adjust themselves in relation to each other so that their currents could be added, but that if an attempt were made to couple them, so that their pressures should be added, they would adjust themselves so that their effects would be opposed.[2]

Perhaps of all engineering problems which have received their solution in the last hundred years that of the greatest practical importance is the conversion of the energy of heat into the energy of visible mechanical motion. The science of thermodynamics has advanced along with the practical improvement of the steam-engine. By its aid, particularly by the aid of the so-called second law, we know what is possible of attainment by the engineer under given conditions of temperature. I must not trench on the subject of one of my successors, but I may point out that our knowledge of the second law of thermodynamics was first developed by means of mathematics, and that to-day its neatest expression is by means of partial differential equations. The two most notable names in connection with the development of the second law of thermodynamics in harmony with the first are those of Kelvin and Clausius; both dealt with the subject in a mathematical form not comprehensible to those who have not had substantial mathematical training.

Illustrations such as these might be multiplied almost indefinitely. They show that the advancement of the science of engineering has been aided in no inconsiderable measure by the labours of mathematicians directly applying the higher mathematical methods to engineering problems. They show, too, one way in which respect for a formula may be dangerous, one way in which it is true that mathematics may be a bad master. In St. Venant's problems we have an example in which the use of older results of limited application in cases where the assumptions on which they rest are not true will mislead. The examples show the proper remedy; it is a more complete application of mathematical methods. The error is just one which a man will make who has the power to use a formula without a ready understanding of how it is arrived at. A practical man, ignoring mathematical results, might or might not escape the error of supposing that a triangular shaft would break at the angles under torsion; the half-educated mathematician would certainly fall into the snare from which complete mathematical knowledge would deliver him. You can only secure the services of that good servant, mathematics, and escape the tyranny of a bad master by thoroughly mastering the branches of mathematics you use. The mistake caused by the wrong application of mathematical formulæ is only to be cured by a more abundant supply of more powerful mathematics.

There is another drawback to the use of results, taken, it may be, out of an engineering pocket-book by those who are not prepared to understand how they are reached and on what foundations they rest. The educational advantage is lost. The close observation which enabled the earlier engineers to proportion their means to the ends to be attained was no doubt very laborious, and the results could not be applied to cases much different from those which had been previously seen, but the effect on the character of the engineer was great. In like manner, to thoroughly understand the theory of an engineering problem makes a man able to understand other problems, and in addition to this precisely the same mathematical reasoning applies to many cases. The mere unintelligent use of a formula loses all this; it leaves the mind of the user unimproved, and it gives no help in dealing with questions similar in form though different in substance.

But even the use of mathematics by competent mathematicians is not without drawbacks. Mathematical treatment of any problem is always analytical—analytical, I mean, in this sense that attention is concentrated on certain facts, and other facts are neglected for the moment. For example, in dealing with the thermodynamics of a steam-engine, one dismisses from consideration very vital points essential to the successful working of the engine, questions of strength of parts, lubrication, convenience for repairs. But if an engineer is to succeed he must not fail to consider every element necessary to success; he must have a practical instinct which will tell him whether the instrument as a whole will succeed. His mind must not be only analytical, or he will be in danger of solving bits of the problems which his work presents, and of falling into fatal mistakes on points which he has omitted to consider, and which the plainest, intelligent practical man would avoid almost without knowing it.

Again, the powers of the strongest mathematician being limited, there is a constant temptation to fit the facts to suit the mathematics, and to assume that the conclusions will have greater accuracy than the premises from which they are deduced. This is a trouble one meets with in other applications of mathematics to experimental science. In order to make the subject amenable to treatment, one finds, for example, in the science of magnetism, that it is boldly assumed that the magnetisation of magnetisable material is proportional to the magnetising force, and the ratio has a name given to it, and conclusions are drawn from the assumption, but the fact is, no such proportionality exists, and all conclusions resulting from the assumption are so far invalid. Wherever possible, mathematical deductions should be frequently verified by reference to observation or experiment, for the very simple reason that they are only deductions, and the premises from which the deductions are made may be inaccurate or may be incomplete. We must always remember that we cannot get more out of the mathematical mill than we put into it, though we may get it in a form infinitely more useful for our purpose.

Engineers no doubt regard their profession from very different

[1] [illegible] of [illegible] Engineers, November [illegible].
[2] [illegible] Inst. C.E., [illegible]; Institution of [illegible] Engineers, November 13, [illegible]

points of view; some think it a mere means of making money; some regard it as an instrumentality for benefiting the race; whilst others again delight in it as an interest in itself, and delight in it most of all when new knowledge is added to that which we know already. It is just the same with the medical profession; some attend patients for the guineas they receive, some give a very high place to motives of benevolence, whilst others love it as a field where new knowledge may be found and the delight of discovery enjoyed. In regard to the first class of engineers, I have no doubt a little skill in managing a board of directors or impressing a committee of Parliament will be much more useful to the engineer than a great deal of mathematics. Let him manage his board and buy his mathematician, and it is very probable he will make much more money than the mathematician or any other person of skill whom he may employ. But we cannot all of us make money in this way. In the future it is likely that educated men will have to work harder and receive less, and it is a great thing if their work can be made itself a joy, and surely this can best be by a thorough understanding of the reason of all they do by the feeling that they have full competence to form their own judgments without depending much on the authority of others. This can only be in the words of Sir John Herschel by a "sound and sufficient knowledge of mathematics, the great instrument of all exact inquiry, without which no man can ever make such advance in any of the higher departments of science as can entitle him to form an independent opinion on any subject of discussion within their range."

After all, in any department of applied or pure science the highest satisfaction comes from accomplishing that which no one has done before, from disclosing what no one hitherto has known. If a department of the arts or sciences ceases to advance and becomes simply the application in known ways of known principles to obtain known ends, that department has lost its charm till the time comes for a fresh advent of change and development. To effect such advances it is easy to show that mathematics is a most necessary instrument. Here it is no drawback that the mind of the discoverer is too analytical; he may deal at his pleasure with one aspect of a problem, and it does not detract in any way from the value of his solution that he does not touch on incidental matters. Some of you who love the interest of continual advance in our science and practice, may look forward with a shade of sadness to a possible time when all is done or known which can be done or known, and the work of the engineer shall be merely applying principles discovered by his predecessors. In such a state, when the experience of the older generations shall control the practice of to-day, the free use of mathematical methods may be effectually superseded by the application according to rule of mathematical formulæ. But it would be a much less interesting condition than the constant change of to-day, when the practical experience of ten years ago is in many departments rendered worthless by later discoveries. But we need not fear that such a time of petrifaction will come so long as, whilst reverencing the discoverers who have added to our knowledge, we endeavour to replace their methods by better, and expect that those who come after us will, in their time, improve upon ours. Our knowledge must always be limited, but the knowable is limitless. The greater the sphere of our knowledge the greater the surface of contact with our infinite ignorance.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—By a resolution of Congregation, the care of such portions of, as may seem desirable, the Lee collection of anatomical and physiological specimens, which have for many years past been placed in the University Museum under care of the Linacre Professor, may be transferred to the care of other Professors with the sanction of the Trustees of the Lee bequest.

The date of the preliminary examinations in natural science in the Michaelmas term has been fixed for the Monday in the eighth week in Full Term in lieu of the dates hitherto observed.

The resolutions proposed by the committee on the granting of degrees for research were brought before Convocation on Tuesday afternoon. The first resolution, affirming the general principle that it was desirable that such degrees should be established, was agreed to *nemine contradicente*. Some difference of opinion manifested itself in the discussion on the succeeding resolutions. That which suggested that the new degrees should be styled Master of Science and Master of Letters was rejected on a division, with the intention that the titles should be further considered by the committee. The remainder of the resolutions were agreed to, and the drafting of a statute embodying the recommendations of the committee was referred to a committee consisting of the Vice-Chancellor and twelve others.

The annual Boyle Lecture was delivered on Tuesday evening by Prof. A. MacAlister, who chose as his subject, "Some morphological lessons taught by human variations." The lecture, which is held under the auspices of the Junior Scientific Club, was largely attended.

Cambridge.—The new Engineering Laboratory, just completed under the supervision of Prof. Ewing, will be formally opened on May 15, at 3 p.m., by Lord Kelvin, President of the Royal Society. The Vice-Chancellor will preside, and it is expected that Prof. Kennedy and others will deliver addresses on the occasion. After the opening ceremony Prof. and Mrs. Ewing will be "at home" in the laboratory, in order to give members of the University an opportunity of seeing for themselves the provision that has been made for the scientific study of engineering.

The degree of Doctor of Laws will, on May 10, be conferred upon Dr. Carl Theodor von Inama-Sternegg, honorary Professor of Political Science in the University of Vienna, and President of the KK. Statistical Central-Commission of the Austro-Hungarian Empire. Prof. von Inama-Sternegg was President of the Demographic Section of the International Congress of Hygiene held in London in 1891, but was unable to visit Cambridge with the other members of the Congress for the purpose of receiving the degree.

At the same Congregation the complete degree of M.A. will be conferred on Prof. Ewing's able demonstrators, Mr. W. E. Dalby and Mr. C. G. Lamb, who are already Bachelors of Science of the University of London.

Mr. Oscar Browning, who is an officier d'Académie, will next month represent the University of Cambridge at the festal opening of the new Palais des Facultés of the Académie of Caen.

Dr. Hobson, F.R.S., has been appointed a syndic of the library, in the room of the late Prof. Robertson Smith.

A grant of £20 from the University chest has been made to Mr. H. Yule Oldham, University Lecturer in Geography, for maps and apparatus.

The growth of the botanical department under the direction of Deputy-Prof. F. Darwin, F.R.S., has led the General Board of Studies to recommend that his stipend as reader, and that of Mr. W. Gardiner, F.R.S., as lecturer, should be increased to £150 a year. An additional demonstratorship in botany is also proposed. The Board further recommend that the annual stipend of Mr. S. J. Hickson, as lecturer in Advanced Morphology, should be increased to £100.

The Natural Sciences Tripos, for which there are about 130 candidates, begins on May 23, and will extend to June 12.

The Convocation of the University of London met on Tuesday. It was expected that a warm discussion would take place on the Gresham scheme, but the expectation was not realised, as the chairman, Mr. E. H. Busk, ruled out of order all motions relating to that subject. One of these resolutions, standing in the name of Mr. Thiselton-Dyer, was—"That Convocation, while reserving its right to represent its views before the proposed Statutory Commission, hereby expresses its general approval of the Report of the Royal Commission." The *Times* reports that, when this and other motions had been ruled out of order, Prof. Silvanus Thompson moved the adjournment of the House. After some discussion an amendment to Prof. Thompson's motion—that the House should adjourn until seven o'clock—was accepted almost unanimously, the common object of all parties being to ascertain the result of the voting for the annual committee, for the election of which the two parties had their separate lists, one list consisting of those who were practically in favour of the Gresham scheme, and the other desiring to leave the whole question in the hands of the joint committee. The former party carried their whole list.

On the adjournment before the declaration of the poll a body of some 230 graduates met in the Graduates'-room of the University to draw up a protest against their having been again prevented from discussing the report of the Gresham Commission. Sir Henry Roscoe presided, and the speakers were Mr.

Thiselton-Dyer, Mr. Anstie, Q.C., Prof. Silvanus Thompson, Dr. Allchin, Sir Philip Magnus, Dr. R. D. Roberts, and Principal Cave. A resolution was unanimously passed in the following terms—"That this meeting of graduates, while reserving its right to represent its views before the proposed Statutory Commission, hereby expresses its general approval of the report of the Royal Commission." A second resolution expressed regret that, for the second time, discussion in Convocation of the report of the Gresham Commission had been prevented. Further, that an account of the proceedings at this meeting of graduates be prepared by the secretaries, and at once be transmitted to the Senate and to the press. A committee of graduates has been formed under the chairmanship of Mr. H. H. Cozens-Hardy, Q.C., M.P., for the purpose of obtaining from the graduates at large an expression of opinion in support of the scheme of reconstruction proposed by the Gresham Commission.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, April 30.—M. Lœwy in the chair. —On the equilibrium of ocean waters, by M. Poincaré. A mathematical paper dealing with the theory of tides.—On the soil and climate of the island of Madagascar from an agricultural standpoint, by M. Grandidier. The author warns intending colonists of the comparative infertility of most of the soils in Madagascar, notwithstanding the apparently vigorous vegetable growth supported thereon, and points out the importance of meteorological conditions, which are peculiarly unfavourable in certain districts.—Digestion without digestive ferments, by M. A. Dastre. Fresh proteids (fibrin, albumin, &c.) undergo the same series of changes when subjected to the prolonged action of 10–15 per cent. solutions of ammonium or sodium chloride (or 1–2 per cent. sodium fluoride), as when acted on by gastric juice.—Observations of Gale's comet made at Nice and at Algiers, by M. Tisserand.—Elliptic elements of Denning's comet, 1894, by M. L. Schulhof.—Observations of the same comet made at Toulouse Observatory, by MM. E. Cosserat and F. Rossard.—A theorem concerning the areas described in the movement of a plane figure, by M. G. Kœnigs. If a finite arc AB of any curvature roll upon any arc of equal length successively on the two sides of this arc, the area swept by the radius IM joining the instantaneous centre to a point M on the arc AB is independent of the form of the arc AB.—On the lines of curvature of *surfaces cerclées*, by M. Lelieuvre.—On the analytical integrals of equations of the form

$$\frac{d^n z}{dy^n} = F(z), \; F(z) = \Sigma a_{ik} \frac{d^{i+k} z}{dx^i \, dy^k}, \; i + k < n,$$

by M. Delassus.—A note by M. Bendixon on a theorem by M. Poincaré.—On hysteresis and permanent deformations, by M. P. Duhem.—On a new method of determining critical temperatures by the *critical index*, by M. James Chappuis. The author employs the method of interference fringes for following the variation in the index of refraction of the substance examined. The critical temperature of carbon dioxide determined by this method is 31·40°, a number in substantial agreement with Amagat's determination 31·35.—On a new method for the determination of the lowering of the freezing point of solutions, by M. A. Ponsot. The temperature is read at which a solution is in equilibrium with a quantity of ice with which it is thoroughly agitated, the exterior radiation being minimised, and the solution is then in part withdrawn and analysed.—On cupric bromide, by M. Paul Sabatier. The anhydrous salt and the form $CuBr_2, 4H_2O$ are described. The green crystals of the latter lose water over sulphuric acid and are converted into black $CuBr_2$.—On an unsaturated natural ketone, by MM. Ph. Barbier and L. Bouveault. This ketone is obtained from crude essence of lemon grass (*Andropogon citratus*). It has the composition $(CH_3)_2 : C : CH . CH_2, CH_2, CO, CH_3$. It has a very agreeable but penetrating odour, and boils at 169–170° under ordinary pressure.—A purely mechanical action suffices for Cliona to bore its tunnels in the valves of oysters, by M. Letellier.—On the glandular system of ants, by M. Charles Janet.—Creation of new varieties by grafting, by M. Lucien Daniel. Hybridisation by grafting is possible for certain herbaceous plants which can be made to acquire new alimentary qualities by grafting them on plants superior to them in this respect, and afterwards sowing seed from the graft. The influence on the graft varies, but is particularly marked among the Cruciferæ.—On the chemical composition of wavellites and turquoises, by M. Adolphe Carnot.—On the microstructure of *mélilite*, by M. L. Gentil.—New researches on association among bacteria. Augmentation of the virulence of certain microbes. Increase of receptivity: A note by M. V. Galtier in which the following conclusions are given:—(1) Microbes, attenuated till they cannot alone produce a mortal malady, become again virulent when two species are introduced into the organism. (2) The two species may multiply side by side, but generally one tends to disappear, and the other becomes again pathogenous. (3) When two species of microbes are found associated, it is sometimes one and sometimes the other which regains its virulence according to the conditions. (4) Association of bacteria is able to be employed in the laboratory to render attenuated microbes again virulent. (5) Not only can the return of certain epidemics be explained by it, but the effects of vaccination with mild virus may be aggravated by this means. (6) The passage of one microbe, conferring immunity against a given malady, may predispose to the attack of another.—Properties of serum from animals protected against the poisons of different species of serpents, by M. A. Calmette.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—The Country Month by Month, May: J. A. Owen and Prof. Boulger (Bliss).—Die Fauna von Goriach: A. Hofmann (Wien).—Die Cephalopoden der Hallstätter Kalke: Dr. E. M. E. von Mojsvár, 2 Band, Text and Atlas (Wien).—La Rectification de l'Alcool: E. Sorel (Paris, Gauthier-Villars).—Biological Lectures and Addresses: Prof. A. Milnes Marshall (Nutt).

Pamphlets.—McGill University, Montreal, Engineering and Physics Buildings, Formal Opening, February 24, 1893.—Theophrastus Paracelsus: G. W. A. Kahlbaum (Basel, Schwabe).

Serials.—Science Progress, May (Scientific Press, Ltd.).—Bulletin of the New York Mathematical Society, Vol. 3, No. 7 (New York, Macmillan). Quarterly Journal of the Geological Society, Vol. L., Part 2, No. 198 (Longmans).—Fortnightly Review, May (Chapman and Hall).—Jahrbuch der K. K. Geologischen Reichsanstalt Jahrg. 1893, xliii. Band, 3 and 4 Heft (Wien).—Medical Magazine, May (Southwood).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique (Bruxelles).—Himmel und Erde, May (Berlin).

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THURSDAY, MAY 17, 1894.

TEXT-BOOK OF COSMICAL PHYSICS.

Joh. Müller's Lehrbuch der Kosmischen Physik. Fünfte umgearbeitete und vermehrte Auflage, von Dr. C. F. W. Peters. (Braunschweig: Friedrich Vieweg und Sohn, 1894.)

NEARLY everyone who has become at all acquainted with popular German scientific works will have at some time fallen in with this well-known book by Dr. Müller. It first appeared in the year 1856, and received particular favour, in that in the first place it was really popularly written, and secondly, that it was useful as a book of reference for many questions which dealt with every-day phenomena. The book reached its fourth edition in 1875, and since then none other has appeared, except the one that we now have under consideration. Nineteen years have thus flown by since Dr. Müller undertook the last revision, and in this period one is not at all surprised to find that accepted views on many points have undergone great changes, and in some cases entire revolutions.

For those of our readers who have not had the opportunity of examining previous editions for themselves, a few words as to the gap which the author intended that the work should fill may not be out of place. Referring, in the preface to the first edition, to the great stir Humboldt's "Kosmos" made throughout Germany, attracting general attention to the study of cosmical phenomena, he stated that he intended to produce a work, in the form of a text-book, in which the physics of the heavens and the earth should be systematically brought together. In astronomy it was true that many popular works were at hand, but in physical geography and meteorology they were to a certain extent wanting. With such an object in view it was necessary to keep the book within certain limits, and not to enter too far into mathematical developments: this accounts for the brevity of some parts in the astronomical and optical sections. On the whole, however, a non-mathematical reader should rest very content with what he has before him.

In this new edition, Dr. Peters, who has undertaken the revision, has not deviated from the original idea of dividing the work into four books, and they are, as formerly, devoted to (1) the movements of the heavenly bodies and their mechanical explanations; (2) cosmical and atmospheric phenomena; (3) heat phenomena on the earth's surface and in the atmosphere; and, lastly, (4) atmospheric electricity and terrestrial-magnetism.

Covering as the work does over 900 pages, a systematic treatment of each section would be impossible, so we will limit ourselves to searching out what is not in the book which ought to be there, and *vice versâ*. With regard to the latter, with the exception of what is referred to later on, there is not much that need be said, except it be that some old incidents of observed phenomena might have made place for others more recent, as, to take one example, that referred to under "Magnetische Störungen" (p. 858).

The first book, dealing with astronomical phenomena consists of over 300 pages, and is the largest of the four. This has received many and various alterations and additions; among the latter may be mentioned references to the new moons of Mars and Jupiter, the discoveries relating to the periods of rotation of Mercury and Venus (Trouvelot's work somehow being overlooked here), variable stars of the Algol type, and photographic and spectrum analysis work. Those important phenomena, the tides, receive due attention, and instead of being dismissed in two pages, as in the last edition, in this one have twelve devoted to them. In the section on time, it is a pity that more is not said about the new system of time-zones, for this is just a typical point to which an ordinary reader might wish to refer. Under the description of what we know about the planet Venus, there are several important points which do not receive mention. Thus, for instance, no reference is made to the snow-caps of which Trouvelot has published so many drawings, nor can an account be found of the curious and quick changes which have been observed to occur on the terminator and limb, and which afford strong arguments in favour of a rapid rotation of the planet. The transit of Venus, on the other hand, is fully discussed and described.

In the chapter dealing with comets, excellent descriptions are given of their gravitational motions, and of remarkable appearances, while the forms of their tails are discussed at some length. During the last few years astronomers have had many opportunities of studying these bodies, and our knowledge has very much increased. Thus we now generally suppose them to be swarms of meteorites under the influence of gravitation pursuing their course round the sun, the particles of which they are composed banging and clashing about near perihelion, and producing light and heat. One might at first be led to consider that the author had overlooked such new knowledge, as the reader is pulled suddenly up by a section on the "meteorite." It is not till after twenty-five pages have been passed over that he is informed of this suggested relation between comets and meteors, and then in only a few words. This subject is mentioned again briefly under the spectra of comets.

Coming now to the second book, our luminary the sun is the first dealt with. In this part we may mention one or two points which we think are deserving of more attention. Thus, *à propos* of sun-spots, such an absorbing question as the unequal period between a maximum and a minimum and a minimum and a maximum receives no mention, or even the important fact of the latitudinal changes that the positions of spots undergo during a period; in fact, in fifteen lines the whole reference to spot-period is treated. In the explanations given to account for spots, Zöllner's ideas are the most modern hinted at; there is no statement as to our present view, that they are caused by down-rushes of cooler matter from the upper regions of the solar atmosphere.

An interesting account of the zodiacal light is followed by a section on planetary photometry, in which G. Müller's recent work is referred to. In the section on variable stars, the Algol type is fully dealt with, but no attempt is made to explain other kinds of variables, although several plausible suggestions are at hand. Under temporary stars exactly the same is the case, in spite of what has been recently done with regard to this most fascinating puzzle in astronomy. The remainder of this book deals briefly, among other things, with nebulæ, star clusters, comets and their spectra, spectroscopes, &c. The chapter on atmospheric light phenomena has received but little alteration; in it are described refraction, mirages, halos, twilight, &c., which call for little if any change.

In the third book we are introduced successively to chapters on the distribution of heat on the earth's surface, the pressure of, and disturbances in, the atmosphere, and hygrometry; these may be all included in the word "meteorology." In the science of meteorology very rapid advance has been made, and the last twenty years have witnessed changes which have been sweeping in their nature. Such being the case, we expect to find here considerable alterations and additions, and indeed we are not disappointed, for we find this part "zum grossen Theile ganzlich umgearbeitet." Thus, to mention one or two instances, the Ice age is dealt with at some length, and is accompanied by an excellent map showing the glacial distribution. The paragraphs on the internal heat of the earth are also likewise lengthened, and much new matter inserted. In the section on earthquakes, on the other hand, we fail to notice any reference to Prof. Milne's important work that he has been carrying out in Japan on a truly scientific basis. A brief description of this, and a few words on the seismograph, would have made an interesting addition.

The fourth and last book will be found to have received little alteration. This seems perhaps striking, in the face of the great amount of work that is now being done in this direction. There is no doubt that at present we are rather gathering facts systematically and accurately acquired, than subjecting those already obtained to detailed discussion. Nevertheless we find no changes or additions under the paragraph entitled "das spectrum des Nordlichtes," or any other explanation of this phenomenon than that of De la Rive, indicating that the work done during the last nineteen years has been void of results worthy of mention. In the part on lightning, we are rather surprised to see no reference to photography, which has enlightened us much on this phenomenon, showing us that a forked flash is by no means "instantaneous," to use a word which is rather ambiguous, but lasts, comparatively speaking, a considerable time.

We cannot conclude without referring especially to the admirable illustrations, which throughout the work form a very prominent feature. The plates at the end of the book may be said to be the same as those that appeared in the last edition, but in the case of those in the atlas which accompanies the volume many important alterations and additions have been made. Thus, to mention some of the more important. Those showing the paths of the planets have been revised and much improved. Two rather startling (as regards colour) pictures of the planet Mars (June 3 and 14, 1858), after Secchi, are inserted, also an excellent map of his surface, after Schiaparelli.

Among other very good plates is one of Jupiter and his spots (Warren de la Rue), Saturn (Trouvelot), two of the moon after negatives taken at the Lick Observatory, Mount Hamilton, a lunar crater after Nasmyth, Roberts' Andromeda nebula, and Langley's enlarged picture of sun-spots.

The maps and diagrams referring to the meteorological and magnetical sections are as numerous as ever, and have all been carefully revised and brought up to date. New pictures of the auroræ, as observed in Kingua Fjord in 1882 and 1883, are also inserted.

In the above rapid survey of the 900 pages which this book contains, one can form an idea of the great difficulty the bringing of such a work as this up to date must have been to the reviser. Having to bear in mind that no part must be more elaborately developed than another, and that the limit of range as regards details must be restricted, Dr. Peters has had no light task before him. Cosmical physics is such a wide-spreading subject, and the information here brought together so plentiful, that the few remarks we have made above fall, for the most part, into insignificance.

As a popular treatise the work should be widely read, and the special index should considerably facilitate the utility of the work in its function as a book of reference.

W. J. LOCKYER.

ALCHEMY AND CHEMISTRY.

The Alchemical Essence and the Chemical Element, an Episode in the Quest of the Unchanging. By M. M. Pattison Muir. Pp. 94. (London: Longmans, Green, and Co., 1894.)

THIS is a very interesting book; its object is stated in a sentence printed on a fly-leaf following the title-page—"This essay is written in the hope that some of the men who exercise their 'wit and reason' in examining the problems of life may help to answer the questions that nature propounds to those of her students who follow the quest of the unchanging."

The author begins by quoting two definitions, one by an alchemist: "There abides in nature a certain form of matter which, being discovered and brought by art to perfection, converts to itself, proportionally, all imperfect bodies that it touches"; and the other by a chemist: "In chemistry we recognise how changes take place in combinations of the unchanging." It may here be said that it would often materially add to the interest of the work if the names of the authors of these and of other quotations in the book had been given.

The difficulties that many have experienced in understanding the writings of the alchemists are accounted for by showing that the names which they used, and which have survived as the names of well-known substances, were applied only to certain principles or properties that matter was supposed to possess: thus the word sulphur represents the principle of changeability, and the word mercury the principle of malleability and lustre which the metals exhibit. The alchemists used expressions of this kind partly to hide their secrets from the uninitiated, and also to preserve themselves from suspicion of dealing with the evil one, who was considered to be the possessor of the earth. The mystical language was derived, to a large extent, from theology, the science which at that time pervaded all the thoughts of the learned. Possibly the alchemists really attached some definite meaning to the fantastical terms they used, which meanings are now lost to us.

When the use of the accurate balance was introduced into natural science, it revolutionised the methods of investigation: it now became possible to trace the changes which occur during the interaction of bodies in a way quite different from that employed in earlier times. Thus the alchemist observed only the changes of properties of the substances with which he experimented; the chemist investigates, in addition, the changes of mass which occur when alterations of matter are produced.

It must not be supposed that the early workers were ignorant of the increase of weight which occurs during the calcination, or, as we now call it, the oxidation of metals, but they gave very fanciful explanations of the fact; thus George Wilson, in his "Compleat Course of Chymistry," printed in 1721 (how many students at the present time would rejoice in a complete course of chemistry in 383 pages!) says, when writing of the calcination of lead, "It gains in weight by calcination, because a greater quantity of igneous particles insinuate themselves into the lead, than the sulphurous ones the fire drives out, for in calcination, the acid of the fire, joins itself to the alkali of the lead, and having driven away its combustible sulphur, makes a new and incombustible body."

Mr. Pattison Muir gives some illustrations of the use of the balance, but one of these seems not quite a happy example. He states that when water was evaporated in an open dish and a residue was left, the alchemist "pointed to the earthy matter in the dish as proof of the transformation of water into earth." He afterwards says that a weighed quantity of water was distilled, the distillate was weighed and was found to be less than the original water; "but the sum of the weights of the condensed water and the earthy matter was equal to the weight of the water before boiling," showing that the residue was dissolved in the water used. It is not stated by whom this experiment was made, but it is inferred that it was performed in the early days of quantitative work. As spring water rarely contains more than one-tenth per cent. of dissolved matter, it would have been interesting if the author had informed us what precautions were taken to secure such a result, which would be difficult even with our modern appliances.

By the use of the balance it was found that some substances differed from others, some being composed of different kinds of matter, and hence called compounds, whilst others could not be thus separated, and were regarded as simple bodies or elements. When an element is transformed into a compound, the latter almost invariably possesses properties very different from those of the element, and the element appears to have been destroyed; the alchemist thought that it was really destroyed, but the chemist shows that it is only hidden, and can be obtained from the compound in the same quantity that was used to prepare the compound; moreover, the weight of the compound is invariably equal to the sum of the weights of the elements composing it.

As far as we know at present the elements are unchangeable; however complex the compounds which are formed by their combination, the elements can always be obtained from them with all their original properties. Thus the formations of compounds from elements and the decomposition of compounds into elements are properly called the "changes in combinations of the unchanging." The alchemical principles could not be weighed or measured, so that it was not possible to explain the properties of bodies by the assertion—for it was nothing more—that they contained more or less of these principles.

The author next tells us that the same elements in the same proportions can form compounds with different properties, and then passes on to the laws of multiple proportions, showing how these are accounted for by the theory of atoms. The periodic law is then explained, and it is pointed out that the periodic properties of the elements and of their compounds contrast very strongly with the ideas of the alchemists with regard to the principles that were supposed to account for the different properties of substances. The striking difference between alchemical and chemical reasoning is well illustrated by the history of the theory of combustion, the escape of the principle of fire, as held by the phlogistians to be the cause of combustion, being contrasted with the combination of the burning substance with oxygen, as discovered by Lavoisier.

The author appears to be rather hard on alchemy when he says "the great business of alchemy was to prevent men from coming into close contact with external realities. Alchemy was a manufacturer of blinkers that shut off the objects on either side, and so distorted the vision." No doubt this was in some ways the result of alchemy, but it can hardly be supposed that it was its object. It is difficult to place ourselves, even in imagination, in the position of the alchemists, but we may hope that they were struggling after truth to the best of their powers, their failure being due more to their holding preconceived notions than to a desire to obscure facts.

Some may not agree with the author in classing together alchemists, spiritualists, theosophists, and theologians; though, no doubt, all have erred in making assertions with an insufficient knowledge of facts. So also it seems not quite justifiable to restrict the term science to the investigation of natural phenomena, for surely the study of the moral and spiritual actions of man are also worthy of the name of science. Some may not accept spiritual truths, considering that they are beyond their experience; but it is hardly scientific to deny their existence, any more than it was reasonable for the inhabitants of Flatland to deny the existence of space of three dimensions.

Mr. Pattison Muir's book will well repay perusal; it will appeal not only to the chemist, but also to the general reader, who cannot fail to obtain much insight into the ideas of the alchemist, and also into the accurate methods of the modern chemist. HERBERT MCLEOD.

OUR BOOK SHELF.

Principia Nova Astronomica. By Henry Pratt, M.D. (London: Williams and Norgate, 1894.)

WE confess to having read a great deal of this book, and to have wasted a corresponding amount of time, in an unsuccessful attempt to wrestle with the novelties submitted to consideration. The only possible consolation or reward is the thought that a brief notice may prevent others from a similar distress and dissatisfaction. To say that the author does not accept the first law of motion, will perhaps serve to indicate the kind of man with whom we have to deal. After this one will be prepared to believe that any amount of curiosities and world-worn paradoxes will be met with in this collection of some two hundred quarto pages.

The feature, however, which distinguishes this production from all other works of the same character is the numerous suns which the author is obliged to introduce in order to explain the motions of the earth and moon. For those who are so benighted as to accept the gravitational theory, as developed by Newton and his school, one sun suffices; but the new Principia requires at least four. First, we have a central sun occupying "the eccentric centre of an ideal sphere." This phrase is hard to understand. It is suggested that it may mean that an imaginary sphere rotates about a point not its centre. Round this "ideal sphere" we have a so-called polar sun, circulating with its cortège of solar bodies and their satellites. This sun is called a polar sun because it revolves in a plane approximately parallel to the axis of the earth; but in what the peculiar necessity of its creation consists, we have failed to fathom with distinctness, and fear to misrepresent the ingenious author. On the surface of this ideal sphere another sun, called the equatorial, also revolves, this time from west to east, in a "mean equatorial plane." These three suns are necessarily made to be non-luminous bodies, only recognisable by the effects their "eccentric attractions and orbital revolutions" exercise on the earth and moon. Finally we have the visible sun. Of these four, the central sun is the master-key of the whole system, from which energy radiates in every direction, upholds all the members of the system, while simultaneously holding them apart. And any one who is at all accustomed to this kind of literature will conclude, without any further warning, that electricity is the energy invoked to sustain this system. It would have been distinctly disappointing not to have had electricity introduced as the mainstay.

Those who wish to see how this complication can be made to explain the precession of the equinoxes, the motion of the lunar nodes and apsides, nay, the predominance of land and water in the northern and southern hemispheres of the earth respectively, and many other strange things, must be referred to the book itself. There is, in fact, only one sentence in the book with which we can cordially and entirely agree, and that is the first "Who," says the author, "Who will believe the theory of astronomical motion set forth in the following pages? Not the astronomers, certainly." We venture to assure him that he is perfectly correct in this conjecture.

W. E. P.

A Manual of the Geology of India. Second edition. Revised and largely re-written by R. D. Oldham, A.R.S.M., Calcutta: Geological Survey Office. London: Trübner and Co., 1893.)

THE first edition of this book has been out of print for some years; meanwhile, Indian geology has greatly advanced, so that a revised and extended issue, bringing the work in line with the new results of the Geological Survey, has long been needed. Few are more capable of doing the re-writing and revision better than Mr. Oldham. He has had a wide and varied experience of survey work in India, and his acquaintance with the literature pertaining to the subject is evidenced by the "Bibliography of Indian Geology," compiled by him in 1838. Mr. Oldham has entirely altered the arrangement of the book. The original edition consisted of a series of descriptions of separate districts; but in the present volume the rocks are described in chronological order. All references to economic geology are excluded, being relegated to the works specially devoted to it, while this deals with stratigraphical and structural geology. In the detailed table of contents, the excellent plan has been followed of indicating by a different type the matter which is new or entirely re-written in the present edition. A glance at this shows at once that Mr. Oldham has produced almost a new book. Especially interesting is the chapter on the "Homotaxis of the Gondwána System." Most geologists will remember the bitter controversy that once raged over the age of this system, but which has now died out. Mr. Oldham has made a detailed study of the rock-groups of the Gondwána system, and has compared them with their representatives in Australia and Africa. He has thus been able to show the relation of the Upper Palæozoic and Lower Mesozoic rocks of India, Africa, and Australia to those of Europe. The two last chapters in the book are entirely new. One deals with the age and origin of the Himalayas, and the other with the geological history of the Indian peninsula. In both of these a number of important questions are discussed in a scientific manner. Wherever Mr. Oldham has interpolated new matter, he has done it well. Unlike many other revisers, therefore, he has produced a restoration which really improves the old structure. The result is that the manual is once more the standard work on the present state of knowledge of the geology of India.

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 Weight of the Earth.

IN a letter in this week's NATURE, signed "The Reviewer," the writer does not notice that in the English language, and in all legal and common usages of it, including that of all scientific men in speaking of their weighings by ordinary balances, *weights* mean *masses*. The fact that the weight of the earth is $6 \cdot 14 \times 10^{21}$ tons is as clear as that the weight of a parcel of tea is 3 lb. It is the *heaviness* of a weight or mass that is a property accidental to its position, being less at the equator, greater at the poles, and nothing at the earth's centre. I have never yet heard a "box of weights" called a box of masses. I don't believe even "The Reviewer" calls it a box of masses. If carried to the centre of the earth it is still a box of weights, though the heaviness of the weights is zero.

The word "weight" is often used to denote the heaviness of a weight or mass. No dictum, either of "The Reviewer" or of myself can eliminate this ambiguity from the English language. But scientific men may greatly diminish the inconvenience of it, and may even tend to eliminate it altogether, if they persistently use the word "heaviness" when they mean heaviness.

May 12. K.

"THE REVIEWER" makes a number of statements which he does not stop to prove; as, for instance, when he says that "the weight of a body would be practically nothing if the body was removed to a few million miles from the earth." But an appeal to experiment will show that the weight is unaltered. To fix the ideas, consider an astronomical or astrological chart, in which the earth is at the centre of a Zodiacal circle. Now, if a 100-ton gun is weighed in the scales of Libra, the weights required for equilibrium, as given by the lumps of metal in the other scale pan, will amount to exactly 100 tons; so that the weight of 100 tons at the distance of the Zodiacal circle, or at any other distance, is exactly 100 tons.

But if "The Reviewer" takes a ball of the mathematician's imaginary fine, weightless string, which he lets down from Libra to the surface of the earth, to the end of which weights can be attached, so as to equilibrate the 100 ton gun at the distance of the Zodiacal circle; now it is certainly true that a much smaller weight will suffice to produce equilibrium. Suppose, for instance, that the Zodiacal circle has a radius equal to the distance of the moon, or sixty times the earth's radius; then 22,400÷3600, say, 6 lb., suspended near the earth's surface at the end of the string, some 240,000 miles long, will suffice to balance 100 tons in the other scale pan, close up to the Zodiacal circle. But if the 100 tons is also lowered down by another mathematical string to the surface of the earth, then 100 tons is required to equilibrate it; and so it will for any intermediate position, when the lengths of the strings are equal; so that it does not tend to any clear or useful end to say that the weight of 100 tons at the distance of the moon is only about 6 lb. On the contrary, the weight of 100 tons is everywhere 100 tons.

The *weight* of a body is the *that which* is measured in lb., tons, kilogrammes, or other standards of weight; and these standards are certain lumps of metal licensed by Acts of Parliament, and carefully preserved against change or degradation.

The weight of the Earth, for instance, as determined by the Cavendish experiment, is about 6×10^{21} tons; and it is not necessary to dig up the Earth and to weigh the fragments at the surface of the Earth for the determination of this weight.

It is too late now to change the meaning of a word that has been in immemorial use in all languages; such a quasi-Gothic revival would have to restore all literature, as, for instance, the lines of Ovid (Art. Am. 3, 319):—

> "Quæ nunc nomen habent operosi signa Myronis
> Pondus iners quondam duraque massa fuit."

A. G. GREENHILL.

The Niagara River as a Geologic Chronometer.

WHEN we quote an author whose views coincide with our own, we are apt to speak of him as an authority on the subject; but when we dissent from the views we quote, we are not so apt to recognise the high authority of that author. This reflection on a phase of mental bias is suggested by a personal experience with reference to the age of Niagara Falls. The geologists and others who have discussed the length of post-glacial time may be rudely classed as minimists, maximists, and agnostics. Within the past five years I have been frequently and approvingly quoted by the minimists as estimating the portion of time consumed by the Niagara River in cutting its gorge at 7000 years, and the reputation thus acquired has not been noted without personal appreciation. But self-complaisance in that regard has been somewhat impaired by the thought that the honour is ill-founded, and that the insecurity of its foundation would sooner or later be discovered. Not less disturbing was the fear that when the maximists or agnostics took their turn at writing, I should be classed with the goats instead of the sheep. There can be no doubt that the manly and in every way proper course would have been followed had I years ago disclaimed the glory accidentally thrust upon me; but it is easy to bask in the sunshine of even unmerited applause, and conscience was too weak to determine action until another motive was added by a blow from the agnostic side. In his recent book Dr. James Geikie, after quoting me as an authority for the 7000-year estimate, adds that "all such estimates are in the nature of things unreliable." I now hasten to declare that I never said or thought that the period in question was about 7000 years. What I did incautiously say was, in effect, that the time allowance for the cutting of the gorge would be about 7000 years if the rate of the cutting were uniform, but that there was good reason to believe the rate had not been even approximately uniform.

Dropping personalities, which lack interest for your readers unless they involve principles, I beg to say a few words on the actual value of Niagara Falls as a chronometer. In 1844 James Hall made a map of the brink of the Falls, and established bench marks to which changes could be referred. Within a few years several other surveys had been made and connected with the first bench marks. It has thus become known, first, that in the middle of the Horseshoe Fall, where the principal body of water descends, the brink retrogrades at the rate of four or five feet per annum; second, that the American Fall, carrying a much thinner sheet of water, retrogrades so slowly that its rate is concealed by errors of survey. The gorge, which has been cut since the ice sheet retreated from the region, is six miles long, and the division of this distance by the annual rate determined for the Horseshoe Fall yields a period agreeable to the minimists. Had the conditions remained uniform, no fault could be found with this estimate, but there is reason to believe that the conditions have varied enormously in nearly every particular. The thickness of the resistant bed at the crest of the Falls is far from uniform, and it was altogether wanting for part of the distance. During the period of gorge-cutting, the height of Lake Ontario, which gives base-level to the river, has varied through a range of several hundred feet. The volume of the river has doubtless varied somewhat through climate, but it has probably varied enormously by reason of changes in drainage systems, resulting chiefly from differential uplift. The Niagara now carries surplus water from the basins of Lakes Erie, Huron, Michigan, and Superior. There was probably a post-glacial epoch during which three of these lakes discharged their water in other directions, and only the basin of Lake Erie fed the Niagara River. During that epoch the volume of the river was so small that canyon-cutting was effected only by the feeble process now illustrated by the American Fall, instead of the vigorous process illustrated by the Horseshoe Fall. These considerations, which the inquiring reader may find more fully set forth in the annual report of the Smithsonian Institution for 1890, tend strongly to sustain the agnostic view of the Niagara River as a geologic chronometer. G. K. GILBERT.

Washington, April 30.

The Teeth and Civilisation.

ON the 8th inst., Dr. Wilberforce Smith read a short communication before the Anthropological Institute on the teeth of ten Sioux Indians attached to the Wild West Show. His investigation showed that in regard to molars and premolars (the only teeth examined), these Indians were wholly free from caries. In the discussion which followed the reading of the paper, it was mentioned that the same fact was revealed in the skulls of the Fourth Egyptian Dynasty brought to England by Dr. Flinders Petrie, and in some skulls examined by Dr. Wilberforce Smith himself, which were derived from the ruins of Pompeii. The teeth of the Indians, both old and young, and those in the skulls just referred to, all showed more or less wear of the cusps, which is a most unusual circumstance in the teeth of modern civilised people, and it was thought that some difference in the food, or its mode of preparation, would be required to account for the absence of signs of wear in our time.

Now, it has never been proved that the increasing prevalence of caries is due to weakness of the teeth owing to comparative disuse, but there is nevertheless great probability in the inference, especially as signs of wear and freedom from caries appear to occur together, and *vice versâ*. There is, however, a further point in regard to the existing liability to the attacks of caries which I think can be best explained by a transference of nourishment to other parts governed by the same nerves. On inquiry of several dentists, I find that the teeth most subject to decay are the molars, and of these the upper molars are more often attacked than those in the lower jaw. The molars of the upper jaw are fed by a branch of the fifth nerve, and in modern life this nerve has, perhaps, more strain put upon it than any other in the body. We use our eyes, partly supplied by the ophthalmic branch of this nerve, not at intervals, but often closely throughout a long day. And it seems, therefore, that with so many increasing calls on this bundle of nerve fibres, the filaments sent to the teeth are, by an automatic economy of expenditure, robbed of the energy necessary to perform their functions properly. The teeth through lack of use may not excite the nerves to natural action, and thus from both sides there is a failure of function, and the teeth are consequently more and more unable to resist the attacks of caries. I am disposed to attach some importance to this explanation, as I find that those who have great calls on their nervous energy are more liable to caries than people of quieter habit and slower temperament. Dr. Wilberforce Smith mentioned the alarming increase of dental decay amongst hospital nurses, whose occupation is certainly one demanding a constant drain on their nervous energy. It was also noted that people in towns lose their teeth more rapidly than those living in the country, which also bears out the idea here suggested. On the other hand, the savage is seldom required to strain his facial nerves continuously for any length of time, and in reference to general nervous expenditure he enjoys long periods of rest which are wholly denied to the civilised man in towns. No doubt in consequence of the excessive calls on our nervous energy the distribution of it is undergoing modification in civilised man, and parts not used to any extent are being deprived of the supply necessary to healthy growth. It is much to be feared that the teeth, though so essential to the welfare of the body, are in this predicament. But we are sadly in need of more definite information than is at present available, and it is partly in the hope that some of the readers of NATURE, who have opportunities which I do not possess, may be induced to test this and other ideas relative to the increase of caries, that I have written on the subject. The whole question is at present much obscured by misconceptions due to ignorance. One fact, however, emerged only too clearly from Dr. Wilberforce Smith's investigation, namely, that while the grinding teeth of civilised men of middle age are either missing or practically useless for their purpose, the ancients enjoyed a perfect set of teeth till advanced years, and modern savages enjoy the same blessing.

Clapham, May 10. ARTHUR EBBELS.

Johannes Muller and Amphioxus.

THE story of Muller's Neapolitan visit in search of Amphioxus, as copied in NATURE (May 3, p. 14) from the *Lancet*, belongs to the category of those that are *ben trovato* or the reverse. To anyone acquainted with the works of this brilliant morphological genius the tale bears internal evidence of entire lack of foundation.

Müller's chief memoir on Amphioxus appeared in the *Abhandlungen der Berliner Akademie* 1842. If Prof. Todaro had ever read the original, or an earlier note in the *Berichte* 1839, he would scarcely have related the story. Müller's work begins with an historical summary of previous researches on the animal, and in particular he relates (*Berichte* 1839, p. 199) that the first specimens he examined were obtained from Prof. Retzius. Moreover, Costa's description, mentioned by Prof. Todaro as being the immediate cause of Müller's expeditious trip to Naples, *appeared in* 1839, *and in the same year* Müller published observations on the two specimens given him by Retzius. At this period he was in ignorance of its occurrence at Naples, for (p. 200) he says it has been found "on the English, Norwegian, and Swedish coasts." His chief work—the one before mentioned—was carried out on *living* specimens got by Muller himself near Gothenburg, on the Swedish coast, and, as is well known, and also expressly stated by himself, he worked at the microscope for twelve days in order to complete his task on the spot. The evidence goes to show that Muller obtained no Amphioxus—not even the one he is credited with!—from Naples until his work was completed; and (p. 81, foot-note) he remarks: "In Naples the capture of the animal is very easy close inshore, for it lives in great numbers in the sandy ground of Posilipo. In 1842 I brought back from Naples *over* 1000 *specimens* in spirit."

If the journey referred to ever took place, there is no record of the one specimen in any of his works, and Muller, who could sacrifice a very rare Pentacrinus to the scalpel, was not the man to spare an Amphioxus. It must indeed have been a "miraculous draught" that yielded only one specimen of Amphioxus off Posilipo.

However "interesting" and amusing the story may be to those who have a preference for fiction, it is to be regretted that, with no [illegible] of fact to support it, a *zoologist* should have told it of one whom zoology will always rank as a chieftain amongst her greatest sons. To many of us, who regard Muller with something akin to reverence, the fable is less interesting than painful. J. B.

The Scandinavian Ice Sheet.

IN reply to the letter of Prof. T. G. Bonney (NATURE, vol. xlix. p. 338), which I by chance have read to-day, concerning the difficulty of explaining how the Scandinavian land-ice could have crossed the deep channel of Skagerak and Kattegat, and have reached the East Anglian coasts, I should like to remark that this difficulty is not new to me, and will exist after it has been explained how the ice-stream from Norway could have crossed the named channel and extended over Denmark and North-western Germany. It is, however, an undisputed fact that certain Norwegian boulders are very common in the most northern parts of Jylland, and from there dispersed over the whole Jylland (though their rarity increases with distance from Norway), the northern parts of Fyn and Sjœlland, over Slesvig and Holstein and North-western Germany from Fehmarn towards the west, further over Dutchland and Belgium to several localities at the English east coast, under such conditions that they could not have been transported by floating ice. It is consequently a fact that the ice-stream from Norway has crossed the named channel. I think, therefore, that the best explication is that the Skagerak channel in its present condition was at first formed after or during the period of largest glaciation, to which the Norwegian ice-stream belongs, but before the Baltic ice-streams, both of which, I suppose, are posterior to the greatest extension of the land-ice. The chief reason for the formation of these ice-streams is the existence of the above-named channel, which has prevented the ice-stream from Norway from extending over Denmark for the second time.

Copenhagen, May 2. VICTOR MADSEN.

The Earliest Mention of Dictyophora.

TWAN CHING-SHIH'S "Miscellanies," compiled in the ninth century A.D. (Japanese edition, 1697, book xix. p. 7), has the following note:—"In the 10th year of the period (Tá-Túng (544 A.D.) a fungus grew in Yen-hiáng Gardens owned by the Emperor Kién-Wan. It was eight inches long with a black head resembling the fruit (that is, the Torus) of *Euryale ferox*; stem hollowed through inside like the root of *Nelumbium speciosum*; skin all white except below the root, where it was slightly red. Portion like the fruit of Euryale had below a joint like that of the bamboos, and was removable; from the joint a sheet was developed, simulating a network, five or six inches in circumference, surrounding the stem in the manner of a bell, but distant and separate from it. The network was fine and lovely, and also removable from the stem. It is allied to Wei-hi-chi (the Auspicious Fungus of Graveness and Pleasure) of the Taoist writings." This description seems to have been passed over by readers as a mere fiction, but I find that it agrees very well with the figure of a Dictyophora, and may probably be the earliest mention of it. A Japanese botanist, Kōzen Sakamoto, has figured the two forms of Dictyophora in his "Monograph of Fungi" (1834, vol. ii. p. 15), but has not referred to the above-cited description. KUMAGUSU MINAKATA.

May 4.

The Scope of Psycho-physiology.

I HAVE no wish to enter into a triangular duel with Dr. Titchener and "the writer of the note" who has provoked his fire. But since my name has been introduced, a word or two of explanation seems necessary.

Some time before Dr. Titchener discharged his first barrel, I was requested by the editor of this journal to contribute a popular article on "the scope of psycho-physiology." In complying with his request, I accepted (1) the conditions implied by the word popular, which no doubt laid me open to the criticism that my "whole treatment" was "a little general and superficial"; and (2) the title suggested to me, since I regarded it as comprehensive and not specially provocative of terminological controversy. C. LLOYD MORGAN.

Bristol, May 10.

The Aurora of February 22.

THE splendid aurora of February 22-23 began on the Pacific coast of North America on the former date, extending unusually far south in California, New Mexico, and Arizona, but did not become conspicuous on the eastern half of the continent until the day following. The earth currents affecting the telegraph lines were troublesome west of Chicago exclusively on February 22 also, not being felt east of that point until the day following. This localisation of the aurora in longitude has been noted in numerous other instances as well. An arrangement has been made to secure records of the geographical distribution of earth current disturbances on the lines of the Western Union Telegraph Company, which extend very widely over the North American continent. From what appears in the case above described, such records are likely to prove to be of very great interest.

April 30. M. A. VEEDER.

THE ROYAL SOCIETY SELECTED CANDIDATES.

As in former years, we give the qualifications of the candidates for election into the Royal Society, who were selected by the Council at its meeting on Thursday last.

William Bateson,

M.A. Fellow of St. John's College, Cambridge. Balfour Student. Rolleston Prizeman of the University of Oxford. Distinguished as a Zoologist. Author of the following memoirs:—"The Early Stages in the Development of *Balanoglossus* (sp. incert.)" (Quart. Journ. Micros. Sci. vol. xxiv., p. 208); "The Later Stages in the Development of *Balanoglossus Kowalevskii*, with a Suggestion as to the Affinities of the Enteropneusta" (*ibid.*, vol. xxv., supplement, p. 81); "Continued Account of the Later Stages in the Development of *Balanoglossus Kowalevskii*, and of the Morphology of the Enteropneusta" (*ibid.*, vol. xxvi., p. 511); "The Ancestry of the Chordata" (*ibid.*, p. 535); "On some Variations of *Cardium edule*, apparently correlated to the Conditions of Life" (Phil. Trans., 1889, p. 297); "Notes on the Senses and Habits of Marine Animals" (Marine Biol. Assoc. Journ., new ser., vol. i., p. 211); "On the Sense Organs and Perceptions of Fishes" (*ibid.*, in the press).

George Albert Boulenger,

Assistant (First Class) in the Zoological Department, British Museum. Distinguished for his knowledge of Herpetology. Author of the Catalogues of Batrachia (2 vols., 1882); of Lizards (3 vols., 1885-87); of Chelonians and Crocodiles (1889). In these volumes, which are the standard works for the study of these animals, all the species known are described, their systematic arrangement being based on a critical examination of the more recent researches into their anatomical structure and geographical distribution. He is also the author of a volume of the "Fauna of India and Burma," which is devoted to the Reptiles and Batrachians; and of a great number of memoirs and papers published in the Transactions and Proceedings of the Linnean and Zoological Societies, the Geological Magazine, Annali del Museo Civico di Genova, and others. From 1880 to 1890 he has prepared the annual reports on Reptiles, Batrachians, and Fishes for the Zoological Record.

John Rose Bradford,

M.D., D.Sc. Physician. Assistant Professor of Clinical Medicine at University College. Author of "Electrical Phenomena of Secretion" (jointly with Mr. Bayliss) (Proc. Roy. Soc., 1886); "Physiology of Gland Nerves" (Journ. of Physiol., 1887 and 1888); "Innervation of the Renal Blood-vessels" (Proc. Roy. Soc., 1889); "Innervation of the Pulmonary Blood Vessels" (*ibid.*, jointly with Mr. Dean); "Influence of the Kidney on Metabolism (*ibid.*, 1892), and other papers.

Hugh Longbourne Callendar,

Fellow of Trinity College, Cambridge. Lecturer on Physics. Has made important investigations on the measurement of temperature by electrical means. These are described in the papers:—"On the Practical Measurement of Temperature" (Phil. Trans., 1887 A, p. 161); "On the Determination of the Boiling Point of Sulphur, and on a Method of Standardising Resistance Thermometers by reference to it" (*ibid.*, 1891 A) (this paper is written in conjunction with Mr. Griffiths); "On the construction of Platinum Thermometers" (Phil. Mag., July, 1891); "Some Experiments with a Platinum Pyrometer on the Melting Points of Gold and Silver" (*ibid.*, February, 1892).

William Watson Cheyne,

M.B., C.M. (Edin.). F.R.C.S. (Eng.). Joint Professor of Surgery in King's College, London. Distinguished as one who has made discoveries in Bacteriology and Pathology, and as the author of the following works and papers:—"On the Relation of Micro-organisms to Antiseptic Dressings" (Trans. Path. Soc., 1879); "Antiseptic Surgery, its Principles and Practice" (awarded the Jacksonian prize of the Royal College of Surgeons, 1882); "On Micro-organisms in Purpura Hæmorrhagica" (Trans. Path. Soc., 1884); "On *Bacillus Alvei*, the Cause of Foul-brood in Bees," in conjunction with Mr. Cheshire (Journ. Roy. Micros. Soc., 1885); "A Study of certain of the Conditions of Infection" (Brit. Med. Journ., 1886); "On Suppuration and Septic Disease" (Lectures delivered before the Royal College of Surgeons, 1887); "On the Pathology, Etiology, Results and Treatment of Tubercular Diseases of Bones and Joints" (awarded the Astley Cooper prize, open to International competition, 1889); and numerous other valuable contributions to Bacteriology and Pathology.

Robert Edmund Froude,

Superintendent of the Admiralty Experimental Works. Associate Member of Council, Institution of Naval Architects. Distinguished for original mathematical and experimental investigations which have greatly advanced knowledge of (*a*) the resistance offered by water to the movements of ships; (*b*) the forms of ships tending to diminish resistance; (*c*) the efficiency of propellers. In these departments of inquiry, he for many years assisted his father, the late Mr. W. Froude, F.R.S. Since 1878 he has worked independently, and been in full charge of the Admiralty Experimental Works, first at Torquay and then at Haslar. The existing establishment, with its novel mechanical arrangements for experimenting with models of ships and propellers, was designed by him. His advice has been sought and given in organising similar establishments in this country and abroad. His mathematical and experimental work has had great and beneficial influence on ship-designing, primarily for the Royal Navy, but also for the mercantile marine. Under his direction the system of model experiments has been greatly extended, enabling naval architects to proceed with great certainty in dealing with problems of propulsion, and effecting large economies of engine power in steamships. He has published many original papers on these special subjects, most of them appear in Transactions of the Institution of Naval Architects. Amongst these the principal papers are: "The Leading Phenomena of Wave-making Resistance" (1881); "Screw Propellers and their Efficiency" (1883 and 1886); "Theory of the Screw Propeller" (1889 and 1892).

M. J. M. Hill,

M.A., D.Sc., late Fellow of St. Peter's College, Cambridge. Professor of Mathematics in University College, London. Eminent Mathematician. Author of the following papers on pure and applied Mathematics:—"The Steady Motion of Electricity in Spherical Current Sheets" (Quart. Journ. Math., vol. xvi.); "Some Properties of the Equations of Hydrodynamics" ("*ibid.*, vol. xvii.); "On Functions of more than two Variables Analogous to Tesseral Harmonics" (Trans. Camb. Phil. Soc., vol. xiii.); "Calculation of the Equation which determines the Anharmonic Ratios of the Roots of a Quintic" (Proc. Lond. Math. Soc., vol xiv.); "On some General Equations which include the Equations of Hydrodynamics" (Trans. Camb. Phil. Soc., vol. xiv.); "On the Motion of Fluid, part of which is moving rotationally, and part irrotationally" (Phil. Trans., 1884); "On the closed Link Polygons belonging to a System of Co-planar Forces having a Simple Resultant" (Proc. Lond. Math. Soc., vol. xv.); "The Differential Equations of Cylindrical and Annular Vortices" (*ibid.*, vol. xvi.); "On the Incorrectness of Rules for Contracting the processes of finding the Square and Cube Roots of a Number" (*ibid.*, vol. xviii.); "On the c- and p-Discriminants of Ordinary Integrable Differential Equations of the First Order" (*ibid.*, vol. xix.); "On Node- and Cusp-Loci, which are also Envelopes" (*ibid.*, vol. xxii.); "On the Locus of Singular Points and Lines which occur in connection with the Theory of the Locus of Ultimate Intersections of a System of Surfaces" (to be published in Phil. Trans.).

John Viriamu Jones,

B.Sc. (Lond.). Principal and Professor of Physics in the University College of South Wales and Monmouthshire. Fellow of University College, London. Distinguished for his acquaintance with physics. Engaged in the teaching of physics as well as in the organisation of scientific studies, and is anxious to promote the progress of science. Author of a memoir "On the Determination of the Specific Resistance of Mercury in Absolute Measure" (Phil. Trans., vol. clxxxi., 1890). Author also of the following papers:—"On the Calculation of the Co-efficient of Mutual Induction of a Circle and a Coaxal Helix" (Proc. Phys. Soc., vol. x.); "On the Use of Lissajous' Figures to determine a Rate of Rotation, and of a Morse Receiver to measure the Period Time of a Reed or Tuning-fork" (*ibid.*); "Suggestions towards a Determination of the Ohm." Read before the British Association at Leeds, 1890 ("The Electrician," vol. xxv.).

AUGUSTUS EDWARD HOUGH LOVE,

Fellow of St. John's College, Cambridge. Lecturer in Mathematics. Author of the following papers of merit, connected with mathematics:—"On recent English Researches in Vortex Motion" (Math. Ann., vol. xxx., 1887); "On Dedekind's Theorem concerning the Motion of a Liquid Ellipsoid under its own Attractions" (Phil. Mag., 1888); "The small Free Vibrations and Deformation of a Thin Elastic Shell" (Phil. Trans., 1888); "On the Motion of a Liquid Elliptic Cylinder under its own Attraction," and "The Oscillations of a Mass of gravitating Liquid in the form of an Elliptic Cylinder which rotates as if rigid about its axis" (Quart. Journ. Math., 1888); "The Free and Forced Vibrations of an Elastic Spherical Shell containing a given Mass of Liquid" (Proc. Lond. Math. Soc., vol. xix., 1888); "The Oscillation of a Rotating Liquid Spheroid, and the Genesis of the Moon" (Phil. Mag., 1889); "Vortex Motion in certain Triangles" (Amer. Journ. Math., 1888); "The Motion of a Solid in a Liquid when the Impulse reduces to a Couple" (Proc. Phil. Soc., Camb., 1888); "On the Equilibrium of a Thin Elastic Spherical Bowl" (Proc. Lond. Math. Soc., vol. xx., 1889); "On Sir W. Thomson's Estimate of the Rigidity of the Earth" (Trans. Phil. Soc., Camb., vol. xv., 1890); "Note on the Present State of the Theory of Thin Elastic Shells" (Proc. Roy. Soc., vol. xlix., 1891); "Wave Motion in a Heterogeneous Heavy Liquid" (Proc. Lond. Math. Soc. vol. xxii., 1891); "On the Theory of Discontinuous Fluid Motions in two Dimensions" (Proc. Phil. Soc., Camb., vol. vii., 1891).

RICHARD LYDEKKER,

B.A. (Camb.). Formerly on the Geological Survey of India. Distinguished for his acquaintance with the science of Palæontology. Author of a series of illustrated quarto memoirs on the Tertiary and Post-Tertiary Vertebrata of India, "*Palæontologica Indica*" (Memoirs Geol. Surv. India, 1876-86); also a part of the Mesozoic Vertebrata of India (*ibid.*); of "Catalogue of the Fossil Mammalia in the British Museum," in five parts (1885-87), of "Catalogue of the Fossil Reptilia and Amphibia," now in course of publication; and of many papers on Palæontological subjects to the Quart. Journ. Geol. Soc., Proc. Zool. Soc., &c.

Supplementary Certificate.

Author of:—British Museum Catalogue of Fossil Reptiles, 4 vols.; British Museum Catalogue of Fossil Birds; Vol. II. (Vertebrates) of Nicholson and Lydekker's Manual of Palæontology. Joint author, with Sir W. H. Flower, of "The Study of Mammals"; a monograph of the Extinct Argentine Dinosaurs; Cetaceans and Ungulates in the La Plata Museum; and numerous minor papers.

FRANCIS CRANMER PENROSE,

M.A., F.R.I.B.A., F.R.A.S. Honorary Fellow of Magdalene College, Cambridge. Architect. Surveyor to the Fabrick of St. Paul's Cathedral. Late Director of the British Archæological School at Athens. Author of books or memoirs on (1) "Principles of Athenian Architecture," 1851; (2) "On the Prediction and Reduction of Occultations of Mars and Eclipses by a Graphical Process," 1869; (3) "On the Determination of the Elements of the Orbits of Comets by Graphical Processes," Monthly Notices, 1881; (4) "Two papers on the Ancient Hecatompedon, Athens," 1891 and 1893; (5) "On the Orientation of Greek Temples and the Amplitudes of Stars at the time of the Foundation of the Temples," Phil. Trans., 1893. Observer of the Total Solar Eclipses of 1870 and 1878. Inventor of Instruments for drawing the Logarithmic Spiral; for drawing the Hyperbola by continued motion parallel to the Asymptotes; for the Mechanical Solution of Spherical Triangles, &c.

DUKINFIELD HENRY SCOTT,

Ph.D. (Würzburg), F.L.S. Honorary Keeper of the Jodrell Laboratory, Royal Gardens, Kew. Dr. Scott is a person attached to science and anxious to promote its progress. He is distinguished for his acquaintance with Botany, and has made discoveries in that branch of science which have been published in the following papers: "Entwickelungsgeschichte der gegliederten Milchröhren" (Inaug. Dissert., Würzburg, 1881, published in Arbeiten des Bot. Instituts, Würzburg, 1881; translation in Quart. Journ. Micros. Sci., 1882); "On the Laticiferous Tissue of *Manihot Glaziovii*" (Quart. Journ. Micros. Sci., 1884); "On the Occurrence of Articulated Laticiferous Vessels in Hevea" (Journ. Linn. Soc., Botany, 1885); "On the Nuclei of Oscillaria and Tolypothrix" (*ibid.*, 1887); with Mr. Wager, "On the Floating Tissues of *Sesbania aculeata*" (Annals of Botany, I., 1888); with Mr. Brebner, "On the Anatomy and Histogeny of Strychnos" (Annals of Botany, III., 1889); "On some Points in the Anatomy of *Ipomaea versicolor* (*ibid.*, v., 1891); with Mr. Brebner, "On Internal Phloem in the Root and Stem of Dicotyledons" (*ibid.*); "On the Secondary Tissues in Certain Monocotyledons" (*ibid.*, vii., 1893); with Miss Sargant, "On the Pitchers of *Dischidia Rafflesiana* (*ibid.*). Dr. Scott is also the author of many botanical reviews, notes, &c. He co-operated with Prof. Bower, F.R.S., in the preparation of the English edition of De Bary's "Comparative Anatomy of Phanerogams and Ferns" (Oxford, 1884); and with Prof. Howes in the preparation of the new edition (1888) of Huxley and Martin's "Elementary Biology." From 1882-85 Dr. Scott was Assistant to the Professor of Botany at University College, London, and was from 1885-92 Assistant Professor in Biology (Botany) at the Royal College of Science, South Kensington, a position which he resigned to take up that which he at present occupies at the Royal Gardens, Kew.

REV. FREDERICK JOHN SMITH,

Clergyman of the Church of England. Millard Lecturer in Experimental Mechanics, Trinity College, Oxford. Distinguished for his researches in practical mechanics and physics, and the invention of important dynamometric and integrating instruments; also of the chronograph—registering graphically periods of time from ·00005 sec. to 1·0 sec.—now used in the measurement of the flight of projectiles and in physiological research. Author of numerous papers, among which may be mentioned:—"An Experimental Investigation of the circumstances under which a Change of the Velocity in the Propagation of the Ignition of an Explosive Gaseous Mixture takes place in Closed and Open Vessels. Part I.—Chronographic Measurements" (Proc. Roy. Soc., vol. xlv., 1889); "Description of Dynamometer and Integrator for measuring the work done in Driving Dynamos and other machines" (Electrician, 1881); "Ergometer or work measuring machine" (Phil. Mag., vol. xv., 1883, and NATURE, vol. xxx.); "A new form of Electric Chronograph (Phil. Mag., vol. xxix., 1890); "On some new Methods of investigating the Points of Recalescence in Steel and Iron" (*ibid.*, vol. xxxi., 1891); "On some of the Effects of Magnetism on Rods of Iron, Nickel, and other Metals which have received a Permanent Torsional Set" (*ibid.*, vol. xxxii., 1891).

JOSEPH WILSON SWAN,

M.A. (*honoris causa*) Durham. F.C.S. F.I.C. Has devoted himself for many years with great success to experimental scientific work, chiefly in relation to Electric Lighting, the Electro-deposition of Metals, and the Improvement of Photographic Processes. His labours have resulted in material extension of knowledge, and in important inventions, among which are the Incandescent Electric Lamp, the Carbon Process, by which the first permanent photographic prints were produced and which has formed the basis of many processes of photo mechanical engraving (in this relation the property of salts of sesquioxide of chromium to combine with gelatine and render it insoluble was discovered), the highly sensitive Gelatino-bromide Photographic Plate, the result of an original observation of the effect of heat on the gelatino-bromide of silver emulsion, the Cellular Form of Electrical Secondary Battery Plate, the production of Lamp Filaments from Solutions, Integrating Electric Meters, Safety Lamp for Miners, and an Electric Firedamp Indicator.

VICTOR HUBERT VELEY,

M.A., F.C.S. Lecturer on Chemistry. Author of the following papers: "On the Oxides of Manganese and their Hydrates" (Part I., Chem. Soc. Journ., 1880; Part II., *ibid.*, 1882); "On the Rate of Decomposition of Ammonium Nitrate" (*ibid.*, 1883); "On some Sulphur Compounds of Calcium" (*ibid.*, 1885); "On the Lime Process for the Purification of Coal

Gas" (Soc. Chem. Indust. Journ., 1885); "On some Sulphur Compounds of Barium" (Chem. Soc. Journ., 1886); "On the Conditions of Evolution of Gases from Homogeneous Liquids" (Phil. Trans., 1888); "On a Method of Investigating the Dissolution of Metals in Acids" (Chem. Soc. Journ., 1889); "On the Conditions of the Reaction between Copper and Nitric Acid" (Roy. Soc. Proc., 1889).

THE ARCTIC EXPEDITIONS OF 1894.

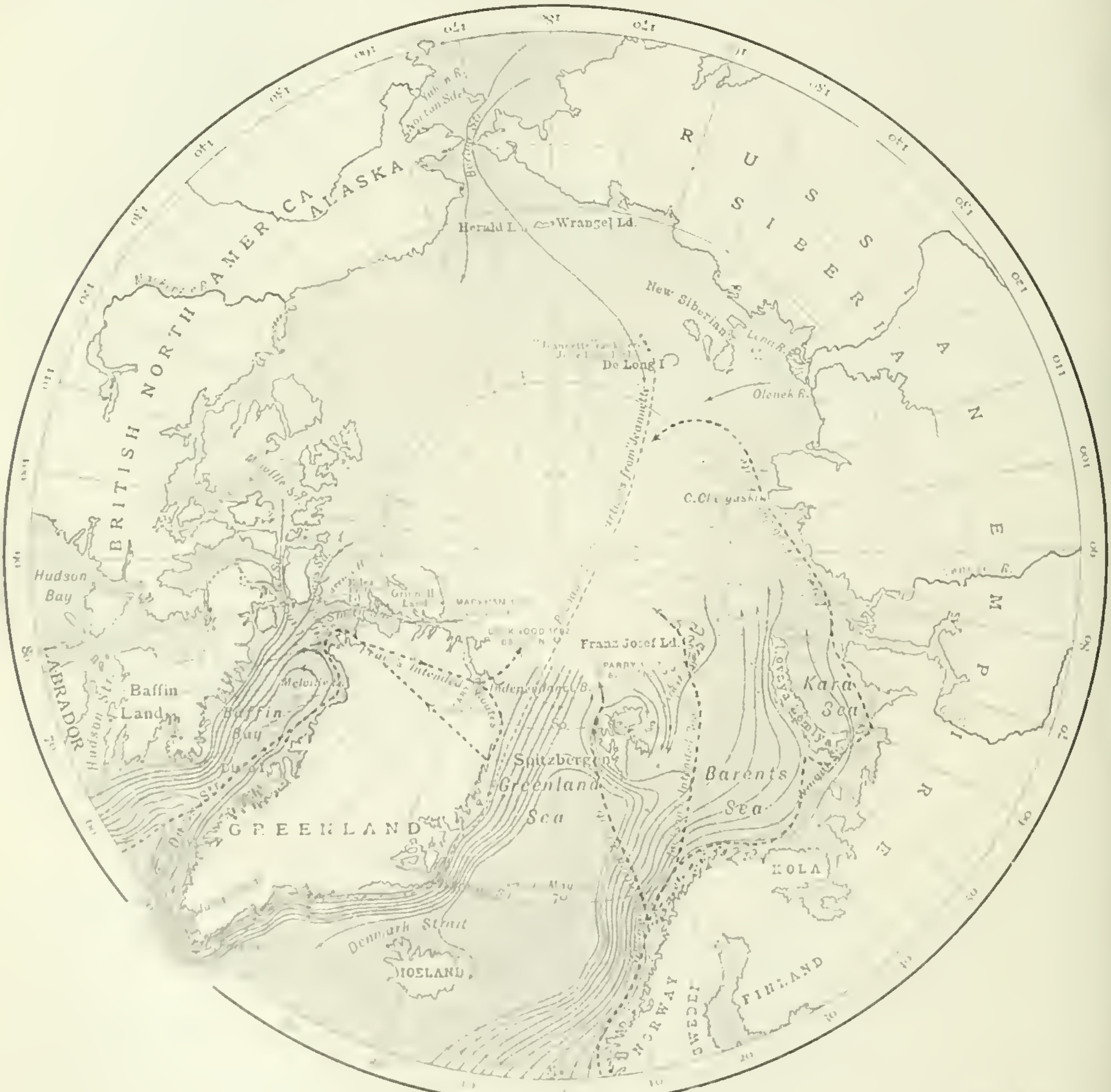
IT is not easy to speak definitely regarding the various Arctic Expeditions which will be in the field this year, for several of the most loudly advertised ventures have collapsed or been postponed, and it is possible that some quiet and determined explorers may set out without calling public attention to their plans. There is undoubtedly to be keen rivalry in the North Polar basin for several years to come, and even an incomplete forecast of the projected work may serve to direct notice to the regions whence good results in the way of Arctic discovery may be looked for. It is unnecessary to insist in the pages of NATURE, however needful the caution may be to the general public, that no credit for Arctic exploration can be given until the intending explorer returns, bringing with him proofs of his achievements which will bear the keenest criticism of experts.

Two well-equipped expeditions have been in the field since last summer, working by different methods, from different sides, but both led by men of experience and manned by tested Arctic travellers. Nansen's expedition in the *Fram* appeals most powerfully to the imagination for the boldness of its plan and the faith with which its leader bases his success and even his life on the truth of his theory of ocean-currents in the far north. The general trend of these currents, as drawn by Dr. Nansen, is shown on the accompanying map, which is reduced from one published in the *Geographical Journal*, vol. ii. His strongest evidence for the existence of a drift across the centre of the polar basin was, as is well known, the discovery on the ice off the south of Greenland of relics from the American exploring ship *Jeannette*, which sank off the New Siberian Islands; but this was fortified by much additional information. The *Fram* sailed from Christiania on June 24, 1893, passed through the Waigatz Strait on August 3, and the last news was that on August 6 some Samoyeds saw her passing along the Yalmal coast between the ice and the land. Nansen intended to call at the mouth of the Olenek River in September before turning finally northward, but he did not do so. If he had called, or even been sighted off the coast, the fact would have been reported to Baron Toll, who was in the neighbourhood of the Olenek until November. It seems probable that, making an easy passage across the Kara Sea, Dr. Nansen found sufficiently open water to induce him to turn northward off Cape Chelyuskin, as he was urged to do by Captain Wiggins, and that the *Fram* has passed the winter fast in the ice somewhere within the 80th parallel, possibly drifting polewards. No news can now be looked for by way of Siberia, and it is very unlikely, though just possible, that one of the expeditions going north this year, by Franz-Josef Land or Spitzbergen, may meet the crew of the *Fram*, where all meridians converge towards the pole.

Mr. Peary, after raising the necessary funds in America by writing and lecturing, returned to the scene of his former triumphs at Independence Bay on the north-east coast of Greenland. He and his party landed at Bowdoin Bay on Inglefield Gulf in Smith Sound on August 3, 1893, and established themselves there for the winter, being comfortably settled when the steamer left on August 20. Sledging parties were at once despatched to *cache* provisions at convenient depôts on the inland ice on the way to Independence Bay. Mr. Peary intended to commence his main journey about the middle of March this year, and to reach Independence Bay in the first week of May. Here the party will divide, three men being despatched to sledge south-eastward and survey the coast along the quite unknown stretch to Cape Bismarck, returning thence across the ice-cap to Inglefield Gulf. The other party will push northward from Independence Bay, and endeavour to completely survey the land which was seen across the strait last year, at the same time trying to attain the farthest north. The position of Navy Cliff, on the south side of Independence Bay, was fixed as 81° 37′, and since Lockwood's farthest north was 83° 24′, it is practically certain that Peary, with his great experience of foot-travel on the ice, will be able to make his way more than the 125 miles which would carry him nearer the pole than any previous traveller. This year he is not to depend entirely on dog-sledges, but to experiment with Mexican donkeys, which are accustomed to carry heavy loads in the low temperature and thick snow of the high Cordilleras. Whatever the result may be in record-breaking of northern latitudes, we may confidently expect a great deal of solid geographical and scientific work from this expedition. A steamer will call at Bowdoin Bay to bring back the party, or at least obtain news of them, in August or September.

The third expedition left Tromsoe on May 1, 1894, for Spitzbergen, with the object of repeating the attempt so gallantly made by Parry in 1827, when he reached 82° 45′. It is under the command of Mr. Walter Wellman, a journalist of Washington, who has carefully thought out his plan of action, and has commenced to carry it into effect without delay. Although he has had no previous Arctic experience, he is a man of great energy and enthusiasm; his companions are as enthusiastic and resolute as himself, and it is by no means improbable that he may be able to give a good account of his time. He terms his enterprise "a dash for the pole," and is determined to be back in America before the end of October. However, as a precautionary measure he is to provision the old seal-hunters' house on Danes Island in the north-west of Spitzbergen for a year, in case of enforced wintering. The object of starting so early in the season is to avoid the strong southerly drift of the ice, which so greatly hampered Parry's sledging parties. Thus, if Mr. Wellman's theory is correct, he will reach his farthest north before the drift becomes serious, and have the southward drifting ice-floes to help him on his return. By the use of very light boats, constructed entirely of aluminium, and provided with runners to convert them into sledges, the weight to be pulled will be greatly reduced. It is to be feared that Mr. Wellman's plan of taking Belgian draught dogs for his sledges will lead to difficulties on account of the difference in climate and in the nature of the work from those to which they are accustomed. The behaviour of the aluminium boats will be looked forward to with much interest.

Finally, the Jackson-Harmsworth expedition will take the field early in July, having for its purpose the exploration of the polar area lying north from Franz-Josef Land. Mr. Harmsworth, who is bearing the whole cost of the expedition, has purchased the *Windward*, of Peterhead, a well-known steam whaler of 320 tons, to take the party out to Franz-Josef Land, but the exploration will be conducted by land or across the ice. Mr. F. G. Jackson, the originator and leader of the expedition, has long thought over this matter, and devoted most of his time for two years to the study of Arctic problems. He spent a great part of last winter in the north of Russia, testing sledges and other appliances for ice-travel and practising surveying on the little-known Waigatz Island. Like Peary, he intends to try the endurance of stronger animals than dogs in Arctic work, proposing to take a number of Russian ponies. The *personnel* of the expedition, although probably not exceeding six, will include trained specialists and collectors, who will map their route, make meteorological and magnetic observations, and collect geological, botanical, and zoological specimens. After calling at Archangel, in the end of July, to take on board a Russian log-house, and then at Khabarova to ship West Siberian dogs and drivers, the *Windward* will proceed to Franz-Josef Land and make a landing somewhere in the south of that region, the exact spot depending on the state of the ice. The route to and his companions will spend the winter at their base, where the conditions of life were found to be quite endurable by Mr. Leigh Smith when he was compelled to spend a winter there, with very poor accommodation and equipment, after the wreck of his yacht, the *Eira*, in 1881. Early in the spring of 1895 the expedition would push northward, moving very slowly because of the necessity of traversing the distance several times over in order to carry the quantity of stores necessary to establish a depôt every thirty or forty miles along the



North Polar Map to illustrate projected Polar Expeditions.

Franz-Josef Land will thus be due north from near Kolguef Island, instead of north-eastward from Norway as shown on the map. The wooden house will be erected on a secure and sheltered site, and stocked with the necessary stores for four years, after which the ship will return. If, as seems possible from Payer's observations, Austria Sound should be found open, provisions will be carried north along it in a steam-launch and *cached* for subsequent use. Mr. Jackson route. This slow progress will, of course, give an opportunity for repeating observations for position, and so add to the accuracy of the map. The direction of advance will probably be along Austria Sound and across Petermann Land, the farthest north sighted by Payer in the Austro-Hungarian expedition, and lying in 83° N. Should Petermann Land extend to the north, Mr. Jackson intends to proceed along it, mapping his route as he goes. Boats would be carried for crossing open water, and if oceanic ice intervenes, it would be traversed as rapidly as possible, and a return made to the farthest north point on solid land, where winter-quarters could be established; but should this be impracticable, the retreat would be continued to the base, where the second winter would be spent. In the spring of 1896 the party would turn northward again, the chain of depôts accelerating their progress. In the summer of 1896 the ship will return with additional stores and men, and to obtain news; but it does not appear to be Mr. Jackson's intention to return, unless he is satisfied that his work is final, until 1897. This expedition ought certainly to extend our knowledge of the most northerly land known, and if fortune favours it, the advances made may be great. Its equipment is of the very best, and no excuse of bad material can be brought forward to explain unsatisfactory results.

The expedition for the exploration of Ellesmereland, to which reference has several times been made in NATURE, planned by Mr. Robert Stein, of the U.S. Geological Survey, has been postponed; we hope only until next season. Still efforts will be made this summer to clear up the fate of the unfortunate young Swedish naturalists, Björling and Kalstennius, with their mate, Gilbert Dunn, and cook, Herbert MacDonald, of whom the last news received was that they intended to seek shelter with the reported Eskimo of Ellesmere Land. Mr. Elis Nilson has been sent out by the Swedish Anthropological and Geographical Societies, on the Dundee whaler *Eclipse*, to visit the Carey Islands and Clarence Head, if the ice permits, and search for any relics of the missing party, whose fate, after two years without supplies, can scarcely be considered doubtful. Baron Nordenskjöld has interested himself particularly in the search, and will probably arrange for other whalers to deviate from their course in order to obtain information.

Dr. F. A. Cook, the ethnologist on Peary's former expedition, has issued a prospectus of a pleasure trip which he is to conduct up Baffin's Bay to Smith Sound, with the opportunity of a slight change of route should any of the passengers desire it. This would, if the state of the ice permitted, render it possible to call at Clarence Head and the Carey Islands, and make at least a hasty search for the missing party; but a pleasure trip scarcely lends itself to serious Arctic exploration.

Prophecy with regard to the results of geographical exploration is too uncertain to be indulged in by modern critics, and in Arctic exploration particularly the conditions are so difficult to predict that success may attend the most inexperienced and worst equipped, while experience and all the resources of wealth and science would struggle in vain against adverse conditions. There are certain remarkable features about the new expeditions which distinguish them from most of the earlier efforts. Each has been planned and is being carried out by a man who is thoroughly in earnest, and whose reputation rests on his success. This is widely different from the case of a commander "ordered" to carry out the plans of others. Each expedition is small; Nansen's, which is the largest, comprises only thirteen men. Two of those which have already faced the awful monotony of the Arctic night, have appliances for dissipating the darkness by the electric light, an advantage which can hardly be over-estimated in its effect on the spirits of the men. Provisions and equipments have been greatly improved, even since the time of the *Alert* and *Discovery* and of the *Jeannette*. Most important of all, three of the expeditions are free from the responsibility of a ship. In all these ways the four serious attempts of this year have elements of success never combined previously. Their results will not be known for some time. News of Mr. Peary will certainly be received this autumn by the vessel to be sent up to Inglefield Gulf to bring him home if he considers his work satisfactorily finished. It is probable that Mr. Wellman also will return; but unless he should by some scarcely credible good fortune meet the crew of the *Fram* at his farthest north, we cannot hope to hear of Nansen for another year at least; and Mr. Jackson's scheme provides for a possible absence on his part for four years, though progress should be reported before the end of next year.

HUGH ROBERT MILL.

THE CRINOIDEA OF GOTLAND.[1]

THIS is the first instalment of a memoir based on a revision of the specimens of crinoids in the Angelin collection at Stockholm. It is published in English, and is illustrated by Mr. G. Liljevall, who has produced 382 remarkably beautiful figures upon ten quarto plates. Their accuracy may be relied on by those who know Mr. Bather's own scrupulous carefulness as an artist.

The author commences by pointing out the need for a thorough re-examination of the Stockholm specimens, the drawings in Angelin's "Iconographia Crinoideorum" being so frequently misleading, and having been in many cases produced by a union of several distinct individuals. The older palæontologists certainly had not that reverence for type-specimens which now very justly prevails among curators; they brought out, as they thought, the salient points of their specimens, filled in a sort of fancy groundwork of rock around the drawing, and left students to search in vain in the collection for the exact object that had thus been honoured above the others.

The classification of the Crinoidea undergoes considerable changes with each new descriptive paper, and Mr. Bather's works are a healthy example of receptivity and indifference to precedent. We read each in the light of the glossary appended to it, ridding our minds as far as possible of the technicalities that we have previously learned. We must confess that such changes in nomenclature are based on observation and on additions to our knowledge, and we need only quarrel with the terminology when it is reduced to algebraic symbols.

The abolition of the Fistulata and the Larviformia as sub-orders of the Inadunata (p. 8), and the substitution—quite temporarily—of divisions based on the presence or absence of infrabasals, may be hailed as a simplification, allowing more latitude in the association of the several genera. But the value of such close and detailed work as that of the present memoir will depend in no way upon the stability of the classification utilised. Mr. Bather (p. 19) can thus treat even the Inadunata as a convenient portmanteau, soon to be worn out; and specialists will turn with pleasure to the critical descriptions of individual specimens in the collections.

A fine example of how the collation of specimens, year after year, will add profoundly to our knowledge of ancient life upon the earth, is to be found in the story of *Herpetocrinus* (pp. 36-45). The crown of this genus was detected in certain Dudley specimens by Mr. Bather himself, Salter's opinion being thus amply verified; and the coiled stem, often supposed to be an arm, is now shown to have had a permanent tendency (p. 45), by its very structure, to bend round in one direction, while it could probably be uncoiled "by the simple contraction of the large muscles on the outer part of the articular surface." With a quaintness of expression now familiar to us, our author proceeds: "It is very probable that the animals usually broke off any rooted attachment they may have formed, and that they clung to corals or other submarine objects by their cirri." It is further suggested that they could move from one spot to another.

[1] "The Crinoidea of Gotland." Part i. The *Crinoidea Inadunata*. By F. A. Bather, M.A., F.G.S. (Stockholm: Kongl. Svenska Vet.-Akad, Handl. Bt. 25. 1893.)

The extraordinary difficulties surrounding this genus are illustrated by the fact that Mr. Bather himself at one time described the arm of a *Streptocrinus* as the stem of *Herpetocrinus* p. 176).

Controversial matters are treated in this paper with the delicacy of the duellist rather than with the tactics of the football-field; and Mr. Bather may be congratulated on the position he has gained among the exponents of intricate research. We look forward with keen interest to the completion of this handsome memoir.

G. A. J. C.

A DEDICATORY NUMBER OF THE QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE.

A SPECIAL complimentary number of *The Quarterly Journal of Microscopical Science* has been issued, dedicated by his colleagues to Prof. E. Ray Lankester, F.R.S., in celebration of the completion of twenty-five years of editorship. The *Journal* contains contributions by Dr. E. Klein, F.R.S., Prof. A. G. Bourne, Mr. Adam Sedgwick, F.R.S., Mr. W. C. McIntosh, and Prof. A. A. W. Hubrecht, of Utrecht University. It is prefaced by the subjoined historical sketch, signed by Mr. Sedgwick and Prof. Weldon.

It is now five-and-twenty years since Prof. Lankester first undertook the task of editing the *Quarterly Journal of Microscopical Science*, and by issuing the present number his colleagues desire to mark the occasion, and at the same time to take the opportunity of offering to him their hearty congratulations on the success which has attended this quarter of a century of effort on his part.

The *Journal* was founded in the year 1853 by the publisher, Mr. S. Highley, and was edited by Dr. Edwin Lankester and Mr. George Busk. In 1856 the publisher's business was transferred to Mr. John Churchill, with which firm it has remained ever since. Up to 1868 the *Journal* published the "Transactions of the Royal Microscopical Society of London," but in 1869 the Society started its own publication, and a new editorial arrangement of the *Journal* was made. Mr. George Busk retired, and Mr. Ray Lankester, who had lately taken his degree at Oxford, joined his father in the editorship.

Mr. Ray Lankester's connection with the *Journal* began in 1863 with the publication of a paper on "Our Present Knowledge of the Gregarinæ," followed in 1864–5 by a memoir, in three parts, on "The Anatomy of the Earthworm." In 1865 he suggested the publication of a quarterly chronicle of the progress of histology and microscopic investigation, and joined Mr. Busk in its preparation. Curiously enough, this feature has been abandoned since 1872, whilst the Royal Microscopical Society has taken the task in hand, and produces an admirable and extensive record.

In 1872 Ray Lankester's father ceased to take part in editing the *Journal*, and was succeeded by Dr. J. Frank Payne. Lankester and Payne added Mr. Thiselton Dyer (now Director of Kew Gardens), to their editorial body in 1873, and he was succeeded in 1876 by Mr. Archer, of Dublin, the Secretary of the Dublin Microscopical Club, and the author of so many interesting discoveries among freshwater Rhizopoda. In 1877 Dr. Payne retired, and Dr. Klein joined the editorial staff.

In 1878 a further change was made. Prof. Lankester became sole editor, with the co-operation of Archer, Francis Balfour, and E. Klein. This arrangement has continued ever since, with various changes in the list of those co-operating. Thiselton Dyer returned for a few years as one of those giving his co-operation; and Moseley and Milnes Marshall have in turn assisted in the conduct of the *Journal*, and have published in it many of their most important papers, inducing their pupils to adopt the same mode of publication.

The number of contributions which this energetic policy attracted to the *Journal* soon made it necessary to enlarge it; and the term of Lankester's editorship has been marked by a continuous increase in the amount of letterpress and in the number and excellence of the plates. This has of necessity been accompanied by a rise in price. The original price was four shillings per number—the numbers being issued quarterly. At that time the volume consisted of some eight-and-twenty demy octavo sheets and twenty plates, mostly also octavo. The last volume contained thirty-six royal octavo sheets and forty-two plates, many of which were coloured, while the majority were of quarto size. The change from demy to royal octavo was effected at the commencement of 1883, and in 1890 the strict quarterly publication of the *Journal* was abandoned, so that more than four numbers could be issued in the year. During the eleven years which have elapsed since 1883, sixty-one numbers, divided into fifteen volumes, have been issued; so that the increase in size and price has not only affected the magnitude of each number, but has been accompanied by an increased rapidity of publication.

Every reader will remember that Prof. Lankester's energy has by no means been exhausted in merely editing the *Journal*, for besides his many writings elsewhere, he has published more than sixty memoirs in the pages of this *Journal* alone; and we may, perhaps, be permitted to mention a few of the more prominent of these—such as that on "The Development of the Pond Snail" (1874), which marks the starting-point of his well-known investigation of the development of Mollusca; the "Notes on the Embryology and Classification of the Animal Kingdom" (1877), which exercised so great an influence upon the whole tendency of morphological speculation; the descriptions of Limnocodium (1880); the series of memoirs on Apus and Limulus (1881–1884), and on Rhabdopleura (1884); the first description of the atrio-cœlomic funnels in Amphioxus (1875), and the subsequent memoir on the anatomy of the same animal, together with the account, commenced in conjunction with his pupil, Mr. Willey, and continued by Mr. Willey alone, of the later history of its remarkable larva.

It would be useless to enumerate all the naturalists who have contributed to the *Journal* since Prof. Lankester's successful enterprise has made it the chief medium of publication for English morphological work; but it is interesting to notice that the contributors have constantly included foreign naturalists of distinction, including E. van Beneden, Bowditch, Carrière, Claparède, Dollo, Giard, Hubrecht, Iijima, Ischikawa, Kingsley, Mitsukuri, H. F. Osborn, Oudemans, Packard, Patten, Pelseneer, Pouchet, Ranvier, Whitman, and others. Some of these have taken the opportunity, by contributing to the present number, of joining in the hearty congratulation on his past achievement, and sincere good wishes for the future, which Prof. Lankester's associates now offer to their chief.

NOTES.

THE following fifteen candidates were selected on Thursday last by the Council of the Royal Society, to be recommended for election into the Society:—Mr. W. Bateson, Mr. G. A. Boulenger, Dr. J. R. Bradford, Mr. H. L. Callendar, Prof. W. W. Cheyne, Mr. R. E. Froude, Prof. M. J. M. Hill, Prof. J. V. Jones, Mr. A. E. H. Love, Mr. R. Lydekker, Mr. F. C. Penrose, Dr. D. H. Scott, Rev. F. J. Smith, Mr. J. W. Swan, and Mr. V. H. Veley. We print their qualifications in another column.

THE "Ladies' Conversazione" of the Royal Society is announced for Wednesday, June 13.

THE death is announced of Dr. E. H. Vinen, at the age of sixty-nine. He was a Fellow of the Linnean Society, and well known among botanists and geologists.

WE regret to learn of the following deaths among scientific men abroad:—Dr. Louis von Uslar, Professor of Pharmacy in the University of Göttingen; Dr. A. Schmidt, Professor of Physiology in the University of Dorpat (or Jurieff); and Prof. Thomas Morong, the well-known botanist.

THE Council of the British Medical Association are prepared to receive applications for grants in aid of researches for the advancement of medicine and the allied sciences. Applications for sums to be granted at the next annual meeting must be made on or before June 15 in writing, addressed to the General Secretary, at the office of the Association, 429, Strand, W.C. They must include details of the precise character and objects of the research which is proposed. Reports of work done by the assistance of Association grants belong to the Association. Instruments purchased by means of grants must be returned to the General Secretary on the conclusion of the research in furtherance of which the grant was made. The Council of the Association are also prepared to receive applications for one of the three Research Scholarships which is vacant, of the value of £150 per annum, tenable for one year, and subject to renewal by the Council for another year.

A LECTURE on "Recent Discoveries at Koptos," with illustrations, will be delivered by Prof. Flinders Petrie at University College, Gower Street, on Saturday, May 26, at 2 p.m. These discoveries include the long-sought rise of Egyptian art, and the prehistoric remains of the race on entering Egypt. The lecture will be free to the public without ticket.

AT the annual general meeting of the British Ornithologists' Union, held on Wednesday, the 9th inst., Lord Lilford was re-elected President, and Mr. F. D. Godman Secretary, for the ensuing year, and Lieut.-Colonel L. H. Irby and Mr. W. T. Blanford, F.R.S., were placed on the committee in lieu of two retiring members. It was agreed that a new (seventh) series of *The Ibis* should be commenced in 1895 with the thirty-seventh volume, and that Dr. P. L. Sclater, F.R.S., and Mr. Howard Saunders should be appointed as joint editors of it.

IT is impossible to speak too highly of the part taken by the Smithsonian Institution in diffusing knowledge. Not the least important of the methods adopted to make the works of men of science known unto the ends of the world, is the inclusion of miscellaneous reprints of memoirs in the annual reports of the Institution. A report just received shows the operations, expenditures, and condition of the Institution in 1892, and contains an appendix of the kind referred to. Therefore it is useful and interesting to all engaged in the promotion of knowledge. Of the thirty-three papers appended to the report, six have been reprinted from NATURE, and, we need scarcely say, proper acknowledgment of the source is given in each case. There are several translations of important papers, among them being Prof. J. A. Palmén's report on the migration of birds, presented to the second International Ornithological Congress in Budapest in 1891; and translated extracts from an ornithological essay on the flight of birds, by M. L. P. Mouillard, published in Paris in 1881 under the title "L'Empire de l'Air." Other contributions calling for special mention refer to the geological history of the Yellowstone Park, Mr. W. Woodville Rockhill's explorations in Mongolia and Thibet, and the progress of astronomy during 1891 and 1892.

THE recent publication of several important works has brought into prominence the subject of the theo y of functions. Those who are interested in this branch of mathematical science will therefore be glad to know that Messrs. Mayer and Müller, of Berlin, intend to publish, in about eight volumes, the collected papers of Herr Karl Weierstrass, who has been termed the creator of the modern theory of functions. The work will be issued under the auspices of the Königlich Preussischen Akademie der Wissenschaften, and it is with the sanction of Prof. Weierstrass himself that this edition of his collected mathematical works is allowed to see the light. Messrs. Mayer and Muller rightly ground the importance of this publication on the name of the author. The first part is to contain memoirs already published, or which are ready for publication, in three volumes, the papers being printed in chronological order. The series is to open with "the development of the modular functions" which was presented to the Prüfung's-Commission at Münster in 1841. This part also contains the Braunsberg School programme, the fundamental importance of which in the theory of the Abelian functions is well known. The second part is to consist of five volumes, and will include the greater part of the lectures delivered in the University of Berlin. In the first volume of this part is the lecture based on "the Theory of the Elliptic Functions," which was delivered for the first and only time in the Professor's sixtieth year (*cf.* Forsyth, cap. v.-vii.) The theory is here established on Euler's Addition-theorem. The lecture closes with an application to several geometrical and mechanical problems. A later volume contains "the general Elliptic Transcendents," as well as a detailed discussion on the transformation of elliptic functions. The theory of the Abelian functions occupies the remaining volumes, one of which is devoted to a special discussion of the theory of the so-called hyperelliptic functions. The lectures are to be edited by a former pupil of Prof. Weierstrass, who, however, will himself supervise the publication. The work is to come out in quarto volumes, and great care is to be bestowed on their production. It is expected that all the volumes will be issued in a few years.

PROF. W. C. MACKENZIE, of the College of Agriculture, Ghizeh, has sent us some interesting information with regard to the existence of nitrate of soda in Egypt. It appears that the natives of Upper Egypt, from Keneh to Esneh, are in the habit of carrying a substance called "tafl," from the hills on the east side of the river, to manure their fields, especially the maize crop. That this was done seems to have been well enough known to many people in the habit of spending some time there, but beyond a casual knowledge of the fact that the "tafl" was used as a manure, no further interest seems to have been taken. What the valuable ingredient was, does not seem to have been known, and the name "tafl" was used indiscriminately for clay for pottery and clay for manure. Analyses of several samples of this substance showed, however, that they contained nitrate of soda from 2 per cent. to 18·5, mixed with varying proportions of chloride and sulphate, as well as calcium carbonate and clay. Further examinations of other samples did not show such a high percentage, the richest containing only 4 per cent. Prof. Mackenzie visited the deposit in the hills east from Luxor, and some eight miles distant from the town across the desert, and there found the "tafl" right on the face of a limestone hill, apparently cropping out of the rock. Samples taken at different heights gave percentages varying from 2 to 9·5 of nitrate of soda. On sending in a report about this nitrate, Nubar Pasha, the present Prime Minister, arranged to send up Mr. E. A. Floyer and Prof. Sickenberger to investigate the whole question, and endeavour to estimate the quantity. The investigation will no doubt throw considerable light on the origin of this curious occurrence of nitrate. Prof. Mackenzie thinks that the idea that the clay has simply acted as an absorbent for nitrates got from accumulations of potsherds, &c., does not seem possible, for at Luxor there is no evidence of this whatever, the deposit of nitrate-bearing clay being at the foot of a limestone cliff, and no appearance of potsherds anywhere. He believes that more probably caves or swallow-holes in the limestone cliffs have collected clay and organic matter from the river, and the nitrification of this organic matter has produced the nitrate where it is now found. Messrs. Floyer and Sickenberger's report will, however, no doubt clear this point up.

AMONG the shorter contributions in the May number of the *Psychological Review* is one by Prof. W. O. Krohn on the relation of sensation-areas to movement. He had the opportunity of testing the sensitivity of the skin of a man who had had his left forearm encased in a plaster-of-paris case for a period of three months. During this entire period the forearm could not be moved either at the wrist or at the elbow. Prof. Krohn compared the sensitiveness of the skin of the uninjured right forearm with that of the left forearm of the same person, after the plaster case had been removed, by means of the usual æsthesiometric tests. He found that on the latter forearm the one so long unmovable, when the two points of a pair of dividers or compasses, touching the skin at a given locality, were separated by as much as fifty-five millimetres, they were felt as one instead of two; while on the right forearm they only had to be about twenty millimetres apart in order to be perceived as two. On the back of the left arm, at a different locality from that just mentioned, it was found that even when the two points of the dividers were seventy-five and eighty millimetres apart, they were felt as one; while at a corresponding locality on the right arm the skin was so sensitive that points but 17 mm. apart could be felt as two. It should be mentioned that the subject was practically ambidextrous before meeting with the accident which led to the casing of his arm in plaster. Prof. Krohn thinks, therefore, that the sensitivity of the skin over the injured forearm was lost simply because that member was for so long a time immovable. He points out that this has an important bearing upon the principle that "the localising power is delicate in proportion as the skin covers a movable part of the body."

An "Atlas of the French Lakes" has been in progress since 1886, under the auspices of the Ministry of Public Works in France. It is now completed, and published in ten sheets, with coloured contour-maps of the French lakes, great and small. Lake Geneva, partly done by Swiss surveyors, is drawn to scale 1 50,000, Lake d'Annecy to scale 1 20,000, and the others 1 10,000. Several results of general interest are obtained—for example, the regular spherical shape of old crater lakes in the Auvergne district, the shallowness and irregularity of lakes at the outflow of a glacier, such as Lake Sylans in the Ain Department; again, the filling-up of lakes at the inflow of the river, typically shown by Lake Brenets, in the course of the River Doubs. The work has been accomplished by M. André Delebecque, Civil Engineer of Bridges and Roads, assisted by his colleagues MM. Garcin and Magnin. The day has yet to come when our Government will authorise a similar special work on British lakes.

So little is known about the origin of many infectious diseases that an article by Dr. Keser, in the *Medical Magazine* for May, will be read with interest. The chief reason why the matter is in obscurity is that the descriptions of diseases found in the works of early writers do not afford the necessary means of identification. A noteworthy exception to this, however, is Thucydides' narrative of the plague of Athens. The author gives a graphic account of an acute well-marked epidemic disease which invaded Athens in the year 430 B.C., appearing unexpectedly amongst healthy people, and destroying the lives of many thousand inhabitants during the three years that it lasted. It has been supposed by some that the disease was small-pox, while others have considered it to have been a malignant form of scarlatina or typhus. A careful review of the facts and evidence, however, leads Dr. Keser to believe that the plague of Athens was probably a variety of the true Oriental plague, characterised chiefly by a varioliform exanthem with redness and lividity of the skin, by ulcers, and by the absence or rarity of buboes. The connecting links between this form of the plague and the typical *Pestis inguinaria* still remains a matter of conjecture.

The April number of *Das Wetter* contains an article on sun-spots and weather, by P. Polis, based on sixty-four years' observations at Aix-la-Chapelle (1830-93). The author has tabulated Wolf's relative sun-spot numbers, together with the yearly, winter, and summer mean temperature values, the number of thunderstorms and annual rainfall, and has also represented the values graphically. The curves show that down to the year 1878 the summer and annual mean temperatures decrease with greater sun-spot frequency, and that an increase of summer and yearly temperature occurs with a decrease of sun-spots. The winter temperature curve also agrees generally with the other two. From the year 1878 the temperature curves are reversed, a decrease of sun-spots corresponding with a fall of temperature, and *vice versâ*. The rainfall curve is irregular, but it appears, contrary to results obtained elsewhere, to take exactly an opposite course to that of the sun-spots. The number of thunderstorms increases generally with a decrease of sun-spots, and *vice versâ*.

For some years past, Prof. Klossovsky, Director of the Meteorological Observatory of Odessa, has been actively engaged in collecting and discussing observations bearing on the climate of south-west Russia, and the observers co-operating with him amounted in 1892 to 1900 in number. A valuable paper on the climate of Odessa has recently been published (in Russian), from which it appears that the mean annual rainfall for 1866-92 was about 17 inches; the wettest month during this period was June 1886, in which the rainfall was 6.6 inches, while in September 1892 no rain fell. The annual mean temperature was 50°.2; the maximum was 95°.4, and the minimum −18°.8, giving an annual range of 114°.2. Several papers have also been published, bearing upon the agriculture of the district, including phenological observations, and also the occurrence of sandstorms, which are frequent in that part of Russia.

A recent number of the *Comptes Rendus* contains a paper by M. R. Swyngedauw, on the ratio of the currents produced by the discharge of a condenser in two circuits placed in parallel, one containing a spark-gap and the other self-induction. The apparatus employed by the author consists of a battery of two Leyden jars charged by a Holtz machine. The conductor which joins the coatings of these jars contains (1) a spark gap I_1; (2) a coil T which is traversed by the whole discharge Q_T; (3) two branch circuits, one containing a coil D exactly similar to T, the other containing a spark-gap I_2. The two coils T and D are identical, and can be placed either simultaneously or separately on the cross-bar of a Wiedemann-d'Arsonval galvanometer. Thus, by placing first the coil T and then D on the galvanometer, the total quantity of electricity discharged, or the fraction which passes through the branch circuit containing the coil, can be measured. The author finds that if the sparking distance I_1 is left constant, that the quantity of electricity passing through the branch circuit containing the coil increases continuously as the spark interval I_2 is increased. When the spark interval I_2 passes a certain limiting value, the quantity of electricity passing through the branch coil is greater than that passing through the coil T. This anomalous increase might be considered to be due to a dissymmetry in the spark-gap I_2, so that oscillatory currents set up in the branch circuits would pass one way but not the other. The author finds, however, that if this spark-gap is changed, or the direction of the discharge changed, the increase is still observable.

An elaboration of the presidential address delivered by Dr. D. Christison in November 1892, before the Botanical Society of Edinburgh, has just been published in the Society's *Proceedings* (vol. xix. part 3). The subject of the address was the actual size of the largest trees of species, native or long-naturalised, in Britain, particularly in Scotland, with a discussion of the question of their probable age. At the end of the paper Dr. Christison dispels a few pleasing illusions with regard to some historic trees. It is chiefly the oak, among trees, that has been associated with historic deeds, and perhaps none has acquired such fame as the Boscobel oak, reputed to have concealed Charles II. after the battle of Worcester in 1651. Dr. Christison says that an inscription which was placed against the present tree in 1875 certifies:—"This tree, under the blessing of Almighty God, had the honour of sheltering from his foes King Charles II." But, it is pointed out, Mr. R. F. Collins (*Trans. North Staffordshire Field Club*, 1890) has shown that this tree, being only eleven feet ten inches in girth, could not have been the pollard oak of nearly two and a half centuries ago, and that a previous inscription in 1817 testified that "the present tree sprung, it is said, from the above tree" (meaning the Royal tree). Previous inscriptions were also referred to, from which it seems that the original tree disappeared soon after 1787. Indeed, Dr. Stukely recorded that in 1713 "the tree was in the middle almost cut away by people who came to see it." As to historic hawthorns, one is credited with having witnessed the death of Lord Maxwell at the Battle of Dryfe Sands, and several have been associated with Mary Queen of Scots; but Dr. Christison remarks that it is scarcely possible that any hawthorn could exist for three hundred years, as the species rarely exceeds a very moderate size, and his observations show that it grows at a fair average rate.

MR. THOMAS CARROLL'S general report on the Irish Agricultural Department during 1892, published a few weeks ago, contains the results of experiments carried out under his direction, having for their object (1) the determination of the mode by which the disease *Phytophthora infestans* reaches the tubers of the potato plant, and (2) the examination of measures for the prevention of, or for the lessening the effects of, the disease upon the crop. The point upon which information was especially desired was, whether the disease producing Mycelium reached the tubers of the potato plant through the aerial and underground stems, or by means of the disease-producing spores falling upon the ground, and being carried through it to the surface of the tubers. To test this, a portion of ground upon which potatoes were growing was covered beneath the potato stems and leaves with a layer of cotton wool. This cotton wool was carefully placed around the stems, and every means used to have the ground perfectly covered with it, with the view of filtering out the spores that might fall upon the ground. No diseased potatoes were found on plants protected in this manner, whereas many occurred on plants grown in ground not covered with cotton wool. These experiments, which were very carefully carried out, serve to indicate that the disease is carried to the tubers of the potato plant through the spores which cause the disease being taken through the earth to the tuber, and not by means of the Mycelium finding its way to the tubers through the stem of the plant. An experiment, having for its object the testing of the effect of removing the stalks of potatoes upon the appearance of disease, with the view of preventing the tubers from being affected, was carried out at the Ballacutranta School Farm, County Sligo. This system of removing the potato haulm upon the appearance of the disease has frequently been recommended as a preventive. To test it, two plots of ground bearing a crop of potatoes were marked out for experiment. On one the stalks were removed; on the other they were allowed to remain. A comparison of the weights of the crops in each case, and the amounts of diseased tubers, shows, however, that through the removal of the potato haulm, before the crop was matured, the yield of crop was lessened without commensurate benefit in freedom from disease.

MR. GEORGE S. PERRIN has sent us a paper on "Australian Timbers," read before the Royal Victorian Institute of Architects in September 1893, and having special reference to the ornamental and decorative woods of Australia.

Bulletins Nos. 48, 49, and 50 have been sent out from the Purdue University Agricultural Experiment Station. They contain the results of experiments with small fruits; a history of the attempts that have been made to establish the sugar-beet in America, with a statement of the conditions required for its successful cultivation; and the results of some field experiments, by Prof. W. C. Latta, with Indian corn and oats. The *Bulletins* are sent free to all agriculturists in Indiana who desire them, and their contents are found iovaluable.

ON April 18 the Geological Survey of Alabama attained its majority—twenty-one years—under the present management. It has been thought desirable to mark this occasion by some sort of permanent memorial, and to this end maps are in course of preparation showing the condition of knowledge of the geology of the State at the beginning and at the end of the period 1873–1894, and columns showing the relative amounts of raw materials and of finished products from Alabama mineral resources at the same times, are also in preparation. In the line of this design a sketch has been prepared by Mr. E. A. Smith, showing the origin and progress of the survey, the difficulties under which it has laboured, what it has accomplished, what it has cost, and what it yet hopes to accomplish.

A LIST of apparatus for the psychological laboratory designed by Prof. J. Jastrow, and made by the Garden City Model Works, Chicago, has been received. It comprises descriptions of æsthesiometers, for determining the distance upon the skin at which two points are just perceived as two; pressure attachments, for testing the pressure sense of the skin; apparatus for the sense of roughness and smoothness; apparatus for all kinds of reaction experiments; an arrangement for testing the appreciativeness of changes of temperature; others for recording involuntary movements; and for testing memory. The character of some of the apparatus shows that experimental psychology and physiology overlap to a large extent. Indeed, it is often difficult to define the limits of psychological and physiological research. Like many other branches of science, these two merge into one another, and their peculiar provinces of investigation are comparatively small.

The fourth volume of the *Proceedings* of the Chester Society of Natural Science and Literature, which has just been published, contains a number of very interesting articles by several well-known men of science. It is a matter for regret that the publication of some of the papers has been so long delayed. For instance, we note that a paper by Prof. T. McKenny Hughes, F.R.S., on the Silurian Rocks of North Wales, was read before the Society in January 1886, and another, on caves and cave deposits, in October of the same year. Mr. A. O. Walker contributes to the volume some notes on the natural history of the Chester district, from 1879 to 1893, a paper on the climate of Chester, and one on that of the North Coast of Wales. The Heron, and Heronries of Cheshire and North Wales, forms the subject of a contribution by Mr. R. Newstead, who also gives a preliminary list of the mammals of the same district. Another important list gives the results of observations on the occurrence and distribution of birds in different parts of West Cheshire, Denbighshire, and Flintshire. This list was drawn up by Mr. W. H. Dobie, and is accompanied by a map. From this brief description it will be seen that the Chester Society of Natural Science is doing something to promote the study of natural knowledge. We are glad to learn that the Society is in a very flourishing condition, the number of members being at present over six hundred.

THE Society for the Protection of Birds have added to their list of publications a pamphlet by Mr. W. H. Hudson, entitled "Lost British Birds." The species described as lost by Mr. Hudson are those of which the British race is extinct, or very nearly so. The list includes the Crane, White Spoonbill, Capercailzie, Avocet, Great Bustard, Blacktailed Godwit, Great Auk, Red Night reeler, Bittern, Marsh Harrier, Ruff and

Reeve, and Hen Harrier. Though it may be thought a little "previous" to refer to some of these species as lost, there are others, such as the Goshawk, Night Heron, Little Bittern, and Baillon's Crake, not included in the list, but which there is reason to believe were once summer residents and breeders in Great Britain. It is often remarked that the total disappearance of some species of birds, and the extreme rarity of others once common in this country, is due to the draining of marshes and similar changes on the face of the land. But the facts brought together by Mr. Hudson show that the disappearances have been mostly brought about by the direct action of those inveterate bird-destroyers, described as "The Cockney sportsman, who kills for killing's sake; the gamekeeper who has set down the five-and-twenty most interesting indigenous species as 'vermin' to be extirpated; or, third and last, the greedy collector, whose methods are as discreditable as his action is injurious." If these and others who have helped to degrade the character of our bird-population will read Mr. Hudson's little pamphlet, they will see the greatness of the change that has taken place.

Further interesting properties of sodium peroxide are described in the current *Berichte* by Prof. Poleck, of Breslau. It is shown that sodium peroxide rapidly reduces salts of gold, silver and mercury with separation of the metal and evolution of oxygen gas. Platinum, however, is not precipitated from chloroplatinic acid or chloroplatinates until they are decomposed with a silver salt, when reduction both of the resulting platinum chloride and of the silver chloride occurs, both metals being precipitated. Ferric hydroxide is precipitated, as might be expected, from both ferrous and ferric salts; from manganous salts manganese dioxide is precipitated, presumably hydrated, and from salts of cobalt the higher cobaltic oxide. Permanganates are reduced to manganese dioxide, but chromic oxide is oxidised to chromic acid. The separation and quantitative estimation of iron and chromium or manganese and chromium are easily achieved by utilising these reactions, for iron is precipitated as ferric hydroxide and manganese as peroxide, while chromium remains in solution as chromate of sodium. Sodium peroxide also produces the highly oxidised sodium peruranate, $Na_4U_2O_8 + 8H_2O$, directly from salts of uranium, and it may readily be isolated by addition of alcohol which precipitates it. It is also interesting that iodine is oxidised on warming directly to the difficultly soluble acid sodium periodate, and upon decomposition of this salt with silver nitrate the normal silver periodate is at once produced, and free periodic acid $HIO_4 + 2H_2O$ may be readily obtained from it in large crystals by decomposition with bromine and subsequent evaporation *in vacuo*. Potassium ferricyanide behaves towards sodium peroxide in a similar manner to its action with hydrogen peroxide, reducing it energetically to ferrocyanide, and the volumetric process of Kassner can be readily carried out by use of it. Sodium peroxide reacts with lead oxide in presence of water to produce a plumbate of sodium of the composition $Na_2PbO_3 + 4H_2O$. Organic compounds dissolved in alcohol are usually very rapidly oxidised by sodium peroxide, while the alcohol itself is not attacked. Ether, on the contrary, at once ignites when brought in contact with the peroxide. Prof. Poleck recommends its use likewise in the separation of arsenic, antimony and tin, for the sulphosalts of these elements are at once oxidised by sodium peroxide in presence of water to oxygen compounds, the whole of the sulphur being simultaneously converted into sulphuric acid. Hence in toxicological investigations it is only necessary to oxidise the sulphosalts with sodium peroxide before proceeding immediately to employ Marsh's test. The practical uses of sodium peroxide appear indeed to be very numerous, and the information now rapidly accumulating concerning it will doubtless prove of value both from the theoretical and the technical point of view.

In our note concerning the atomic weight of barium (vol. xlix. p. 562), the statement that "the highest and lowest individual values obtained among the whole fifty separate estimations were 137·42 and 137·45" should have read "the highest and lowest of the mean values obtained from the different series of estimations were 137·42 and 137·45."

The additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythrus*, ♀) from South-east Africa, presented by Mr. H. Tattenhall; two Laughing Kingfishers (*Dacelo giganteus*), two Berigora Hawks (*Hieracidea berigora*) from Australia, presented by Mr. A. E. Henniker; seven Spanish Blue Magpies (*Cyanopolius cooki*) from Spain, presented by H.R.H. the Comte de Paris; a Tuatera Lizard (*Sphenodon punctatus*) from New Zealand, presented by Dr. W. J. Mackie; an Egyptian Terrapin (*Trionyx ægypticus*) from West Africa, presented by Mr. F. W. Marshall; a Green Lizard (*Lacerta viridis*) European, presented by Miss S. Borgaes, a Yellow-billed Sheathbill (*Chionis alba*) from Antarctic America, a Red and Blue Macaw (*Ara macao*) from South America, a Black Iguana (*Metopoceros cornutus*) from San Domingo, a Geoffroy's Terrapin (*Hydraspis geoffroyana*) from Trinidad, seven Say's Snakes (*Coronella sayi*) from North America, deposited; a Derbian Wallaby (*Halmaturus derbianus*, ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Finder-Circles for Equatorials.—A very ingenious and what may prove a most useful addition to an equatorial are the so-called star-dials or finding-circles, a brief account of which is contributed to the current number of the *Zeitschrift für Instrumentenkunde* (4 Heft, April 1894). Every worker with the equatorial will no doubt at some time have found out that the present mode of setting the instrument on some object, as, for instance, a star, is not always very convenient, and in addition employs comparatively far too much time. The object of these finding-circles is to reduce this time very considerably, and a use of three years has shown that its aim has been successfully attained. The instrument to which it has been applied is the 12-inch of Georgetown College Observatory, Washington. On the pillar of this instrument are the two hand-wheels, by means of which the telescope is moved in right ascension and declination, and also two microscopes for reading the R.A. circle. Both axes of the telescope carry the usual circles for orientation, each being graduated in fine divisions on silver and large white divisions on a dark background. The finding-circles are situated just above the hand-wheels mentioned above, and fixed to the pillar, looking like a pair of aneroid barometers or steam gauges; they are arranged as follows:—The circular divided disc, with the declination divisions arranged round its circumference, is fixed firm in its case, and the index is so geared to the telescope that any movement of the latter is recorded on the dial; this gives one directly the declination. In the case of the other dial, that for right ascension, the disc is divided into two circles of twelve hours each, and instead of being fixed is moved by clockwork, sidereal time being shown on its face by means of another index; this latter index responds also to the movement of the telescope, but is quite independent of the first one. It will at once be seen that with these two dials so conveniently placed the telescope can be at once oriented, while the question of hour-angle is entirely eliminated.

The Harvard Observatory in Peru.—An historical sketch of the establishment of the Peru branch of the Harvard College Observatory, and the investigations carried on there, is contributed to the *Harvard Graduates' Magazine* for March by Prof. W. H. Pickering. The Observatory is situated about two miles from Arequipa, and four hundred feet above it, on the slopes of Mount Chachani. It is furnished with a very complete instrumental outfit, the most important instrument being a 13-inch equatorial, capable of being used for either visual or photographic purposes, and an 8-inch photographic telescope. Five meteorological stations have been established by the Observatory. One is at Mollendo, on the sea-coast, 100 feet above sea-level. The second is at La Joya, in the desert, altitude 4140 feet. The third is at the Observatory itself, altitude 8060 feet. The fourth is upon the side of the Misti, at an altitude of about 16,000 feet, and the fifth is upon the summit of the Misti, altitude 19,200 feet. The discoveries made at the Observatory are enumerated by Prof. Pickering. They include double stars, the "lakes" on Mars and the rapid changes in some of the canals and dark markings on the planet at the time of the melting of the southern snow-cap, the observations of changes of shape of Jupiter's satellites, which led to the conclusion that the outer satellites are not solid bodies, but dense swarms of meteorites, and pointed to a modification of Laplace's nebular hypothesis, to explain some of the diffitulties inherent in it. Peculiar lunar formations have also been observed, and an explanation has been given of the bright streaks seen at the time of full moon. A new class of lunar rills has been found, winding and tapering like a terrestrial river bed, and various facts have been determined with regard to what are called "variable spots" on the moon, which darken as the sun rises upon them, and fade out as it sets. Finally, the remarkable photograph of the spectrum of Nova Normæ, showing the star's constitution to be the same as that of Nova Aurigæ, was obtained at Arequipa. But only a small portion of the work of the Observatory is devoted to original research, the greater part of the time being taken up by routine work. Few observatories, however, can show a better record than that made at Arequipa during the three years of the Observatory's existence.

THE DIAMETERS OF SOME MINOR PLANETS.—Various attempts have been made to measure micrometrically the diameters of some of the larger asteroids, and also to determine them by photometric means, but the values obtained have never been very trustworthy. Prof. E. E. Barnard has now taken up the work, using the 36-inch of the Lick Observatory, and has already obtained some new results (*Astronomy and Astro-Physics*, May). So far, he has succeeded in directly measuring Ceres, Pallas, and Vesta, to which he assigns the following diameters:—

Ceres	...	599 ± 29 miles.
Pallas	...	273 ± 12 ,,
Vesta	...	237 ± 15 ,,

It will be seen from this that, contrary to the general belief, Ceres is the largest of the minor planets, and not Vesta. The values obtained by Argelander from a consideration of the relative light of the three foregoing asteroids and Juno, and those determined by Mr. E. J. Stone in 1867 from measures made by Herschel and Lamont, are as follows:—

		Argelander.		Stone.
Ceres	...	230 miles	...	196 miles.
Pallas	...	162 ,,	..	171 ,,
Juno	...	108 ,,	...	124 ,,
Vesta	...	275 ,,	...	214 ,,

Juno will soon be in a favourable position for observation, and Prof. Barnard will then apply the filar micrometer to its disc.

RETURN OF TEMPEL'S COMET.—A telegram from the Cape Town Observatory to Prof. Krueger (*Astr. Nach.* 3228) announces that Tempel's periodical comet (1873 II), the return of which was expected this year, was observed by Mr. Finlay on May 8. Its position was then R.A. = 356° 20′ 16″·5. P.D. = 94° 51′ 11″. The object was circular, with a diameter of about one minute of arc and some central condensation, but no tail. Its brightness was about the eleventh magnitude, or fainter.

THE NEW ENGINEERING LABORATORY AT CAMBRIDGE.

THE new Engineering Laboratory was opened on Tuesday by Lord Kelvin, in the presence of a brilliant assemblage of University dignitaries. The building occupies the site of the old Perse Grammar School, and has been erected from the designs of Messrs. Marshall, Vicars, and Co. The exterior is of plain but not unattractive red brick, in the French *château* style. The main building is of three stories. The three chief rooms, one above the other, are on the left of the handsome entrance doorway, and overlook the grounds of Corpus Christi College. To the right of the doorway are offices, small class-rooms, and rooms for special researches. The electrical laboratory is on the ground-floor; above it is the drawing school, excellently lighted by large western windows; and at the top is the mechanical museum, lighted by dormer windows and a cupola. Behind, the fine old schoolroom has been altered by raising its floor, but the beautiful oaken-roof of sixteenth-century work has been preserved, and the room gains rather than loses by the slight change in its proportions. Here is the chief mechanical laboratory, and it is furnished with all needful apparatus for work on the strength of materials, mechanism, and applied mechanics. Beyond, in the old schoolyard an admirable steam and dynamo laboratory has been erected from Prof. Ewing's designs. Here are several types of experimental steam-engines, dynamos, and motors, and in another compartment the boilers and other heavy appliances. The laboratories are on one side contiguous to the Chemical Laboratory, and when some day the necessary extension of the Cavendish Laboratory takes place, they will also abut on the Physical department. The cost of the whole has been some £6000, of which about £5000 was contributed by friends of the University who desired to see engineering science properly established and equipped in Cambridge.

The Vice-Chancellor presided at the ceremony, and in a happy speech alluded to the doubts at first entertained by many worthy Cambridge men as to the wisdom of admitting purely professional studies among those fostered by the University. In medicine, however, in law, and lately in agriculture, the claims of applied and practical knowledge had been recognised, and the recognition had been amply vindicated. It was due to the enterprise and ability of Prof. Ewing that engineering had now overcome all opposition to its admission to rank as a scientific profession, the preliminary training for which might fitly be carried on within the academic precincts. Lord Kelvin, in declaring the Laboratory open, spoke of the direct evolutional connection between the theoretical mechanics and pure mathematics of his day at Cambridge, and the establishment of a department in which their principles found application and verification. The Laboratory was excellently furnished so far as it went, but £20,000 might well be spent, in the interest of the University as well as of engineering science, in extending and completing it. Prof. Kennedy spoke of the place of such laboratories in the training of the engineer. Engineering was taking its due rank as a liberal profession, and from Cambridge, the centre of mathematical and physical inquiry, future engineers would go out fitted for acquiring with sureness and rapidity the practical details of their work. Sir Frederick Bramwell told stories of his early experiences. Prof. Jebb, M.P., and Prof. Ewing, who was very warmly received, gave thanks to all who had wrought with the Engineering Laboratory Syndicate to bring about the result they were celebrating. The donors, past and future, the architect, builders, demonstrators and workmen received their meed of acknowledgment. After the ceremony a reception was held by Prof. and Mrs. Ewing, and nearly 800 of the members of the University and ladies inspected the rooms. The students acted as guides and demonstrators, and at the close it was on all hands acknowledged that the occasion had been one of the most successful of University functions in recent years.

SCIENCE IN THE MAGAZINES.

THOUGH articles on scientific subjects are sprinkled through this month's magazines, they contain little that is new or suggestive. In the *Quarterly Review* (No. 356) two interesting articles appear, one on "Shakespeare's Birds and Insects," and another on "Ocean Meadows." Much has been written concerning Shakespeare's natural history, but the conclusion to which an examination of the poet's writings inevitably leads is that he was not an observant student of animal and plant life. The *Quarterly* reviewer criticises Shakespeare's knowledge of these matters, pointing out that Chaucer wrote of what he saw and heard in the animal life about him with a sense of personal delight that convinces the reader of his familiarity with animate nature. So too with Spenser, and with Ben Jonson. But, says the reviewer, Shakespeare resembles neither of these. "He borrows from Gower and Chaucer and Spenser; from Drayton and Du Bartas and Lyle and William Browne; from Pliny, Ovid, Virgil, and the Bible; borrows, in fact, everywhere he can, but with a symmetry that makes his natural history harmonious as a whole, and a judgment that keeps it always moderate and passable." This indictment is supported by uncontrovertible evidence, and concludes with the remark that Shakespeare's natural history "is commonplace when it is correct, and 'Elizabethan' when it is wrong." His method of handling animated nature has had a momentous effect on all succeeding poetry, so that poetry has sung of nature on Shakespeare's lines with an extraordinary fidelity. Groups of creatures which he misrepresented have been held up to reproach by poets since his time, and many others deserving of notice have been neglected. It is remarked, however, that "there is no necessity for a poet to be a naturalist in order to be true to nature; but there is the most urgent necessity that he should be in sympathy with nature and ready to acknowledge the good and beautiful, even if it should reach him in such questionable shapes as 'the deadly owle' or 'a full-blown toad that venom spits.'" In fact, owing to the great influence of Shakespeare's writings, the peculiarities of his sympathies and antipathies have been followed by almost all succeeding poets. His natural history was largely at fault; indeed, the reviewer asserts that he was sadly unsympathetic and unobservant. We conclude with a quotation which will come as a revelation to many people: "But taking men all round, ordinarily intelligent men of a country life (a town life was in Shakespeare's day what we should now call country life), was Shakespeare, as compared with these average individuals, 'an observer of nature?' The question is one liable to shock whose who have followed blind guides so long. The answer to it is liable to shock them more severely. No. Shakespeare was curiously unobservant of animated nature. He seems to have seen very little. Our authority for this is his own works, which, while they abound with beauties of fancy and imagination, are most disappointing to lovers of nature by (their errors apart) their extraordinary omissions."

Four important works on marine fauna and flora form the basis of an article in the *Quarterly Review* on "Ocean Meadows." In the course of the article, the reviewer refers to the necessity for making scientific investigations in the sea round our coasts, and shows the improbability of such work being furthered when those who hold high offices cannot appreciate its importance. In his words:—

"The minute animal life in turn furnishes food for shoals of fishes, and the importance of an inquiry into the whole life-history and seasonal occurrences of such organisms—the basis of the nutrition of marine life, as green plants are of terrestrial life—can scarcely be overrated. No such inquiry has ever been conducted in a serious scientific spirit in our seas by other than private investigators, unequipped with adequate resources for the proper study of the subject in its economic aspect. Our Fishery Boards concern themselves as little with this vital matter as they possibly can. Nor is this apathy surprising, when it is remembered that the present Government have appointed to the chairmanship of the Scottish Fishery Board an estimable gentleman, who possibly understands the 'branding' of herrings, but whose chief qualification for the post was a safe constituency. Yet, at the moment when this appointment was made, they had the opportunity, pressed upon them by a large body of scientific men, of choosing an eminent naturalist, whose claims as a student of the ocean are admitted by men of all nations to be unrivalled."

Almost every great advance in the study of the ocean has been made by this country, and though other countries are now competing with us, an opportunity will soon arise for us again to forge ahead.

"The proposed Antarctic expedition, for which a convincing case has been made out, can add to its usefulness by taking such an investigation in hand, not only in the Southern Seas but on its way to them. There is probably no region so fertile in the forms of pelagic life as the Southern Ocean, and an expedition which should not make the study of its vegetation one of its main objects had better stay at home. There is little fear of the subject being neglected in its widest aspects, since it is one of the professed 'aims which the promoters have in view,' to use the language of a prospectus. Botanists will have themselves to blame, and the public will have them to blame, if through their supine indifference this great and rich harvest of the ocean be not gathered in. In another respect the times are favourable. For many years this country lost its once eminent position in the study of the coast vegetation of the sea; but during the last six or seven years so much good and honest work has been done by a young and energetic band of observers that this position has been in a great measure retrieved. There are not lacking among our younger botanists men of skill in the use of the most recent methods of research, capable of meeting the Germans on their own field. It will be their fault if the naturalists of another nation forestall them in taking possession of not the least honourable part of our empire over the sea."

In the *Fortnightly*, Mr. Grant Allen, in an article entitled "The Origin of Cultivation," attempts to answer the question as to how early savages found out that plants would grow from seeds. His views are as follows:—"Cultivation began with the accidental sowing of grains upon the tumuli of the dead. Gradually it was found that by extending the dug or tilled area and sowing it all over, a crop would grow upon it all, provided always a corpse was buried in the centre. In process of time corpses were annually provided for the purpose, and buried with great ceremony in each field. By-and-by it was found sufficient to offer up a single victim for a whole tribe or village, and to divide his body piecemeal among the fields of the community. But the crops that grew in such fields were still regarded as the direct gifts of the dead and deified victims, whose soul was supposed to animate and fertilise them. As cultivation spread, men became familiarised at last with the conception of the seed and the ploughing as the really essential elements in the process; but they still continued to attach to the victim a religious importance, and to believe in the necessity of his presence for good luck in the harvest. With the gradual mitigation of savagery an animal sacrifice was often substituted for a human one; but the fragments of the animal were still distributed through the fields with a mimic or symbolical burial, just as the fragments of the man-god had formerly been distributed. Finally, under the influence of Christianity and other civilised religions, an effigy was substituted for a human victim, though an animal sacrifice was often retained side by side with it, and a real human being was playfully killed in pantomime."

Another origin about which Mr. Grant Allen makes suggestions is that of language. His remarks on this subject appear in *Longman's Magazine*, under the title "The Beginnings of Speech." The *Sunday Magazine* contains an article on "The Stuff we are Made of," by Dr. J. M. Hobson, in which some facts concerning amœbæ are stated, and also a sketch of the life and environment of Richard Jefferies, by the Rev. B. G. Johns. "Moon-Man or Moon-Maid" is the title of a short article by Mr. William Canton in *Good Words*. One of Cassini's drawings of the Gulf of Rainbows on the moon shows the form of a girl's head emerging from the rocks of the promontory of Heraclides on one side of the Gulf. M. Flammarion reproduced this drawing in *L'Astronomie* some time ago, and lamented that he had been unable to find the figure in any other drawing, or observe it himself. A few months later, however, M. Quénesset made out the form of a man's face at the spot to which attention had been drawn, and two hours later on the same evening M. Mabire, observing at the Juvisy Observatory, depicted "without a single stroke of imagination" the head of a woman in the same place. Mr. Canton's remarks refer to these two drawings, reproductions of which are given. The illustrations are curious, but not very instructive; they appeal more to the poetical than the scientific mind.

Mr. Henniker Heaton writes on "Telephones: Past, Present, and Future," in the *New Review*, his point of view being chiefly commercial. Sir Herbert Maxwell espouses the cause of tree-planting in London, and enumerates some of the trees suitable for town adornment. "The Imitative Functions, and their Place in Human Nature," is the theme of Mr. J. Royce in the *Century*. *Chambers's Journal* has several quasi-scientific contributions, among them being articles on amber, breath-figures and dust-photographs, and trees of the genus *Adamsonia*—Cream-of-Tartar trees. In addition to the magazines named in the foregoing, we have received *Scribner's*, the *Contemporary*, and the *Humanitarian*; but none of these contain articles calling for comment here.

THE SCIENCE OF VULCANOLOGY.[1]

VULCANOLOGY, or the science which deals with volcanoes and related phenomena, is a very important branch of geology—the science which treats of the earth's crust in general. Geology is yet hardly a century old; for before that time it consisted of little else than a collection of romantic hypotheses

[1] Introductory Address to a Course of Lectures on Vulcanology, delivered in the R. Univ. of Naples, by Dr. H. J. Johnston-Lavis.

and incredible superstitions. This remark applies with still greater force to vulcanology, for the study of which it is necessary to possess an extensive knowledge of physics, chemistry, and a well-developed faculty of observation. For a century or two previous to the nineteenth, however, there were acute observers, and we in Naples well know such names as those of Sorrentino, Duca e Padre della Torre.

Towards the end of the last century the active and extinct volcanic regions of Italy attracted the attention of four great men of science, each of a different nationality. I allude to Spallanzani, Sir William Hamilton, Dolomieu, and Breislak. Although their nationality was different, they had two merits in common—that of scientific truth and that of Baconian methods of reasoning. In other words, they were pure men of science, since by that term we understand one who observes carefully, records neither more nor less than he observes, and draws from these facts, and those collected by others, his conclusions, without disregard to a clear knowledge of the principles involved, and without flights of imagination. It is, therefore, more to these four men that we owe the advance of human knowledge concerning volcanoes than to all the writers who preceded them.

In the first years of the nineteenth century, vulcanological literature was enriched by many workers, because, as the allied sciences were then making great strides, they were able to offer to vulcanologists much more powerful and accurate means of investigation. Thus we had Humboldt, Scrope, Daubeny, Pilla, and Gemmellaro.

Following these came a phalanx of illustrious students of geology, some of whom are still among us, while others, though dead in person, are living and immortal in the memory of man as heroes of science and of human knowledge. Amongst these we may enumerate Lyell, Dana, Scacchi, Palmieri, Silvestri, and Phillips, whilst at present many younger and gifted investigators are not wanting.

No other branch of science has been so heavily burdened by extravagant hypotheses, which have so much retarded its progress, as that of vulcanology. It is not only in the first half of the present century but even still that we find an extensive literature produced by men who advertised themselves as scientific investigators, when in truth they did little else but write memoirs and books to promulgate and sustain fantastic, extravagant, imaginary, and impossible hypotheses. Nevertheless, amongst this chaff we not only meet with grain, but very good grain.

As a subject of study, Vesuvius holds the first place in all vulcanological investigations of this and the last century. A few figures will make this fact more evident. Some four years since, my wife and myself collected the titles of books, memoirs, and other writings referring to the South Italian volcanoes, for the purpose of publishing a bibliographical list. We found the following numbers:—

Graham's Island, or Isola Ferdinandea ...	28
Roccamonfina	33
Lipari Islands	119
Alban Hills	210
Campi Phlegræi	539
Etna	880
Vesuvius	1552

From this table it will be seen how much has been written concerning Vesuvius; in fact, its literature constitutes nearly half of what has been written about all the volcanic regions south of Rome. If we add to these the titles referring to the Campi Phlegræi, we then find that in a total of 3361 not less than 2091 concerns the volcanic district around Naples. Let me, however, give you a still more striking fact. The Naples branch of the Italian Alpine Club possesses the richest vulcanological library in existence. The catalogue contains more than 7000 entries of papers, books, and manuscripts. In this number, however, are included books that not only treat of vulcanology, but in large part refer to seismology and, to a smaller extent, to geology. It will be seen, therefore, that the Neapolitan volcanic district represents more than a quarter of all vulcanological literature.

It is true that the history of Etna and the Æolian Islands reach farther back than that of Vesuvius, but on the other hand the history of this latter is by far the most complete. From a chronological point of view, Vesuvius and also the Campi Phlegræi hold a more important place in history than any of their rivals. Even if the Pompeians, the Herculaneans and the Stabians did lose all their property eighteen centuries since, the modern world has recovered it as archæological treasures, whose value represents, from the point of view of culture, many times the original and the compound interest on the same for the whole interval; and this we owe to our Vesuvius. The Phlegræn region around Naples is so enchained with the poetry of the heroic and classic periods, that without it the legends of Cuma, of Pithecusa, of Sparctacus, of Partenope, of Baja, and so many others, which fill pages and pages of ancient history, would not exist.

Sometimes poetic ecstacy attacks the mind of the scientist; for, contrary to what the general public believe, science rather than abolish poetic sentiment further develops it, but in a more serious and refined form.

When, as we wander around Naples, we reach the hill of Cuma, and we encounter a few ruined walls and a few potsherds that peep out through the rich vegetation of that spot, where now the only inhabitants are the goats and the lizards, our imaginations speed back for nearly three millenniums, when this same rock, almost as in its present state, was chosen by the daring Greek navigators as the site of their new colonial town. All of us know the history of Cuma, all of us know that this little bit of Italy for one half of historic time held a very important place. We are deeply impressed when we make an effort to conceive clearly what 3000 years really is, how many generations lived and died during that time and in that place; but far greater are we impressed when we think that 3000 years is but a fraction in the *geological* history of that hill, and finally our mind fails to grasp the value of time when we consider that the physical record of this hill is not more than a minute fraction of the geological chronology of our globe.

Without going very far back in the geological history of our region, I will ask you to follow me to the first part of the Pliocene epoch, an epoch, as all know, to be considered quite near our own time. All of us now admire the beauty of the Gulf of Naples, which has few rivals in the entire world, but at that time its conformation was very different to what it is now. It then formed a very much larger gulf, represented to-day by the plain we call the Campania Felice, with a large part of the Terra di Lavoro. We must figure to ourselves a broad gulf limited on the north by the promontory of Gaeta, where its confines were limited by high limestone cliffs. Its coast had roughly the following trend. From Gaeta it corresponded with the present provincial road to close under Castelforte, and from there was almost represented by the valley of the Garigliano as far as the gorge between Monte Faito and Monte Cammino, by which narrow strait it was in communication with the sea covering the plain of Cassino. Winding round the south of Monte Cammino it again extended northwards to Mignano. The eastern coast of this strait corresponded with the present line of railway from Mignano to Taverna St. Felice, which coast, turning eastwards, passed under Presenzano to extend into the mountains by the valley of the Volturno. From this point the coast, winding round several islands, represented to-day by hills and mountains separated from the main mass of the Appennines, it extended into these latter, forming so many fiords. The sea then covered all the plain, and its waves beat the foot of the mountains behind Pietramelara, Pignataro Maggiore, Capua, Caserta, Nola, Palma, Sarno, Angri, and Castellamare, and then corresponded roughly with the present coast of the peninsula of Sorrento. In the middle of this great gulf rose two important isles—Capri and Monte Massico, besides a quantity of small ones. Numerous fiords penetrated the Appennines, where to-day we have the Garigliano, the Volturno, Valle di Maddaloni, Valle Caudina, and the Valle di Avella. In fact, this part of the coast of Italy in those pliocene times was very similar in configuration to that of the Istrian coast of to-day.

The rivers bringing down to the sea sand and mud, which, settling at the bottom of the gulf, prepared an almost flat marine floor, which later was to form the foundation of the Campanian Plain. At that period the Campania Felice was only sea, and where to-day flourishes vines, oranges, lemons, and gardens of flowers, then only grew marine algæ.

The great fissure in the earth's crust which corresponds with the western coast of Italy, and along which were formed the Italian volcanoes, opened a way for the igneous magma to the bottom of this gulf. Numerous eruptive centres were formed, giving rise to the volcanoes of Ischia, Roccamonfina, Campi Phlegræi, and Vesuvius. The order in which these different groups were formed is still an unsolved enigma. Ischia, as has been long known, shows by the fossiliferous deposits clothing its flanks, to have undergone great elevation since its original formation, and as we have no such evidence in the other volcanoes, we must conclude for the greater antiquity of Ischia. I also believe that the volcanic group of Roccamonfina is very much older than that of the Phlegræan Fields and Vesuvius, because we find the *piperno* and the *piperno tuff*, very old volcanic deposits in these regions, forming a mantle over Roccamonfina when it was almost a complete mountain. It must not be forgotten, however, that in the "Museum Breccia," first described by me, we have evidence of the effusion in these regions of many varieties of rocks long anterior to the *piperno*.

Gradually the large quantity of lava and fragmentary materials that were ejected at the bottom of the gulf, greatly diminished its depth, and this, combined with general elevation, resulted in the emergence of a number of volcanic islands at Roccamonfina, Ischia, Naples; and probably Vesuvius was, at first, like the others an island. Constant general elevation soon drove back the sea, leaving high and dry all that region we so well know. This plain, with its volcanic hills and mountains, constitutes one of the most beautiful, the most fertile, and the healthiest regions of our earth, if man were more capable of appreciating, enjoying, and developing this *pezzo di cielo caduto in terra*.

So many are the advantages that Vesuvius offers to the student of vulcanology, that I think it advisable to pass them in review. This renowned volcano occupies a very central position in the civilised part of the globe, only a few kilometres from Naples with all the resources of a great city, and in communication by numerous lines of passenger vessels and railways with all parts of Europe and America. Means of visiting Vesuvius are numerous, whilst the volcano is now entirely surrounded by a network of railways, besides good roads. By road and railway the top of the mountain can be reached, and upon its flanks can be found hotels and accommodation of all kinds, besides a meteorological observatory, intended to be used for the daily study and record of its varying phases. The simple but interesting form of the mountain, the extraordinary and unrivalled variety of its productions, which surpass in number, beauty, and interest those of any other volcano yet studied, are also a matter of maximum importance to the student. Besides this, of equal importance we must reckon that continuous activity with variation within such limits as to permit detailed study on the spot, and still more fully in the University laboratories or elsewhere.

Scattered over Italy, and within a few hours' reach, are several other active volcanoes, each having its own special interest, besides a large number of extinct ones and subsidiary volcanic phenomena, all of which, beyond their scientific interest, have a very great importance to the inhabitants from an agricultural, industrial, and hygienic point of view. This is especially the case in the immediate vicinity of the active ones, so that it becomes the duty of the Government to maintain a system of observation and record, and to develop a school in which students may acquire a scientific knowledge of vulcanology.

At Naples we have a chair of terrestrial physics, but as under this name is included a vast amount of different groups of phenomena, it is impossible for its holder to give a fair share of vulcanology alone. So far, the only chair of vulcanology was that of Catania, which was so well occupied by the late Prof. O. Silvestri, and which, after his premature death, was abolished.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—The following have been appointed Public Examiners in the Honour School of Natural Science:—Mr. James Walker, of Christ Church, in Physics, Dr. Henry F. Morley, in Chemistry, and Dr. George A. Buckmaster, of Magdalen College, in Physiology.

The list of the newly elected Fellows of the Royal Society includes three Oxford men—the Rev. F. J. Smith, Mr. V. H. Veley, and Prof. Viriamu Jones.

A conversazione will be given in the University Museum on Tuesday next, by the members of the Junior Scientific Club.

Cambridge.—The Board of Managers of the Arnold Gerstenberg Studentship give notice that a Studentship on this Foundation will be offered for competition in the Easter Term of 1895. Candidates will have the option of being examined either in Logic and Methodology, or in Psychology. The Examination will be held at the time of the Moral Sciences Tripos: that is, not earlier than the last Monday but one in May 1895. The exact date of the examination will be announced later. The schedule of the subjects of examination will be the same as the schedules in Psychology and in Logic and Methodology for Part I. of the Moral Sciences Tripos. The competition will be open to men and women who have obtained honours in Part I. or Part II. of the *Natural Sciences Tripos*, and whose first term of residence was not earlier than the Easter Term of 1889. Candidates must send in their names not later than April 19, 1895, to Dr. Sidgwick, Newnham College, Cambridge, and must declare their intention, if successful, of pursuing a course of philosophical study. The studentship, which will be of the annual value of nearly £90, will be tenable for two years, upon the condition that at the end of the first year the student's progress in philosophical study is deemed satisfactory by the Board of Managers.

Dr. W. S. Melsome, Fellow of Queen's College, and Mr. Hubert Higgins, of King's College, have been appointed Senior and Second Junior Demonstrators of Anatomy respectively.

There are vacancies at the University's tables in the Naples Zoological Station, and at the Plymouth Marine Biological Laboratory. Applications to occupy these are to be sent to Prof. Newton, Magdalene College, by May 24th.

Prof. Macalister announces a short course of lectures in Physical Anthropology for May 16th, 19th, and 21st. The subjects are "Methods of Anthropometry," "The Races of Ancient Egypt" (at this lecture a mummy will be unwrapped and examined), and "The Races of Western Europe."

The Council of the Senate have published a Report recommending that in future all appointments of Demonstrators, and of Assistants to Professors, shall be made for a specific period not exceeding five years. At the end of this period the Demonstrator or Assistant is to be eligible for reappointment. It is also proposed that in the case of the vacancy of a Professorship, the Demonstrators and Assistant are to cease to hold office within three months of the appointment of a new Professor.

The Master, Wardens, and Commonalty of the Society of Merchant Venturers of the City of Bristol have decided that their Technical School shall henceforth be known as the Merchant Venturers' Technical College. In this connection the following nominations have been made:—Principal and Professor of Chemistry, Mr. J. Wertheimer; Professor of Mechanical Engineering, Mr. J. Munro; Professor of Electrical Engineering and Applied Physics, Mr. W. Wilson.

SCIENTIFIC SERIALS.

The Mathematical Gazette, No. 1, April 1893, 8 pp. (London: Macmillan.)—It is now matter of ancient history that a correspondence in the columns of Nature resulted in the formation, in January 1871, of the Association for the Improvement of Geometrical Teaching. The original objects of the association were threefold: to collect and distribute information as to the prevailing methods of instruction in geometry practised in this and other countries, to use its influence to induce examining bodies to frame their questions in geometry without reference to any particular text-book, and to stamp with its approval some text-book already submitted, or to bring out a new one under its own auspices. Ten years later, viz. in January 1881, the association widened its basis, though after some discussion it retained its name. The objects it had in view were now sought to be carried out by the reading of papers and raising discussions, and by the appointment of committees to report on existing defects in the usual methods, order, range, &c., in teaching special subjects—all branches of elementary mathematics and mathematical physics being included in the widened basis. Now that the association has passed its majority, it is thought that it owes its continued existence to a "widespread desire on the part of teachers of mathematics to become acquainted with the methods of other teachers." The editor of the *Gazette*, Mr. E. M. Langley, to whose long-continued and enthusiastic advocacy of its aims the Association for the Improvement of Geometrical Teaching owes so much as late secretary, hopes, through the agency of its columns, to extract from experienced teachers MSS. which have long been lurking in desk or pigeon-hole for want of a suitable organ for making them known. This new venture, which has been started in consequence of a resolution passed at the association's annual meeting in January last, is proposed to be "a terminal journal for students and teachers." The editor has to feel his way: words of encouragement have come from the far East and West, as well as from many teachers in this country. The number before us opens with a short paper, by the editor, on the eccentric circle of Boscovich. We borrow from Dr. C. Taylor's classical book on Conics the following verdict on Boscovich's work:—It is "a clear and compact treatise, which for simplicity, depth, and suggestiveness will not readily be surpassed." Dr. J. S. Mackay abstracts the first book of Gino Loria's treatise on "the exact sciences in ancient Greece," viz. that on the Greek geometers before Euclid. In addition to the works cited by Dr. Mackay, we may call attention to three notes on the history of mathematics by the Danish mathematician, H. G. Zeuthen (which have recently been published in the *Bulletin de l'Académie Royale des Sciences de Danemark* (1893). Prof. A. Lodge gives some useful approximations and reductions. Then follow some elegant solutions of examination questions, and a select number of questions for solution. A commendation of the new French journal, *l'Intermédiare des Mathematiciens* closes this No. 1. The size of the page, the clear type, and the excellent paper, should secure for the *Gazette* far more than a mere *succès d'estime*. The figures are lithographed on a separate sheet. We note one little slip—*Adam's* property for *Adams'* (p. 8.)

American Journal of Mathematics, vol. xvi. 2. (Johns Hopkins University, April, 1894.)—W. H. Metzler in compound determinants (pp. 131–150) shows how to express certain minors of a compound determinant $\Delta_{(m)}$ in terms of the minors of various orders of Δ. The paper is divided into two parts, one relating to determinants, the other to matrices. A short note follows on the order of terms in a semi-convergent series, by H. P. Manning (pp. 151–155). Writing on the addition theorems of Jacobi and Weierstrass (pp. 156–163), E. Study gives a new presentation of results connected with an investigation of the addition theorems given in Hirzel's paper, "Sphärische Trigonometrie, orthogonale Substitutionen und Elliptische Functionen" (1893). Two articles follow by A. Chessin. The first is summation of logarithmic and exponential series (pp. 164–185), the second a note on the general solution of Bessel's equation (pp. 186–7). In an article on adjustable cycloidal and trochoidal curves (pp. 188–204) Prof. F. Morley gives many interesting results in connection with these curves. The text is illustrated with several carefully drawn figures. A two-page note on induced linear substitutions, by Prof. F. Franklin, closes the number.

SOCIETIES AND ACADEMIES.

London.

Royal Society, April 19.—"Electrical Interference Phenomena somewhat analogous to Newton's Rings, but exhibited by Waves along Wires." By Edwin H. Barton, B.Sc., late "1851 Exhibition" Science Scholar.

(1) The preliminary paper (Roy. Soc. Proc., vol. liv. pp. 85–96, 1893) on this subject gave the results of a single experiment, and approximately accounted for them by a mathematical theory of the phenomena involved.

(2) The present paper discusses the question of disturbances, and gives nine experiments. Two of these are similar to the first experiment, but were made under better conditions; the others were made either to lead to these improved conditions or in confirmation of the original fundamental conclusions.

(3) The disturbances alluded to arise from the fact that the electrical waves are not suddenly lost after their first incidence upon the abnormal part of the secondary, but course to and fro until they die out. A method of avoiding the greatest disturbance due to this cause is pointed out and adopted. A correction is also calculated and applied for another disturbance which still remains.

(4) The chief experiment (Expt. v. arts. 42–48) is on interference phenomena, somewhat analogous to Newton's rings, by transmission.

(5) The experiments conclude with two examples (Expts. viii. and ix. arts. 51–62) of modifications of the secondary which produce *no* reflexion. These consisted respectively of thinner wires near together, and of thicker wires further apart, than the normal spacing. In each case the capacity was practically unaltered by the change in the wires; hence, as anticipated from the theory, no reflexion occurred.

(6) The systematic comparison of theory and experiment, made (Arts. 63–77) near the end of the paper, does not exhibit an absolute quantitative agreement. Nevertheless, the two are so far concordant in all their general features as to be mutually confirmatory, and were approved by Prof. Hertz (under whose able guidance the work was carried out in Bonn, 1892–93) as close approximations.

"On Rocks and Minerals collected by Mr. W. M. Conway in the Karakoram-Himalayas." By Prof. T. G. Bonney, F.R.S., and Miss C. A. Raisin.

Physical Society, April 27.—Prof. A. W. Rücker, F.R.S., President, in the chair.—A paper on the mechanism of electrical conduction (Part I. Conduction in Metals) was read by C. V. Burton. Considering a body not at absolute zero of temperature, the author shows that electromagnetic radiation would result in heat being degraded into a lower form of energy, if any parts of finite electric conductivity were present, and from the fact that our planet is not devoid of heat, deduces the following Theorem I.:—"In a region containing matter there may be (and probably always are) some parts which are perfect insulators, and some parts which are perfect conductors, but there can be no parts whose conductivity is finite, unless every finitely conductive portion is enclosed by a perfectly conductive envelope." This conclusion is in accordance with Poisson's theory of dielectrics, and with Ampère's and Weber's theories of magnetism and diamagnetism respectively. Theorem II. is enunciated as follows:—"In metals, and in other non-electrolytes whose conductivity is finite, the transmission of currents must be affected by the intermittent contact of perfectly conductive particles"; and as a corollary, Theorem III. is given:—"If we suppose that in a substance at the absolute zero of temperature there is no relative motion amongst the molecules or amongst their appreciable parts, it follows that every substance at this temperature must have either infinite specific resistance (which does not imply infinite dielectric strength) or infinite conductivity." Fleming and Dewar's experiments on pure metals tend to confirm this. The author then shows why, on the intermittent contact hypothesis, a conductor is heated when a current flows through it. On the assumption that in ordinary conductors the relation between the electromotive intensity in the intermolecular spaces and electric displacement is a linear one, and that the electric forces are small in comparison with the ordinary intermolecular forces, Ohm's Law is deduced. A model is next described by means of which contact E.M.F. and the Peltier effect can be represented and explained, and in considering Volta E.M.F.'s, the author points out that it is doubtful whether experiments in a perfect vacuum could decide the questions at issue in the contact-force controversy. The fact that the transparency of metals is much greater than Maxwell's theory indicates might be explained without attributing any new properties to the electro magnetic field by supposing the dimensions of molecules not quite negligible in comparison with the wave-length of light. Prof. S. P. Thompson thought the paper had an important bearing on the kinetic theory of solids. He saw no reason why Ohm's Law should be proved, for he regarded it as a definition. The President said the author represented all actions as being due to collisions, thereby introducing the same difficulties as were felt in the kinetic theory of gases, viz. that collisions would give rise to mechanical oscillations in the molecules of shriller and shriller pitch. Prof. J. J. Thomson had recently given an explanation of electrical phenomena by vortex filaments. After some remarks on the visibility of molecules by Mr. Hovenden, Dr. Burton, in reply to Prof. Thompson, said Ohm's Law, when expressed as $\frac{E}{C}$ = *a constant*, was really a law, and not a mere definition.—A communication on the design and winding alternate-current electromagnets, by Silvanus P. Thompson, F.R.S., and Miles Walker, was read by the former. The paper describes experiments showing that when the magnetic induction does not exceed 4000 (C.G.S.), the pull exerted by a laminated electromagnet on its armature is the same, whether it be excited by a continuous or by an alternating current of equal strength. For higher inductions the continuous current gives slightly greater force. Another experiment made with solenoids and the U-shaped plunger of a Brush alternate current arc lamp, gave similar results. In considering the question of winding alternate current electromagnets so as to obtain a given excitation when the current is supplied at constant voltage, it is shown that the ampere-turns are inversely proportional to the number of turns, for the impedance varies nearly as the square of the number of turns. One important property of such electromagnets when supplied at constant voltage is that they give a fairly constant pull over a long range, for as the armature moves away from the magnet the current increases, thus counteracting to some extent the effect of distance. On the other hand, the alternating voltage required to obtain a given force is much greater than that needed with continuous currents. With the armature in contact with the core the ratio of the two voltages was found to be 170, whilst separating them by 9·2 mm. reduced the ratio to 21·5. Prof. Perry pointed out that the constant pull of the alternate current magnet followed immediately from the fundamental equation $e = rc + n\dot{I}$ when rc is small, for if e be constant then $\dot{I}$ and therefore I and I^2 are constant. He was interested to see that the pulls for equal ampere-turns were the same, and indicated how the problem could be worked out mathematically when hysteresis was taken into account. Mr. Blakesley thought it better to fill the space on a magnet full of copper, rather than use wire only just large enough to carry the current, for the loss of energy would be reduced. Some of the formulæ given might be put in simpler form. Mr. Swinburne said an alternate current magnet would only give constant pull in special cases. As another rule for winding alternate current magnets, he said, wind the magnets as for continuous currents, and put a condenser in to take the same current, thereby reducing the voltage required. Mr. Blakesley said it would require a capacity of 600 microfarads to suit the magnet mentioned in the paper. Dr. Thompson, in reply, agreed with Mr. Blakesley that the condenser was impracticable in many cases.—Major R. L. Hippisley, R.E., read a paper on a graphical method of constructing the curves of current in electromagnets and transformers, and exhibited a machine for drawing these curves. Taking the ordinary equation for a simple alternate current circuit $E \sin pt - \frac{dB}{dt} = Ri$, where B is the total magnetic flux, and i the current; the author writes it in the form

$$E \sin pt - m_k L \frac{di}{dt} = Ri,$$

where L is the coefficient of self-induction of the circuit with the iron withdrawn and m_k the tangent of the inclination of the BH curve at the point corresponding to the instant considered. This equation is integrated for a short part of the cycle during which m may be considered constant giving

$$i = \frac{E}{R} \cos \theta_k \sin (pt - \theta_k) + A_k e^{-\frac{Rt}{m_k L}}$$

Methods of finding the constants in the last equation are then described, and the method of drawing the current curves step by step explained. The machine for performing the process is illustrated in the paper, and the curve for an electromagnet fed with alternating current shown. The case of a transformer without magnetic leakage is worked out at some length, and the curves of primary and secondary current determined. Dr. Sumpner said the author had used great care in working out a difficult problem more completely than usual. In cases such as arise in practice the Rt term is small, and for this case Evershed showed how to determine the current curves of a transformer when the periodic state had been reached, some five or six years ago. He (Dr. Sumpner) had also shown how to graphically determine the current curves for circuits containing iron in 1888. The author's method was, however, of more general application. Mr. Trotter inquired if whether the machine could be used in practical alternate current problems, say, for example, to predetermine the E.M.F. curve of an alternator. Major Hippisley replied to the points raised.

Geological Society, April 25.—Dr. Henry Woodward, F.R.S., President, in the chair.—Mr. A. R. Sawyer, referring to specimens exhibited by him from the Transvaal, Orange Free State, Cape Colony, Mashonaland, and Matabeleland (the last mentioned collected during the recent war), remarked that gneisses and gneissose granites cover a large portion of Mashonaland, together with patches of schistose rocks and a few stratified rocks. He drew attention to the fantastic shapes assumed on weathering by the granitic gneiss, which he considered solely due to atmospheric agencies, and not to ice-action or to the effects of submersion. The schistose rocks are, for the most part, sheared and altered igneous masses. There are numerous examples of dolerites and epidiorites passing into hornblende-schists, and of more acid igneous rocks. Masses of magnetite occur in various parts of Mashonaland, and serpentinous rocks (which probably owe their origin to the alteration of peridotites) in the north-west corner of the Victoria gold-field. Extremely auriferous veins occur amongst the sheared acid igneous rocks of the Umhungwe Valley in the Manica district, and gold occurs in the kaolin produced by the disintegration of these rocks.—The following communications were read:—Further notes on some sections on the new railway from Romford to Upminster, and on the relations of the Thames Valley beds to the boulder clay, by T. V. Holmes. The author alluded to his discovery of boulder clay on this new railway at Hornchurch (*Quart. Journ. Geol. Soc.* August 1892), and described the finding of more boulder clay close to Romford during the deepening and widening of a cutting there. The boulder clay was on precisely the same level as that at Hornchurch, a mile and a half to the south-east, and, like it, was covered by gravel belonging to the highest, and presumably oldest, terrace of the Thames Valley system. A portion of the silted-up channel of an ancient stream-course was also found in this Romford cutting. Its relations to the boulder clay could not be seen, as they were not in contact, but they were alike covered by the oldest gravel belonging to the Thames Valley system. The author discussed the probable direction of the flow of this stream-course, and the way in which it was superseded by the ancient Thames. After noticing certain points brought forward during the discussion on his former paper, he concluded with a criticism on the views to which Dr. Hicks inclines in his paper on the sections in and near Endsleigh Street (*Quart. Journ. Geol. Soc.* vol. xlviii. 1892) as regards the age of those beds, asserting that they are, in all probability, simply river drift of the Thames Valley system, and consequently post-glacial, in the sense of being later in date than the boulder clay of Essex and Middlesex.—On the geology of the Pleistocene deposits in the valley of the Thames at Twickenham, with contributions to the flora and fauna of the period, by Dr. J. R. Leeson and G. B. Laffan. The section described in this paper was exposed during the construction of an effluent from the Twickenham sewage-works to the Thames. Its length was about one mile. The beds exposed were (1) coarse reddish-yellow gravels, coloured blue below, lying on an eroded surface of (2) dark blue loam, varying in thickness, the greatest thickness seen being three feet, at a place where the bottom was not reached; (3) dark sand; (4) coarse ballast gravel; (5) London clay. The loam (which is quite a local deposit) yielded eight species of mollusca and fourteen species of plants, all still living in the neighbourhood. A number of mammalian bones, referable to seven species, were lying just on the surface of the loam. Amongst the forms were bison and reindeer. The authors consider that the loam was deposited in a small lake, and they alluded to similarities between it and a deposit described by Dr. Hicks as occurring in the Endsleigh Street excavations. In the remarks on these two papers, the President congratulated the authors of the second paper on having succeeded in rescuing so interesting a collection of remains of Thames Valley mammalia. Sir John Evans expressed his pleasure at Mr. Holmes's further discovery of evidence as to the superposition of the old Thames Valley gravels upon the boulder clay, as these discoveries supported the view he had always held that these gravels, whether at a high or at a low level, were "post-glacial" in the sense indicated by the author. He also remarked that the finding of the mammalian remains by Dr. Leeson in the low-level gravels at Twickenham was of interest, as proving the existence of the reindeer and bison in the Thames at the time of the deposition of these beds. As to some of the remains of other animals, however, he entertained doubts whether, though found in the course of the excavation, they really belonged to the gravels. Mr. E. T. Newton, Mr. Lewis Abbott, Mr. G. B. Laffan, Prof. Hull, and Dr. Leeson also spoke, and Mr. T. V. Holmes briefly replied to the remarks made on his paper.—On a new goniatite from the lower coal measures, by Herbert Bolton. Sowerby in his "Mineral Conchology" figures two fossils under the name of *Goniatites Listeri*, of which the left-hand figure is clearly *G. Listeri*, whilst the right-hand one differs considerably from it. The author gave diagnoses of *Goniatites Listeri* and of a new species, which agrees with the form represented in Sowerby's right-hand figure. This species is limited to the shales forming the roof of the "Bullion" or upper foot seam of the lower coal measures, whilst *G. Listeri* ranges from the lower limestone shales to the "Bullion" seam.

Chemical Society, April 19.—Dr. Armstrong, President, in the chair.—The following papers were read:—The magnetic rotations of fatty acids containing halogens; of acetic and propionic acids, phosgene and ethylic carbonate, by W. H. Perkin. The molecular association investigated by Ramsay and Shields is apparently without influence on the magnetic rotations of acetic and propionic acids. In a number of cases where two similar atoms or groups of atoms enter a compound by substitution, the change in magnetic rotation caused by the entrance of the first group is different to that caused by the second; as the President pointed out, Thomsen has observed an analogous phenomenon in his thermochemical investigations. —The action of concentrated acids on certain metals when in contact with each other, by G. J. Burch and J. W. Dodgson. The authors are investigating the chemical and electrical behaviour of different pairs of metals in contact when placed in the strong mineral acids. Very slow action occurs when a piece of sodium impaled on a strip of platinum, iron, or carbon, is placed in concentrated sulphuric acid; the sodium of a sodium-carbon couple requires more than eight hours for its solution in sulphuric acid.—The action of light on oxalic acid, by A. Richardson. Oxalic acid, exposed to light, is slowly decomposed with formation of hydrogen peroxide and carbonic anhydride.—English jute fibre, by A. Pears, jun.—Natural oxycelluloses. I. Celluloses of the *Gramineæ*, by C. Smith.—Preliminary note on the volatilisation of salts during evaporation, by G. H. Bailey. During the evaporation of salt solutions a considerable amount of the salt is volatilised, although every precaution be taken to guard against mechanical loss. Cæsium chloride solution containing 286 grams to the litre lost 18·86 milligrams of salt per litre during evaporation.—Constitution of glycocine and its derivatives, by Joji Sakurai. The author considers that glycocine must be regarded as an internal ammonium salt of the constitution

$$\begin{array}{l} CH_2\text{—}NH_3 \\ |\qquad\ \ | \\ CO\text{—}O \end{array}.$$

Similar views of the constitutions of hippuric acid, aspartic acid, and asparagine are also expressed.—Note on the constitution of glycocine, by J. Walker. Reasoning by analogy, the evidence afforded by the electrical conductivity goes to show that glycocine has the ordinarily accepted constitution

$$NH_2 \,.\, CH_2 \,.\, COOH.$$

—On the oxidation of the alkali metals, by W. Holt and W. E. Sims. Potassium, sodium, and probably lithium may be distilled in perfectly dry oxygen without undergoing oxidation; potassium monoxide, K_2O, is not formed by the oxidation of the metal in any of the oxides of nitrogen, as is generally supposed, and there is no evidence of its existence in the pure state.—The action of iodine and of methyl iodide on aconitine, by W. R. Dunstan and H. A. D. Jowett.

Zoological Society, May 1.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—The Secretary read a report on the additions that had been made to the Society's menagerie during the month of April 1894, and called special attention to a valuable collection of mammals presented to the Society by Dr. J. Anderson, F.R.S., being part of the proceeds of his recent expedition to Egypt.—Dr. Günther, F.R.S., exhibited and made remarks on specimens of a South African Hornbill (*Buceros melanoleucus*) and of a portion of the tree in which the nest was placed, and spoke of its mode of nesting and of its extraordinary habits during that season. The specimens had been transmitted to the British Museum by Dr. Schonland of Grahamstown.—Dr. H. E. Sauvage exhibited a vertebra of the earliest known Snake from the gault of Portugal.—Mr. W. Bateson exhibited a large number of specimens of *Gonioctena variabilis*, a Phytophagous Beetle from Spain, in illustration of discontinuous variation in colour.—Prof. F. Jeffrey Bell gave an account of the Echinoderms collected during the voyage of H.M.S. *Penguin* and by H.M.S. *Egeria*, when surveying Macclesfield Bank. The collection, which had been made by Mr. P. W. Bassett Smith, with the co-operation of Mr. J. J. Walker, was very extensive, and contained examples of many new species, some of which were of a very remarkable character. —Mr. Ernest W. Holt gave an account of some of the results of his recent studies in teleostean morphology made at the Marine Laboratory at Cleethorpe. Mr. Holt spoke first of some specimens of the Birkelänge (*Molva abyssorum*, Nilsson). The regular occurrence of this fish off the Faroe Islands and its occasional capture on the coast of Iceland were now recorded for the first time, the species having been previously observed only on the Scandinavian coasts. The specimens, six in number, all of considerable size, were described in detail, and the species was carefully compared with the allied form *M. vulgaris* (the Common Ling). Mr. Holt next proceeded to describe the "*recessus orbitalis*," an accessory visual organ of the Pleuronectid Fishes. The organ in question was stated to be a highly elastic saccular process of the membranous wall of the orbital cavity. It had been found to occur in all the flat-fishes examined, viz., the Halibut, Long Rough Dab, Brill, Plaice, Flounder, Lemon-Sole, Dab, and Common Sole, and was believed to occur in all flat-fishes with well-developed eyes. Finally, Mr. Holt spoke of an adult specimen of the Common Sole with symmetrical eyes, and discussed the bearing of this specimen on ambicoloration. The specimen in question, about fifteen inches long, was perfectly normal in external configuration, except that the left eye had retained its position on the left side of the head, and was nearly opposite to the right eye. Antero-ventrally it had been somewhat overgrown by the skin. The coloration was normal, the right side being brown and the left side white.—A communication was read from Mr. St. George Littledale, containing field-notes on the Wild Camel of Lob Nor, as observed during his recent journey across Central Asia.—Mr. Oldfield Thomas gave an account of a collection of mammals from Oman, S.E. Arabia, which had been transmitted to the British Museum by Dr. A. S. G. Jayakar, among which were examples of a new Hare (*Lepus omanensis*) and of a new Goat of the genus *Hemitragus*, proposed to be called *jayakari*, after its discoverer. Altogether seventeen species were represented in this collection, from a locality of which very little was previously known.

Linnean Society, May 3.—Prof. Stewart, President, in the chair.—Dr. Johann Mueller, of Aargan, and Prof. K. Mitsickuri, of the University of Tokio, were elected foreign members of the Society.—Prof. Poulton exhibited the larvæ of certain Lepidoptera to illustrate the results of experiments which he had made in regard to the influence of environment upon their colours. Variously coloured twigs and shoots, such as occur in nature, were shown to influence the appearance of many twig-like larvæ in such a manner as to aid their concealment.—Prof. G. B. Howes exhibited and made remarks upon the eggs and young of *Ceratodus Fosteri*, received from Prof. Semon, of Jena, who is engaged in working out the development of this fish.—Mr. James Saunders, of Luton, with the aid of the oxyhydrogen lantern, exhibited plasmodium in the act of forming sporangia; the species, which had been found on birch, was *Didymium squamulosum*.—On behalf of Dr. H. B. Guppy, the Secretary read a paper on the habits of three species of *Lemna*. In this paper, the author detailed the results of experiments made by him during a period of twenty months, and showed that *Lemna gibba* can pass the winter either in the gibbous form or with fronds which in appearance resemble those of *Lemna minor*. The flowering of *Lemna gibba* was observed in July, when it was found that the gibbous plants were producing their flat fronds, which were also in flower, and floating detached. In both cases the flowers were hermaphrodite, but they had the appearance of being unisexual, on account of the flowers of the gibbous plants protruding only the pistil, while those of the flat fronds only evolved the stamens. After describing the habits of the winter fronds of *Lemna polyrhiza*, and alluding to *Lemna minor*, the paper concluded with a table of temperatures relating to the germinating, budding, and flowering of these plants.—A paper was then read on the fertilisation of certain Malayan orchids, by Mr. H. N. Ridley.

Entomological Society, May 2.—Captain Henry J. Elwes, President, in the chair.—Mr. S. Stevens exhibited a specimen of *Argynnis aglaia* var. *charlotta*, taken by the late Rev. James Watson in the New Forest in 1870.—Mr. J. A. Clark exhibited a curious variety of *Chelonia caja*, having an extraordinary wedge-shaped marking extending from the outer margin to the base of the left hind wing, and also, on the same wing, a small spot, which was brown and white in colour, and had the appearance of having been taken from the fore wing and inserted in the hind wing. The specimen was taken at Abbotts Wood, Sussex, in July 1892.—Prof. E. B. Poulton, F.R.S., exhibited living specimens of the larvæ of *Gastropacha quercifolia*, surrounded respectively during the early stages of growth by black twigs and lichen-coloured twigs, the food being the same in both cases. All the larvæ were shown upon a white paper background, but examples of the surrounding twigs which produced the change of colour were shown beside each batch. Mr. Merrifield made some remarks on the subject.—Mr. E. Meyrick communicated a paper entitled "On *Pyralidina* from the Malay Archipelago."—Mr. C. J. Gahan read a paper entitled "A Supplemental List of the Longicorn Coleoptera obtained by Mr. J. J. Walker, R.N., during the voyage of H.M.S. *Penguin*."

PARIS.

Academy of Sciences, May 7.—On the spectra of oxygen at high temperatures, by M. J. Janssen.—Researches on the isomeric propylenes and their compounds with sulphuric acid, by M. Berthelot. Trimethylene is rapidly absorbed by pure sulphuric acid forming the normal ethereal salt $(C_3H_7)_2SO_4$. On addition of water it separates as a heavy oil which is only very slowly acted on by water and is decomposed by potash slowly in sealed tubes at 100°. Ordinary propylene combines with sulphuric acid in the same way to yield a much less stable derivative.—On *Flabellum anthophyllum* from the Gulf of Lyons, by M. de Lacaze-Duthiers.—Articular movements studied by means of photography, by M. Marey. Photographs are taken in successive positions of a bright wire attached to the moving part. The results of a study of human jaw movements are given.—Report of M. Darboux on a memoir on the triangle of sequences (presented by M. Désiré André).—Azimuth, latitude, and longitude, by equal heights without the aid of the chronometer, by M. E. Caspari. The method described is held to have many good characteristics, among which the fact of the same precision being obtained for all latitudes and all zenithal distances is noted.—Experiments on the contraction of liquid jets and on the distribution of velocities internally: abstract of a memoir by M. Bazin.—Mathematical theory of the Watt indicator: abstract of a memoir by M. L. Lecornu.—Observations of the comet Gale, made at Algiers Observatory, by MM. Rambaud and Sy. M. Tisserand gave details concerning a photograph of this comet obtained on May 5, at Paris. The photograph shows the comet with a tail 4° in length.—Emission of sounds, by M. Henri Gilbault.—Equality of the speeds of propagation of very short electric waves in free space and in long wire conductors, by M. M. Dufour. The author experimentally demonstrates the extension of MM. Sarasin and de la Rive's conclusions on the subject to the case of a wave-length of 8·5 cm.—Absorption spectra of cupric bromide, by M. Paul Sabatier. The spectral absorption of aqueous solutions varies with the concentration; alcoholic solutions give the same absorption spectrum as concentrated aqueous solutions, probably the salt here exists in the anhydrous condition.—On the variations of viscosity shown by melted sulphur, by MM. J. Brunhes and J. Dussy.—On the blue lakes obtained from dibromogallanilide and on some reactions yielding blue products of polyphenols, by M. P. Cazeneuve.—On a new carbon chloride, the dichloride of hexachlorobenzene, by M. Et. Barral. The properties are described of the substance C_6Cl_8 obtained from hexachlorophenol by action of PCl_5.—On the aldehyde from essence of lemon grass, by MM. Ph. Barbier and L. Bouveault.—On the industrial manufacture of products rich in nicotine, by M. Th. Schlœsing.—On the oxidation of beer worts, by M. L. Petit.—Researches on the chemical transformations of the fundamental substance of cartilage during normal ossification, by M. C. Chabrié.—On some points in the anatomy of Cryptoproctus from Madagascar, by M. H. Filhol.—The perfume glands of Viverridæ, by M. H. Beauregard.—The sexual reproduction of Ascomycetes, by M. P. A. Dangeard.—The lacustrine basin of Constantine and oligocene formations in Algeria, by M. E. Ficheur.—Examination of milks by pressure, by MM. R. Lezé and E. Hilsont.—On the *réclamation*, by M. Calmette, concerning the antitoxic blood of animals protected against the poison of serpents, by MM. C. Phisalix and G. Bertrand.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Notes on the Ventilation and Warming of Houses, &c.: Prof. E. H. Jacob (S.P.C.K.).—Simple Experiments for Science Teaching: J. A. Bower (S.P.C.K.).—Practical Botany for Beginners: Prof. F. O. Bower (Macmillan).—Alternating Generations; a Biological Study of Oak Galls and Gall Flies: Dr. H. Adler, translated and edited by C. R. Straton (Oxford, Clarendon Press).—Lux Naturæ: D. Sinclair (E. Stock).—Monograph of the Stalactites and Stalagmites of the Cleaves Cove, near Dalry, Ayrshire: J. Smith (E. Stock).—Fallen Angels: One of them (Gay and Bird).—The Steam-Engine and other Heat-Engines: Prof. J. A. Ewing (Cambridge, University Press).—Creatures of other Days: Rev. H. N. Hutchinson (Chapman and Hall).—Theorie des Fernrohrs auf Grund der Beugung des Lichts: K. Strehl; 1 Theil (Leipzig, Barth).

PAMPHLETS.—Tertiary Tipulidæ: S. H. Scudder.—Zweiter Jahres-Bericht des Sonnblick-Vereines für das Jahr 1893 (Wien).—Lost British Birds: W. H. Hudson (Society for the Protection of Birds).—Tracks for the Times (London).

SERIALS.—American Journal of Science, May (New Haven).—Bulletins de la Société d'Anthropologie, January (Paris).—Mémoires de la Société d'Anthropologie de Paris, tome 1 (3e series), 3e fasc. (Paris).—American Meteorological Journal, May (Ginn).—Engineering Magazine, May (New York).—Proceedings of the Chester Society of Natural Science and Literature, No. 4 (Chester).—Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. 8 No. 2 (Manchester).—Psychological Review, Vol. 1, No. 3 (Macmillan).—Astronomy and Astro-Physics, May (Wesley).—Actes de la Société Scientifique du Chili, tome 3, 3e Livn (Santiago).

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THURSDAY, MAY 24, 1894.

PRACTICAL PAPER MAKING.

Practical Paper Making. By George Clapperton. (London: Crosby Lockwood and Son, 1894.)

THE book before us is not without value. The chapters devoted to paper-making proper, that is, to the mechanical details of the art, contain a great deal of useful information; and although "experience" must be classed as of the "incommunicables," the notes and observations of an experienced man serve to concentrate the attention of the less experienced upon those points, the mastery of which constitutes technical skill. Technological handbooks, however, ought in our opinion to possess the higher *educational* value belonging only to those which preserve the perspective of the subject of which they treat. A book, like a lecture, must be diagrammatic to be effective educationally; and in this sense it must be an artistic production. We do not by any means imply that a certain level of literary style must be attained and maintained. In the "literature" of the industrial and physical sciences we must be content, it would seem, with the irreducible minimum of "Queen's English." What we do imply is the infusion of personality, in the clear grasp of principles, and in the consequent development of the subject-matter according to its natural perspective. Judged from this stand-point, "Practical Paper Making" must be labelled "found wanting." If we apply to the art or industry the crude criterion of money values, we find that in the production of paper the proportion of costs, for raw materials, and their chemical treatment, are in this, in comparison with many other industries, unusually high; this being "practically" interpreted, means that chemistry is of first importance in the mill. The author makes an oblique confession of his convictions in this direction in his opening sentence: "As the chemical and physical characteristics of the materials . . . . determine to a marked degree the qualities of the finished product, a thorough grasp of these characteristics is indispensable to all who aim at the production of the best possible results with the minimum of cost." We are quickly reminded, however, of the adage, "red dawning shepherd's warning," as the author plunges at once from the sunshine of first principles into a much less promising treatment of practical matters, opening with the following remarkable sentence:—

> "The percentage of cellulose—or to use a term more readily understood by paper-makers, the amount of available paper-making material—varies with the plants from which it is obtained, and the treatment to which it is subjected. . . . ."

Comment would be superfluous. He then proceeds to extract comfort from "the chemical formula of cellulose—$C_6H_{10}O_5$—which means that six equivalents of carbon, ten of hydrogen, and five of oxygen are united together to form the substance known by that name." This evidently has the effect upon the practical paper-maker which is recorded of the "blessed word Mesopotamia" in another sphere of experience. That is all as to cellulose proper! "Oxycellulose" is then alluded to, and described as possessing "an extraordinary affinity for *vanilline* compounds, uniting with them from solutions containing infinitesimal proportions." It would be thankless criticism to single out mere mistakes from what might be in other respects good matter; but the mistakes in this work are as slovenly as the matter—"vanilline" for "vanadium" (p. 2), and "hypochlorite," used on three successive occasions, for "hyposulphite" (pp. 29-30), are typical mistakes; and for looseness of construction, which characterises the matter throughout, we commend the following example:—"Sulphate of alumina is not a chemical compound of a definite composition, as the alumina varies between 2 and 3 per cent., though that purchased from reliable makers generally contains 15 or 16 per cent." (pp. 71-72). If the author's want of precision were an occasional lapse merely, with the effect of befogging a particular point, we should not have challenged the work upon the issue we have raised; but it extends to the entire ordering and treatment of the subject-matter. The sources from which the author has compiled his account of the chemical processes of the mill are familiar to us. He has probably aimed at reproducing what he may consider the essential and practical features of the originals. But the result is a second-hand and garbled version, and in many important places, more especially where effects are discussed in relation to causes, essentially wrong. Thus (p. 6) "jute fibres" are described as "strong but very difficult to bleach white, and if subjected to such treatment as will dissolve all the extraneous matter and reduce to ultimate fibres, their original strength is much impaired." The facts are that jute is easily bleached white, but then is no longer jute but jute-cellulose; and on the structural question the destruction of the *filament* by no means implies disintegration of the *ultimate fibre*. Then again (p. 7), "Straw fibres are very similar in appearance to esparto, but shorter and more highly polished, tending to make their filling power much less, and rendering paper made from them very brittle." In another place (p. 47), "Papers made from straw are, owing to the hard nature of the ultimate fibres, very hard and brittle." Any explanation appears to some minds better than none, even a re-statement of the fact to be explained, in somewhat varied terms. It does not occur to the author that straw "cellulose" differs constitutionally from esparto, and with these differences are correlated not only the relatively low yields of bleached straw pulp (which the author labours to explain on p. 40), but generally its relationships to oxygen and water (hydration), and these again with its paper-making qualities.

It would serve no useful purpose to continue our criticisms. The best we can say of the work is that it represents a good deal of thought on the part of a man skilled in his art, and struggling to compass the science upon which its successful practice primarily depends. It may be that in this endeavour the author has followed the classic maxim: "If you want to learn a subject, write a book upon it."

To those who will bear in mind that the chemical part of the work is a compilation, not well digested, and in some places unsound, we have no hesitation in recommending it.

E

THE THEORY OF OPTICAL INSTRUMENTS.

Theorie der Optischen Instrumente nach Abbe. Von Dr. Siegfried Czapski. Breslau: Eduard Trewendt, 1893.

HAPPENING not long ago to meet a German friend well posted up in physical literature, the present writer inquired whether any of the year's publications were specially worth getting and reading. The answer was a doubtful "No," and then "Oh, yes—Czapski's 'Theory of Optical Instruments.'" This was high praise, but not unmerited. For although the book will not appeal to a large circle of readers, it will soon become indispensable to all who are interested in the investigation of the merits and defects of optical systems, or who are concerned in turning out high-class optical work.

Although only a third of the book is devoted to the description of the microscope, telescope, and other instruments. there is no unnecessary rambling beforehand —either into the pleasant regions of developmental history or along the more dusty paths of the optical text-book proper. The author acknowledges the value of the undulatory theory as the ultimate test which must be applied when we wish to know how far the conclusions of geometrical optics are valid; and therewith dismisses it. He everywhere tries to be concise: and succeeds so far that the average student might complain of sometimes finding a day's work between one page and the next. But the condensation is not of that meaningless kind which so often irritates one in German school and college text-books. There are frequent (and valuable) bibliographical notes. The references to the works of Smith, Herschel, Lloyd, Airy, Rayleigh, Dallinger, and Pendlebury show that the English literature has not been neglected; indeed, Principal Heath's "Treatise on Geometrical Optics" (which is being translated into German) is recommended as the best of the modern text-books. But whereas these tend to treat optical instruments as convenient illustrations of optical theory or geometrical reasoning, the latter are here treated as strictly subservient to the former. The range is further limited by including among optical instruments only those which are strictly used for producing images of external objects—applications of reflecting mirrors in geodesy and astronomy, the stereoscope, &c., being included. Within these limits our author is at home and speaks with authority. As scientific adviser and technical director in the celebrated workshops of Carl Zeiss in Jena, he has daily opportunities of applying theory to practice with the aid of excellent glass, skilful workmen, and modern machinery; and has had the still greater advantage of continual intercourse with Prof. Abbe, to whose labours the perfection of high-power microscope objectives is so largely due. His debt in this direction is freely and gratefully acknowledged—most conveniently by stating what chapters are not directly or indirectly due to Abbe.

A short introductory chapter on geometrical optics is followed by three others on the geometrical theory of optical images, the fundamental properties of lenses and systems of lenses, and the theory of spherical aberration. In chapter v. (on chromatic aberration and the theory of achromatism) the author gives a simple method for calculating the magnitude of the secondary spectrum (the focus-difference) of a system of two infinitely thin lenses from the dispersion-constants. Assuming these to be achromatised for the lines F and C, he calculates the difference between the focus for light of a given wave-length (λ) and the light of the brightest part of the spectrum $\lambda = 0.55\ \mu$. (According to König the position of maximum brightness in the spectrum of sunlight varies, as the total intensity increases, from $\lambda = 0.53\ \mu$ to $\lambda = 0.61\ \mu$.) The values of the differences $f_\lambda - f_{0.55\,\mu}$ are given in thousands of $f_{0.55\,\mu}$ for various wave-lengths. In the case of a combination of a flint glass of medium density with an English silicate-crown glass the differences decrease from + 1.79 (for $\lambda = 0.77\ \mu$) and then gradually increase to 3.70 (for $\lambda = 0.41\ \mu$). But the researches of Prof. Abbe and Dr. Schott have resulted in the production of improved grades of optical glass, and especially of pairs of flint and crown glass in which the dispersion in various parts of the spectrum is much more nearly proportional. These glasses have been manufactured in the Jena works since 1884, and by their use the magnitude of the secondary spectrum is greatly diminished. Thus in the case of a combination of a heavy barium-phosphate-crown glass with a borate-flint glass the above differences begin at 0.04 (for $\lambda = 0.77\ \mu$) and the maximum value is 0.79 (for $\lambda = 0.41\ \mu$). Curves are given illustrating these results which have been confirmed by direct measurements of focus-differences of telescope-objectives made by Vogel, Hasselberg, and Wolf.

Chapter vi. contains an unusually complete and systematic treatment of prisms and systems of prisms, partly based upon Dr. Czapski's own investigations. The next chapter is devoted to stops and aperture, and the properties of an optical system which depend upon aperture, such as penetrating power and brightness. It is shown that in any instrument used for subjective observation the penetrating power (*i.e.* the total depth of vision) is exactly equal to the sum of the depth of focus of the objective and the accommodation-depth of the eye—a result which is of the greatest practical importance in microscopy. Next comes what is perhaps the most interesting and important chapter—that which deals with the principal types of optical instruments. The book closes with an account of the methods for determining the constants of optical instruments. Some of these will come as a revelation to students who are only familiar with the comparatively rough methods described in the ordinary text-books on practical physics.

Dr. Czapski appears to have at first intended to include in the book a tolerably full account of Abbe's theory of microscopical vision. One cannot help regretting that this intention was abandoned. A letter of his on "The Future of the Microscope," which is printed in van Heurck's sumptuous book ("The Microscope," English edition, pp. 357–364) shows his ability to present such a matter, not only with his usual accuracy, but in a fairly popular form. We understand that a separate volume on this subject may be expected from Prof. Abbe or Dr. Czapski, or both.

pv.

CHEMISTRY APPLIED TO AGRICULTURE.

Manures and the Principles of Manuring. By C. M. Aikman, B.Sc., F.R.S.E. Pp. xxx., 592. (Edinburgh and London: W. Blackwood and Sons, 1894.)

IT was rather more than fifty years ago, in the year 1840, that Liebig presented to the British Association his classical report on "Organic Chemistry in its Applications to Agriculture and Physiology." In tbis, among many bold and startling statements, we find such sentences as the following:—"As there is no profession which can be compared in importance with that of agriculture, so there is none in which the application of correct principle would be productive of more beneficial effects. Hence it appears quite unaccountable that we may vainly seek for a single leading principle relative to this subject in all the writings of agriculture and of vegetable physiologists." "Also, when we inquire in what manner manure acts, we are answered by the most intelligent men that its action is covered by the veil of Isis; and when we further demand what this means, we discover merely that the excrements of man and animals are supposed to contain an incomprehensible something which assists in the nutrition of plants and increases their size. This opinion is embraced without even an attempt being made to discover the component parts of manure, or to become acquainted with its nature." In this, as in other of Liebig's statements, there was much exaggeration. Sir Humphrey Davy, De Saussure, and other labourers in the field of scientific agriculture had not lived in vain. Liebig's writings, however, were productive of much good, and stirred up a great deal of interest in agricultural chemistry which led to many important results. Within a year or two before the date mentioned and five or six years after, not only were most of the more important artificial manures, now extensively used, brought into notice and experimented with, but several important writings on manures and manuring were published Suffice it to say that to this epoch is due the introduction of guano, of nitrate of soda, and of sulphate of ammonia as manures; and that Mr. Lawes (now Sir John Bennett Lawes) took out his patent for the manufacture of superphosphate in 1842; now nearly a million tons of this manure are made annually in this country alone. Two or three important manures, such as the potash salts of Stassfurt and Thomas' basic slag, are of later introduction. To illustrate the attention then given to the subject of manures and manuring generally, and to these new manures in particular, we may note that the second volume of the *Journal of the Royal Agricultural Society of England*, published in 1841, contains a paper by the Sibthorpian Professor of Rural Economy at Oxford, Dr. Charles Daubeney, "On the scientific principles by which the application of manures ought to be regulated," including results of many experiments; also an article by Prof. J. F. W. Johnston, "On Guano," and the results of experiments by numerous agriculturists with nitrate of soda, saltpetre, bones, and gypsum.

Within a very few years of this date Prof. Johnston published his Lectures, and Cuthbert W. Johnson published a very useful and interesting book "On the Fertilisers." It is almost needless to remark that the immortal experiments of Rothamsted were put on to a firm and systematic basis in 1843.

Since that time agricultural chemistry, including a knowledge of the principles of manuring, has steadily pursued its way, fostered by a host of workers, not only in this country but on the continent, and lately in the United States. The last few years have shown some revival of the public interest in the applications of science to agriculture. This has, we think, been brought about partly by the spread of technical education in the rural districts; but also partly byt he continued low prices of agricultural produce, which make it imperative on the farmer, if he would continue to survive, to use every good implement, mental or otherwise, he can in furthering his business.

Although many little books have been lately published in this country on the subject of manures, we may safely say that none of them are so satisfactory as that of Mr. Aikman. Though in some respects incomplete, it is a welcome addition to the literature of the more scientific side of agriculture. The first part of the book is a short historical introduction of 60 pp.; this is good, but too short. Part ii. is on the principles of manuring. It deals with the fertility of the soil, illustrated by and due to its physical, chemical, and biological properties; with the functions performed by manures, and the positions occupied by nitrogen, phosphoric acid, and potash in agriculture, and with nitrification in soils. The treatment of the biology of the soil is all too scanty. Part iii., more than half the book, treats of manures. The most important chapter is on the most important manure—farmyard manure—and this is well treated. Other chapters are on guano, nitrate of soda, sulphate of ammonia, bones, mineral phosphates, superphosphates, basic slag, potassic manures, indirect manures, which include lime, gypsum and salts, the application of manures, manuring of farm crops, the valuation and analysis of manures; and a final chapter giving the results of some of the Rothamsted experiments. There is a very short chapter on sewage, which is inadequately dealt with, and the minor manures are very scantily treated; seaweed is not even mentioned as a manure, and rape-cake and other oil-cakes are only casually alluded to. Generally, Mr. Aikman has done his work carefully and well, and presented the results in a clear and readable form, which will commend itself to his readers. As we confidently expect a new edition ere long, we may perhaps be pardoned for pointing out some of the minor defects of the book. More frequent references should be given to original papers; this might be done without unduly enlarging the volume. The explanation of "unit" values of manurial ingredients is hardly intelligible to one who first comes across it here. On p. 380, the last sentence is wrong; probably the word *only* is omitted. On p. 43, Beyerinck would hardly recognise his name in the way it is spelt; why should the words *glycin* and *glycocoll* be used on consecutive pages as though they denoted different substances; why should carnallite be sometimes spelt with a *c* and sometimes with a *k*, even in the index; also why are sylvine and kainite denied the final *e* usually accorded to minerals in this language?

The scheme of experimental plots, on p. 546, would be made more complete by including an eighth plot manured with phosphates, potash, and nitrogen. The valuation of unexhausted manurial residues, whether derived directly from manures or from foods, might well receive more attention.

The book is a genuine effort to treat the subject scientifically, and at the same time in a manner intelligible and interesting to the farmer of good education. We think it has succeeded. E. K.

LATITUDE BY EX-MERIDIAN ALTITUDE.

The "Ex-Meridian" treated as a Problem in Dynamics, &c. By H. B. Goodwin. (London: George Philip and Son, 1894.)

THE author of this brochure, with a tinge of satire, seems to apologise for its containing nothing about the already exhaustively developed Sumner method. In doing this he alludes to "the too just Aristides." This reminds us of a saying of that practical philosopher, that "the best way to appear just is to be so." The proverb may teach us that the way to obtain dependable results is to have a firm grasp of principles, that the most reliable navigator is one who understands the theory of his problems.

This remark is apposite, for we can conceive many a "simple sailor" being rather frightened at the title of this pamphlet which will first meet his eye, and we hear him say—"Cannot the seaman continue to navigate his ship without learning dynamics?" If he has courage to read a little further on, he finds that his belovedly simple "Sun Mer. Alt." connected with such words as "maximum" and "minimum." Hitherto he has banished the word "maximum" from his thoughts by avoiding the use of the moon and planets for finding the latitude at their culmination; considering that the problem—"To find the time when the moon and planets are at their maximum altitudes" to belong to "the gymnasium of the examination room" rather than to "the arena of every-day practical utility." But now he finds that modern ships require this problem to be considered with reference to all the celestial bodies, and that even the sun may be capricious enough not to "dip" at noon, that, in fact, instead of this phenomenon giving a meridian altitude it gives an ex-meridian altitude which has to be reduced to the meridian.

There is reason to be thankful for this new feature, because it will attract more attention to the hitherto shamefully neglected method of the ex-meridian among ordinary navigators. That this can be no longer thus relegated is exemplified by Mr. Goodwin, as follows:—

"In the *Standard* newspaper of October 23, 1893, it is stated that H.M.S. *Royal Sovereign*, flag ship of the Channel Squadron, had arrived at Gibraltar, having made the passage in less than seventy hours. Such a passage as this has ceased to be regarded as phenomenal, and is looked upon as quite an every-day occurrence. For a portion of the voyage a speed of over fifteen knots was maintained, and on board a ship steaming at this rate nearly due south, at that time of year, the sun would not appear to 'dip' until more than five minutes after noon, and a correction of nearly 45" would be necessary to reduce the maximum altitude to the meridian."

As the ship moves south a fresh horizon comes into view, and the sun will appear to rise until this shift of the horizon (the rate of which depends upon the rate of the ship towards the sun) is less than the rate of his motion in altitude.

There is another reason for being thankful for the sun having to be thus treated at the noon-day observation. It will lead to the moon and planets being no longer avoided for finding the latitude at the time of their culmination. No celestial bodies are more useful for such a purpose, especially at twilight, when a well-defined horizon is frequently available.

Every practical navigator daily uses the *Nautical Almanac*: it would be well if he devoted a short time also to study the "Explanation" at the end of the volume. In explaining "*Var. in* 1 *hour*" which occurs on every page I. of the book, it is stated that this "is the variation at *noon*, and requires to be reduced to midway between noon and the time at which the R.A., Dec., or Eq. of time is required"; in other words, the reduction of the quantities from apparent noon to any other time is a problem in dynamics. The moving body is subject to a uniform acceleration in the direction of its motion, and the space described in a given time is found by multiplying the *mean velocity* during the time by the given time. The same principle applied to the ex-meridian problem gives the result that the reduction is equal to the rate of change of altitude per half-minute of time, multiplied by the number of minutes of time from the meridian.

So far from decrying the rapid methods now so needful in practice, the author advocates their further use. He gives a "Method of solving the Ex-meridian Problem practically by the Azimuth Tables," which are, or should be, in the hands of every navigator, and also "Practical Rules for finding Time of Maximum Altitude," and ends with "Application of the Azimuth Tables to other Problems."

We can heartily recommend this short contribution to the science of nautical astronomy in its application to the practical requirements of modern navigation.

PERFUMERY.

Odorographia: a Natural History of Raw Materials and Drugs used in the Perfume Industry, including the Aromatics used in flavouring. Intended for the use of Growers, Manufacturers, and Consumers By J. Ch. Sawer, F.L.S. Second Series. (London: Gurney and Jackson, 1894.)

THIS book is a continuation of the subject of odour-yielding products treated of by Mr. Sawer in a volume bearing the same title and issued in 1892. Though the present book is a companion volume in every respect to its predecessor, and might well have been designated as the second volume, the author has preferred to call it the second series, thus implying, and indeed distinguishing, the former book as the first series—a little peculiarity which does not in itself affect the value of the work, but which tends to confusion lest the second series might be taken for an extended or enlarged edition of the first; whereas the term volume would have implied that it is an entirely new book, which is really what the author wishes his readers to understand, as he tells us in the preface to the new volume that the matter treated therein is a "continuation of the subjects already discussed."

It is true that many perfume-yielding plants treated of in the first volume are again referred to in the second. Mr. Sawer says that the matter published by him two years ago is now as far as possible brought up to date. This may be so, so far as the chemistry of the various substances is concerned; but we scarcely think, as an instance, that the paragraph on Ambrette (p. 402) indicates any new discovery since 1892, when *Hibiscus Abelmoschus* was briefly referred to and sufficiently described. The following is the paragraph to which we refer. It is placed in Section iv. under the head of "Addenda to Volume i.":—

"Ambrette, the seeds of *Hibiscus Abelmoschus* (Lin. Spec. 980).—'Hibiscus' is one of the names given by the Greeks to 'Mallow,' and is said to be derived from *Ibis*, a Stork, a bird which is said to chew some of the species. 'Abelmoschus' is derived from the Arabic *Kabb-el-Misk*, 'grain or seed of musk.' The 'Mallow' group consists of a very large genus of *Malvaceæ*, characterised by their large showy flowers being borne singly upon stalks towards the ends of the branches, by having an outer calyx or involucel composed of numerous leaves, and an inner or true calyx cut into five divisions at the top, which does not fall away after flowering; by having five petals broad at top and narrow towards the base, where they unite with the tube of the stamens; and by the latter forming a sheath round the five-branched style and emitting filaments bearing kidney-shaped anthers throughout the greater part of its length. The fruit is five-celled, with numerous seeds. *Hibiscus Abelmoschus* is a shrub of 6 to 8 feet in height, native of the East Indies and South America. Its leaves are somewhat peltate, cordate, 5 to 7-angled, acuminated, serrated, stem hispid; pedicels usually longer than the petioles; involucel 8 to 9-leaved. Flowers sulphur-coloured with a dark blue centre. Capsules conicle (*sic*) covered with bristles. The seeds are large and have a very musky odour. The seeds yield on distillation 0·1 to 0·25 per cent. of essential oil, which congeals at + 10° C. Its sp. gr. at 25° C. is 0·900 to 0·905."

It will scarcely be conceded that the bulk of this paragraph brings the information on Ambrette up to any more recent a date than might have been given in the book issued two years ago, for the botanical description is acknowledged as having been obtained from such works as Rumphius' "Herbarium Amboinense," Rheede's "Hortus Malabaricus," &c. The descriptions, indeed, of this and of most other plants referred to is of little or no value in a book of this character, and only helps to increase its bulk, a thing to be avoided in a work "intended for the use of growers, manufacturers, and consumers."

The range of plants over which Mr. Sawer travels is very extensive, and is indicated by the five and half pages of works consulted, as well as by a casual glance through the pages of the book. Many of these plants are new to us as perfume yielding.

The three species of *Barosma*, for instance, namely *B. crenulata*, *B. betulina* (which, by the way, is spelt Barasma), and *B. serratifolia*, the leaves of which are well known in pharmacy under the name of Buchu leaves, seem as much out of place in a work on perfumes as asafœtida or castor oil would be; and the fact that the leaves of the Barosmas "are used by the Hottentots as perfumes," is but a slight recommendation for their adoption in civilised life. Notwithstanding that Mr. Sawer summarises rather fully what has been done by such well-known chemists as Prof. Flückiger, Messrs. Schimmel, and others, in the examination of Buchu oil, he does not inform us whether the oil has been actually used in perfumery, or whether there is any prospect of its becoming an article of the perfumer's trade. All we gather on this point is that its odour agrees with that of peppermint.

Regarding the arrangement of the plants or products referred to in the book, we cannot discover that any systematic method has been attempted; the plants are not classed scientifically nor alphabetically, and if it were not for a fairly extensive index a good deal of difficulty would be experienced in finding any particular plant required. It cannot be denied that the book contains an immense amount of useful and interesting matter, and exhibits an enormous labour expended in its compilation. With a good deal of judicious pruning, a systematic classification of subjects, and much careful editing, the two books might be reduced into one good-sized volume, and made a standard work on all matters relating to perfumery.

That a careful revision has not been made of the proof sheets, is evident from the frequent mis-spelling both of scientific and common words. Thus we find *Melliaceæ* for *Meliaceæ*, String Bark for Stringy Bark, *Stellingia sabifera* for *Stillingia sebifera*, Madagasca for Madagascar, and such like errors that might with ordinary care have been avoided.

OUR BOOK SHELF.

Introduction to Elementary Practical Biology. By C. W. Dodge, Professor of Biology in the University of Rochester, U.S.A. (New York: Harper and Brothers, 1894.)

THIS volume of 422 pp. octavo is the first laboratory book on the established lines of Huxley and Martin's "Elementary Biology" which has reached us from the New World. It, however, excels that in scope, owing to the introduction of additional types of both plants and animals—the Starfish, Locust, Sponges, Rockweed (*Fucus*), Liverwort, and Water-silk (*Spirogyra*) being among those dealt with. The work embodies the results of seven years' experience in practical teaching; but, that notwithstanding, it bears at every turn the impress of the recognised English treatises of its kind, and to these the author, unlike certain writers nearer home, manfully acknowledges his indebtedness. The book opens with an introduction, dealing with instruction in manipulation and the use of instruments, and closes with an appendix, giving lists of and recipes for reagents, and there are added a bibliography of works of reference and a very good glossary-index. The bulk of the volume is subdivided into three parts dealing in succession with the Biology (1) of the Cell, (2) of the Animal, and (3) of the Plant, elementary experimental physiology and the study of habit receiving adequate attention. Such novelty as is claimed for the work is born of its author's conviction that "the methods of teaching now in vogue for elementary classes are methods of *instruction* rather than of *education*" (!) and he sets himself to overcome this imaginary defect of what he terms the "verification method" by the introduction of questions, as opposed to the more diadactic statement of facts customarily resorted to. Up to a certain point this may be all very well. For example, in dealing with the Protozoa, with which and the analysis of simple cell structure the author's course commences, the student, being told how to capture and mount his sample, is asked, "How many different shapes can you distinguish?" "What variations in size?" "In color?" and other questions of like order; but when there follow these (on p. 5 of the work), "How do these animals eat?" "Digest their food?" "Breathe?" (*sic*) we confess to a feeling of sympathy with the befuddled beginner. And when, further, after an altogether insufficient preamble and at the outset of his inquiry into the wide domain of biology, the tyro is asked, of the Amœba, "Is the process [of fission] preceded by sexual union?" "How is one sex distinguished from the other?" and, *à propos* of the cerebral hemispheres of the frog, "Why are they called hemispheres?" one's sympathy gives place to pity for the student thus led astray. We entirely disagree with the author's dictum that sooner or later the student will have to learn to use the microscope, and it matters little when he does so; and we further doubt the advisability of his interrogatory method, when "the questions usually apply equally well to several related forms," particular species being said to be "not required." A training in elementary biology is one in manipulation in a field beset with snares and pitfalls, rendering it a primary necessity to teach the beginner what to leave unconsidered. However, the experiment, while not altogether new, is an interesting one; the book is carefully compiled, and we await with interest the verdict of time upon the system which it advocates.

Notes on the Ventilation and Warming of Houses, Churches, Schools, and other Buildings. By the late Ernest H. Jacob, M.A., M.D. (London: S.P.C.K., 1894.)

A MELANCHOLY interest is attached to this little manual of health in the fact that its gifted author passed away on March 1. His posthumous work shows what a promising life was cut short, and will serve as a memorial to him. The idea that human beings confined in public buildings should have pure air at a suitable temperature supplied them, has only in recent years been taken seriously. It is notorious that in most churches there is no attempt at proper ventilation, and they are only excelled, as far as disregard for the laws of health go, by many Nonconformist chapels with galleries, and mission-rooms created by knocking two cottages into one. Dr. Jacob's manual should be consulted by those who are responsible for such buildings. Therein they will find described the general principles by which buildings are rendered healthy. The book should also be read by the householder, for he will learn from it how an ordinary dwelling-house ought to be ventilated and better, will find that it is an easy and not very costly business to make the average English house less stuffy and more healthy than it usually is. Indeed, all who desire in a popular form information on the subject of ventilation, should procure this book, while architects and builders would benefit the community by taking its lessons to mind.

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.*]

Rotating Shafts.

In your account (NATURE, May 10, p. 43) of Dr. J. Hopkinson's "James Forrest" lecture at the Institution of Civil Engineers, appears the following statement: "Another example, having a certain degree of similarity with the case of struts, is that of a shaft running at a high number of revolutions per minute, and with a *substantial* distance between its bearings. . . . How will the shaft behave itself in regard to centrifrugal force as the speed increases? *In this case, so long as the shaft remains absolutely straight it will not tend to be in any way affected by the centrifugal force*, but suppose the shaft becomes slightly bent, it is obvious to anyone that if the speed be enormously high this bending will increase, and go on increasing until the shaft breaks. In this case also we may use mathematical treatment; we find that the condition of the shaft is expressed by a differential equation of the fourth order, and from consideration of the solution of this equation we can say that if the speed of any particular shaft be less than a certain critical speed, the shaft will tend to straighten itself if it be momentarily bent, but that, on the other hand, if the speed exceeds this critical value, the bending will tend to increase with the probable destruction of the shaft." (The italics are mine.)

The italicised statement seems to imply that a certain operating cause may have absolutely no effect, which cannot of course be the meaning Dr. Hopkinson intended to convey. Most engineers, it is to be hoped, are aware that the natural tendency of the material of the shaft is to retire from the axis of rotation, and that this is *necessarily* associated with a state of strain and stress throughout the shaft, whether straight or bent, for all speeds of rotation. Dr. Hopkinson must, I think, have had his mind so fully occupied with the idea of rupture through instability, worked out by Prof. Greenhill,[1] that he overlooked the fact that his language suggests the non-existence of the more commonplace and essential elastic phenomena.

So far even as rupture is concerned, Dr. Hopkinson's statements are, I believe, incomplete. The ordinary strain and stress developed by rotation in a shaft may, as I have shown elsewhere,[2] exceed the limits of safety before a velocity is attained at which, on the Greenhill theory, instability becomes possible. This is the more likely to happen the shorter the cylinder and the thinner its walls, if it be hollow; but even in a solid iron cylinder of length eight or nine times its diameter—a very substantial distance in a thick cylinder—the strain developed would be such as to merit an engineer's careful attention before a critical velocity was reached associated with instability.

I am somewhat doubtful whether Dr. Hopkinson's remarks on instability itself are altogether satisfactory. On the mathematical theory there appear in reality to be a series[3] of critical values, if any, at which instability *may* occur. Supposing the velocity gradually raised, it seems possible, *theoretically*, for the shaft to safely surmount the first crisis. It then would appear to remain unexposed to instability until the approach of the next higher critical velocity, and so on.

As Dr. Hopkinson says, Prof. Greenhill's instability theory leads to a differential equation of the fourth order. The solution of this equation is, however, dominated by the terminal conditions[4], at the ends or bearings of the shaft, and unless these be correctly assigned the numerical results deduced from the theory are untrustworthy. This is, I think, one of those points where the practical experience of the engineer is a most essential auxiliary to the analysis of the mathematician.

Kew Observatory, May 11. CHARLES CHREE.

IN order to shut out every possibility of ambiguity, I might have said, instead of "substantial distance between the bearings," "distance between the bearings very great in comparison with the diameter of the shaft," and in the next sentence quoted it would perhaps have been clearer if I had said "will not be broken by centrifugal force." But I do not think that in fact I could be misunderstood by anyone.

It was hardly desirable that I should touch upon the terminal conditions, or upon the possibility of stability between the critical values, in a paragraph introduced for illustration and not for detailed information.

But Mr. Chree's letter does remind me that I neglected to refer to Prof. Greenhill's name in this connection. This I should have done with the greatest pleasure, but, unfortunately, for the moment I forgot that it was he who had worked on the problem. I write this note in order to make the acknowledgment.

J. HOPKINSON.

1 Institution of Mechanical Engineers, *Proceedings*, 1883, pp. 182–204.

2 Camb. Phil. Soc. *Proceedings*, Feb. 8, 1892, pp. 283 *et seq.*

3 See *Phil. Mag.* August 1892, pp. [illegible].

4 See Camb. Phil. Soc. *Proceedings*, *l.c.* p. 300, and *Phil. Mag.* *l.c.* pp. [illegible].

The North Sea Ice Sheet.

IN his letter in NATURE, May 3 (p. 5), my friend Prof. Hughes calls attention to a most important fact. In archæology it has long been known how necessary it is to make sure that not only the exact *provénance* of an object is ascertained, but also that when found it was *in situ*, and was not the result of a later disturbance of the ground. Thus Mr. Franks has a pricket candlestick, made at Limoges, which was found several feet deep in gravel at Calcutta, and this strange fact was only explained when it was discovered that the gravel in question was ballast, which had been dredged from the Thames, deposited in the hold of a vessel, and redeposited at Calcutta. The same caution is more especially needed in geology. Prof. Hughes describes the foreign ballast which he saw stranded on our east coast, and warns us of the very wrong inferences that may be deduced from it. I would add to his statement that it was the custom of the old Danish pirates to use blocks of stone as anchors, and thus no doubt some foreign boulders have found their way to the east coast of Britain.

Here we seem to have an explanation of the occurrence of so-called Norwegian boulders on the Yorkshire coast between Hull and Scarborough and at Cleethorpes, and which, oddly enough, are not found in Scotland, though so much nearer Scandinavia.

It must be remembered that the mother rocks from which these Scandinavian boulders are supposed to have been detached do not occur on the western flanks of the Norwegian mountains at all. In this behalf I will quote Mr. Carvell Williams, himself a believer in some ultra-glacial views. He describes these boulders as consisting of the "typical augite syenite, which occurs only at Langesund Fiord, near Breug, and also porphyry and granite from the same region. *All of these rocks*, he says, came out of the Skagar Rack, and were brought by a glacier going south from Christiania and then south-west. Other rocks came from Fredericksvorn on the same coast."

This is assuredly a very difficult journey to understand. If the North Sea, as we are told, was filled with ice, how could an ice stream force its way from the comparatively low country round the Christiania Fiord right round the Nose of Norway, and then across the deep ocean basin to Britain? Prof. Bonney has argued that any ice sheet would be embayed in the great trough which skirts the coasts of Norway, out of which it could not rise again. Apart from this, it must be remembered that if the elevation of this ice sheet was so slight at the point when it started its journey as to enable it to get a load of these Norwegian boulders on its back from the comparatively low ground where the mother rock occurs *in situ*, it could not have the necessary slope to move beyond a very short distance. Pettersen has shown very admirably that the glaciers from the high mountains of Northern Norway, far from traversing the North Sea, were not powerful enough even to reach the string of islands which line the western shores of Norway, *a fortiori* would this capacity be lacking in the case of the ice from Christiania Fiord. The existence of the serrated and peaked Lofoden islands in the route which a North Sea ice sheet must have traversed was long ago pointed out as a great impediment in the way of such a postulate. Again, if this vast ice sheet came from any part of Norway, how did it get the stones on to its back? for in that case all Norway must have been smothered with ice. Lastly, where is the terminal moraine, or anything like a moraine, left by this monster? A glacier is not like a river which deposits fewer and fewer stones from its head waters as it flows. On the contrary, a glacier deposits its greatest load at its furthest extremity. In the case in question we have a few sporadic stones only, whose origin may well have been such as that pointed out by Prof. Hughes. It seems to some of us, and I have argued the question in my "Glacial Nightmare," that the whole notion of a North Sea ice sheet is a product of some other form of reasoning than inductive science, and that we have no good reason to doubt that when the mountains of Scotland and Scandinavia were nursing large glaciers, the North Sea was free from ice, except perhaps some floating bergs, and was the home of a rich molluscan fauna. HENRY H. HOWORTH.

Festoon Cumulus or "Pocky" Cloud.

THE following observation of Dr. Clouston's "pocky" cloud, which I had an opportunity of making a few days ago during a sounding cruise on board H.M.S. *Jackal*, seems to throw some light on the conditions under which this somewhat rare phenomenon occurs in these islands.

At 9.30 a.m. on May 3, while sounding in lat. 59° 45' and long. 1° 20' W., wind west-south-west, force 3 to 5, very gusty, a heavy squall approached from windward and struck the ship; wind in the squall about north, maximum force 8 to 9. Similar squalls came up at intervals during the day, the weather remaining almost unchanged except for a slight veering of the wind in the afternoon and the appearance of a "mackerel sky" of unusually fine texture.

While sounding in lat. 59° 32' N., long. 1° 0' E., a squall similar to the others approached from windward (west), and reached the ship at 6.20 p.m. The wind again shifted some points to the northward, with a smart shower of rain and sleet. Ten minutes later the "pocky" cloud was observed, forming the rear of the squall cloud. The number of festoons or mammæ was eight, with a possible ninth, of which two were incomplete, looking as if the bottom had come out of the "poke." The appearance fully maintained its reputation as a prognostic. The wind shifted to north-west about 9 p.m., and at midnight it was blowing a whole gale from that direction.

Before the "pocky" cloud was observed my attention was specially drawn to the weather by the peculiar nature of the sea disturbance. A moderate swell from windward appeared to be complicated by a cross sea from about north-east, resulting in a kind of miniature of the pyramidal seas met with in the centre of tropical cyclones. When the gale broke out the sea produced in this way tried the *Jackal* to an extent out of all proportion to the violence of the wind. It would appear from the "Daily Weather Reports" that at the time the "pocky" cloud was seen the *Jackal* was slightly in advance and to the right of the centre of a depression which had shortly before begun to increase in depth. If the cloud was observed in a region where an ascending current was increasing in velocity, its indications are of obvious interest. In any case, Abercromby's statement ("Weather," p. 79), that the storm the festoons prognosticate belong to another cyclone following, requires modification.

Oxford, May 10. H. N. DICKSON.

Ouramœba.

THIS peculiar amœboid animal was first observed by the late Dr. Jos. Leidy in 1874. Though he recognised in it the essential characters of the genus *Amœba*, the permanent filamentous appendages with which the posterior end of the body is provided led him to consider it a distinct genus. His description, embodied in "Freshwater Rhizopods of North America," was published by the United States Government in 1879, a brief notice of the form having appeared previously in the *Proceedings* of the Academy of Natural Sciences of Philadelphia. Dr. Leidy cites two or more notices of the same animal by Mr. Archer, of Dublin, who, however, held it to be a form of Wallich's *Amœba villosa*.

In 1879 it was stated by Leidy to be rare, he having found it only in two localities on a single stream in Pennsylvania; but Dr. Stokes, of Trenton, N.J., informs me that it is somewhat common in that vicinity.

My own observations, made in February and March of the present year, upon the only specimens which I have met in this locality, convince me that a suspicion which Dr. Leidy expresses, but which he rejects, is, after all, well grounded, namely, that the filaments, which constitute the only peculiarity of the creature, are of the nature of a parasitic fungus growing upon the genus *Amœba*.

The citation by any reader of NATURE of published observations upon this singular form since Leidy's monograph would be prized by me. WM. L. POTEAT.

Wake Forest College, N.C.

An Intelligence of the Frog.

DR. ROMANES, in his "Animal Intelligence," p. 254, says that, "frogs seem to have definite ideas of locality." This matter appears to have been noticed of old by the Japanese and Chinese, inasmuch as we credit Ryōan Terashima's explanation of the names given to the frog by the two nations. In his "Illustrated Encyclopædia of Three Systems of Japan and China," completed in 1713 (new edition, Tokio, 1884, book liv. p. 553), he remarks:—"When frogs are 'removed far' (Chinese, *hia*), they always 'long' (Chinese, *má*) after the original locality; hence the Chinese name 'Hia-má.' For the similar reason the Japanese call them 'Kaeru' (meaning 'return')." Shisei Tagawa (1707–76), one of the most erudite lexicographers of Japan, holds to the same opinion in his "Dust from a Sawyer's Workshop" (Tokio, 1891, p. 8).

May 12. KUMAGUSU MINAKATA.

PERENNIAL IRRIGATION IN EGYPT.

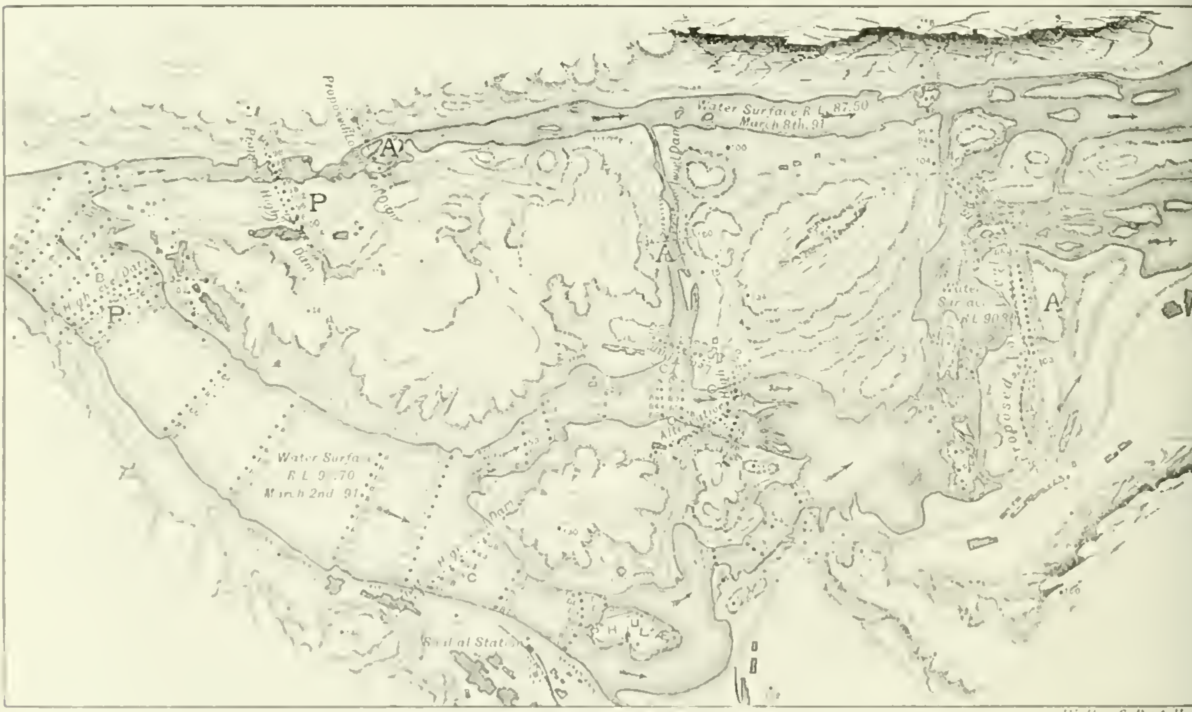
THE "Report on perennial irrigation and flood protection for Egypt," by Mr. Willcocks, brings us face to face with one of the most stupendous applications of science of modern times, and it is to be regretted that in consequence of the tardy arrival of the report and plans in this country, and of the general interest having been directed to a side issue, both the vastness of the scheme and the completeness and admirable method of the preliminary studies have received scant recognition.

Everybody is familiar with the saying of Herodotus that Egypt is the gift of the Nile, but only few are familiar with the conditions of the river, which are thus tersely stated in one of the appendices to the report. "The Nile drains nearly the whole of North-Eastern Africa, an area comprising 3,110,000 square kilometres. Its main tributary, the White Nile, has its sources to the south of Lake Victoria, and has traversed over 3500 kilometres before it is joined by the Blue Nile at Khartoum.

Taking the years since 1873 the mean of the minimums (which vary between May 14 and June 24) was −0·08 of the gauge; the mean of the maximums (which vary between August 20 and October 1) is 8·17. The Nile flood level at Assuân is then roughly 27 feet above average low water. The water therefore passing over the cataract varies enormously in quantity at low and high Nile; we have in an average of 20 years 440 cubic metres per second in May, 9170 in September.

Finally, of all this water which passes Assuân in such varying quantities at different times of the year, the total yearly average quantity being equal to 2990 cubic metres per second, 370 disappear before Cairo is reached, where the discharge is 2610 cubic metres per second; of this again 550 cubic metres are absorbed for the irrigation of Lower Egypt, so that 2060 cubic metres reach the sea each second, or 65,000,000,000 each year.

The rainfall as stated, treated as it is in Egypt at the present day, gives us the land area under cultivation, the number of crops per annum, and the quantity of produce



The Front Cataract at Assuân, showing the Dams proposed. P P, Philæ; A A A, Assuân.

From the junction onwards the river is known as the Nile, and after a further course of 3000 kilometres flows into the Mediterranean Sea by the Rosetta and Damietta mouths. The modulus of the Nile at Assuân is 2990 cubic metres per second, and at Cairo 2610 cubic metres per second."

The total mean annual rainfall in the Nile valley, including the desert north of Khartoum, amounts to 2,633,000,000,000 cubic metres. This water is brought to the main stream by the White Nile in a pretty constant quantity all the year round, but the river is liable to an annual flood which is due to the Saubat, the Blue Nile and the Atbara. Leaving out of consideration the accidents of the river above Assuân, we may state that at that place is the last of a series of cataracts, and also is a gauge by which the various heights of the river at different times of the year and in different years are recorded. The gauges are in metres, and are referred to mean low water level as zero. The zero at Assuân is 85 metres above the level of the Mediterranean.

on which the revenues of the country, and the food of the inhabitants, depend.

The question which has occupied the Egyptian engineers of late years has not been whether waste lands can be brought into cultivation and the agricultural yield increased if there were more water—that has long been obvious—but *how much* water was wanted in the worst years. Other questions were, whether the amount was available in the river, and at what period. First as to the amount wanted:—

		Area in feddans.[1]	Water wanted in cubic metres.
Upper Egypt	Assuân – Assyût	1,200,000	1,160,000,000
Middle Egypt	Assyût – Cairo	1,200,000	950,000,000
Lower Egypt	Cairo – Sea	2,810,000	1,551,500,000

[1] A feddan = $\frac{4200}{4047}$ of an acre.

The water requirement, then, is 3,661,000,000 cubic metres. We have already seen that 65,000,000,000 reach the sea each year. But it is not enough to know this yearly amount, we require to know the amount available *after the flood* each year. Taking the worst, Mr. Willcocks shows that the quantity available for storage in November, December, and January amounts to 6,100,000,000 cubic metres, practically twice the quantity wanted.

Next the water has to be stored *above* the place where it is wanted. Since the southern boundary of Egypt is below the second cataract that is out of the question; the only three possible sites for the dam are at Kalabsheh, Assuân, and Silsila. And now a very important question comes in: the slope of the Nile, except at the cataracts, is so gradual that holding up water to any height by a dam will flood a long reach of the river valley up stream of the dam. The dam must be high to store a sufficient amount of water, and naturally the higher the dam the longer will be the flooded region. Thus a dam at Silsila submerges the whole valley to the first cataract including the town of Assuân. A dam at Assuân floods the valley up to Korosko (199 kilometres); a dam at Kalabsheh floods the valley still further south.

It is to be gathered from Mr. Willcocks' report, and Mr. Garstin's (the Under-Secretary) note upon it, and the recommendation of the Technical Commission, the English and Italian members of which were Sir B. Baker and Signor Torricelli, that the Assuân site is the best. The foundations of the dam can be built in the dry and on hard igneous rock. The estimated cost of the dam is a little over £1,600,000.

The proposed dam is thus described by Mr. Willcocks: "The design for the work consists of a solid unsubmergible dam pierced with 100 undersluices 10 m. × 2 m., and constructed on solid rock. The piers between the undersluices are 3 metres wide, and every set of ten sluices is separated from the next by abutment piers 10 metres in width." The undersluices are regulated by Stoney's patent balanced roller gates.

The dam will be worked as follows: During the flood all the sluices will be open, and the flood waters, with all their contained fertilising mud, will be discharged through the undersluices. When the flood has passed, and the comparatively clear water supply has begun to flow, the lower undersluices will be gradually closed so that the water will begin to rise and flow through the higher sluices. When the water has risen to a height 3 or 4 metres above the floors of the higher sluices, or 10 or 11 above the floors of the lower ones, the latter will be entirely closed, and the river will discharge through the upper sluices, which will be gradually closed until the water gains its full level.

When the reservoir is emptied the reverse process will be followed; the higher sluices will be opened first, and then the lower ones, until the time is reached when the next annual flood is due.

It is next of importance to see how this stupendous scheme bears upon Egypt financially. It is pointed out that the value of the reclaimed lands may be estimated roughly at £46,000,000, the increase in the value of yearly rental at £3,700,000, and of the yearly produce £12,000,000.

It will be perfectly clear that if only half of these values are realised the scheme will work wonders for the prosperity of Egypt, and that it would be a crime not to go on with it.

Rests then the great drawback, that wherever the dam is erected a portion of the up-stream valley will be swamped. All the world has heard of the possible drowning of Philæ provided the dam be built at Assuân. But this cry could scarcely have been started by archæologists, for as a matter of fact Philæ is only one temple site out of very many lying between Assuân and Korosko. Since none of them have been completely explored, it is hazardous to state that it transcends the others in scientific importance, although certainly it is uneclipsed as a beautiful spot.

The ruins besides Philæ threatened with destruction have thus been stated by Mr. Somers Clarke in a letter to the Society of Antiquaries:—

"The dam will create a reservoir of enormous extent, not only drowning the island of Philæ, but extending southward into Nubia for nearly a hundred miles. When full the waters of the reservoir will rise several feet above the highest level of the pylon of the Temple of Isis at Philæ. The rocks surrounding the island are full of hieroglyphic inscription; these will spend many months under water, and there is yet much to be discovered in the immediate neighbourhood. At Debôt is a Ptolemaic temple, which retains its original girdle-wall, three great standing doorways, the first being the entrance through the girdle-wall, the second being the doorway in a ruined pylon, and the third standing more immediately before the temple. At Dimri are the remains of ancient structures still to be explored. At Kertassi there is, in fair preservation, a small hypæthral temple with Hathor-headed columns; a little south are extensive quarries, part of the surfaces covered with graffiti, chiefly Greek votive inscriptions. Surrounding the village of Kertassi is a great wall enclosure. At Tafeh a small temple, very perfect, is still standing in the middle of the village, and near it are some remarkably interesting specimens of Roman masonry, but built in the Egyptian manner. They are the lower parts of houses, rectangular structures with their internal subdivisions still to be traced. At Kalabsheh is the most magnificent structure in Lower Nubia. Overhanging the Nile are the remains of a grand quay pierced by two stairways leading on to a great platform. On this is a long terrace of approach from which we rise to another terrace, parallel with the course of the river and lying in front of the pylon. The walls of the temple are very perfect, the roofs only having fallen in. Surrounding the temple is a girdle-wall of masonry. The entrance court of the temple is full of graffiti of the greatest historic interest, and between the crannies of the fallen masonry can be seen many more now inaccessible. At Abu Hor are ancient remains and a quay standing by the river side; a place that needs careful exploration. At Dendûr are the remains of a temple dating from Roman times. The names of many native gods and princes are carved upon the walls. At Koshtemneh are the ruins of a great brick fort, and in one corner of it are the bases of the temple columns. At Dakkeh is a particularity interesting temple. Stones of an early building of Thothmes III. and Seti I. have been found, but the existing structure was begun under Ergamenes, a native king, and completed under a Roman emperor, presumably Augustus. The pylon is absolutely perfect. This building would be engulfed. At Kobban, opposite Dakkeh, are the remains of a very large rectangular fortress of Egyptian crude brick, some 370 by 350 feet. The remains of a temple of the middle empire can be traced, and outside are the remains of temples of the XIXth dynasty. At Mahārakah are the ruins of a very late temple. Its plan is unique. In addition to the places above mentioned there are traces of buried towns and of tombs in great abundance. The whole of these things will be submerged, and the inhabitants transported I know not where."

It has been stated by some that the destruction of these various memorials of antiquity has been regarded by the Egyptian engineers with absolute indifference. It is only just therefore to print the following extract from Mr. Garstin's note dated December 27, 1893, referring to the Assuân dam:—

"Unfortunately, with every advantage in its favour as to volume of water stored, soundness of foundation, and economy of construction, this site labours under the objection (which I fear may be found insuperable) of having Philæ temple on its up-stream side. No dam could be constructed on the cataract without inundating a great portion of this temple for several months every year. I agree with Colonel Ross that no project, which had this effect, should be admitted, unless it were impossible to find a reservoir site elsewhere. We cannot say that there are no other possible sites. There are Kalabsheh, Philæ, and Gebel Silsila, which are all available, and we cannot therefore claim that if a dam has to be built, it must necessarily be built at the head of the first cataract, and drown the temple of Philæ.

"Admitting this fact to the full, I still consider the Assuan site to be so superior to any other, that if any means could be found for obviating the difficulty which attaches to this temple, I think the subject well worth the consideration of the Egyptian Government, even although it involved additional cost to the project. On p. 36 of his report, Mr. Willcocks suggests the possibility of removing the temple of Philæ from its present site, taking it up stone by stone, and rebuilding it on the adjacent island of Bigeh, where it would be well above the highest water level of the reservoir. I cannot say whether it would be possible to do this without injury to the temple. If so doing would cause any injury, or alteration of any kind to it, I should recommend the abandonment of the Assuan dam altogether. Any work which caused either partial damage to, or the flooding of this beautiful temple, would be rightly considered by the whole civilised world as an act of barbarism. Moreover, it would be an act not absolutely necessitated by the circumstances, for I repeat that we have other possible, though somewhat inferior, sites upon which to construct dams.

"If the removal of Philæ temple is, however, only a question of expenditure, the subject at once commands attention. In this matter I turn naturally to Mr. T. de Morgan, the able Director of the Department of Antiquities in Egypt. If it is possible to remove the temple, and rebuild it upon the adjacent island exactly as it stands at present, we may rely on his ability to do so; and I ask that his opinion as to the removal and reconstruction of Philæ temple be obtained before the project for the Assuan dam be altogether rejected.

"Were the removal of the temple to be successfully carried out, I cannot myself see that it would be an act of vandalism, which, as I read it, is a term meaning the wanton destruction of interesting relics. In this case there would be no question of wanton destruction. The Government of Egypt would duly weigh on one side, the advantages to the country of the safest and most economical dam which could be constructed north of Wady Halfa, and, on the other, the sentiment which clusters round the site of the present temple, and objects to its removal even if it could be done without injury. Finding the advantages to the country to outweigh the sentiment, it would proceed to carry out the work with a religious regard for every detail, and through the agency of the competent staff of the Department of Antiquities.

"Removals somewhat similar to that now proposed have been successfully carried out. Mr. Willcocks mentions in his report having himself, when at Rome, been a witness to the dismantling and rebuilding of the most ancient existing bridge over the Tiber by Italian engineers. Civilised nations in recent times have removed from their original sites, and set up in other countries, interesting and valuable monuments. The Elgin marbles taken from the Acropolis and deposited in the British Museum, afford an example, and so also do the Luxor obelisk in the Place de la Concorde, and Cleopatra's needle on the Thames Embankment. These records of the past have been removed from their historical surroundings, and set up amongst others with which they are not in keeping. We, on the contrary, prompted by a desire to benefit the country, suggest the removal of an ancient building from one site on the Nile to another which is but a few hundred yards distant. We propose re-erecting it exactly as it stands to-day, and on an island in the middle of the great lake which we hope to create, where it would form a beautiful and appropriate object in the landscape."

To us it seems clear that with such a case as the Egyptian engineers have made out for the increased water supply, it is certain that a dam will be built somewhere, and, to be more precise, unless the frontiers of Egypt are enlarged, between Wady Halfa and Assuan. Assuan, Philæ, and Kalabsheh have each been suggested, and in either case the memorials of antiquity along a long reach of the river will be necessarily destroyed. This being so, there is room for an attempt to carry to a completion the work begun by the French Expedition of 1798 and continued by Lepsius in 1844, by making an English survey of the Nile between Philæ and Wady Halfa. Archæologists associated with engineers in such a work as this would certainly be a more pleasant sight to gods and men than when indulging in charges of "vandalism" and the like; and be it remembered no amount of money voted by Parliament, or by the Egyptian Government, no munificence of archæologists and others, with a view of dealing with the case of Philæ alone, will be of avail in final mitigation if a dam is to be built *anywhere*. To consider Philæ alone would convict us of a philistinism by the side of which the "vandalism" of the engineers were small indeed! On the other hand, when such a survey as that suggested has been completed; when what Maspero has called *l'histoire matérielle* of every temple has been investigated; every inscription copied, and every detail photographed, dam or no dam we shall be infinitely better off from the scientific point of view than we are now or should have been for the next century, if the question of the dam had not been raised.

J. NORMAN LOCKYER.

THE CENTENARY OF THE PARIS POLYTECHNIC SCHOOL.

THE hundredth anniversary of the foundation of the Polytechnic School of Paris was celebrated on the 17th, 18th, and 19th of May.

The 17th, consecrated to the memory of old comrades, comprised, in the morning at 10.30, a visit to the tomb of Monge. M. Mercadier, Director of studies at the Polytechnic School, pronounced Monge's eulogy, and deputations from the Institute, &c., assisted him. At 2.30 the President of the Republic visited the school and examined the pupils. M. Faye made a speech recalling different events of the school. Then a tablet was put up to the memory of the comrades killed by the enemy a century ago. The 18th was the "cérémonie des ombres." Lastly the *fête*, which took place on the 19th at the Palais de Trocadéro, constituted, independently of its programme, a special attraction, as *fêtes* had never previously been given at night in the immense and magnificent hall. From 10 o'clock to midnight more than 5000 people took part in the gala entertainment, which was followed by a ball.

The palace and Trocadéro Park were brilliantly illuminated. The entertainment consisted almost entirely of compositions by old pupils of the school. It ended with an apotheosis by M. A. Silvestre, during which a remarkable picture, consecrated by M. Dupain to the glory of the school, was uncovered.

The eulogy on Monge, pronounced by M. Mercadier, was of great eloquence. Monge was, as a child, very remarkable. When sixteen he made a plan of his native town, having invented an instrument for determining angles. At the age of twenty-two he had already invented many things. With the aid of an engineering officer he got into the Engineering School at Mézières, where in 1768 he succeeded Bossut as professor of mathematics, and two years later, Nollet in a course of physics.

He published his great works on "Les Surfaces considérées d'après leur mode de génération" in the Memoires de l'Academie de Turin. The illustrious Lagrange, after reading them, exclaimed "Avec son application de l'analyse à la représentation des surfaces, ce diable d'homme sera immortel!" "Ce diable d'homme" was but twenty-five, but—true to prophecy—made himself immortal.

In 1780 Monge was made professor of hydraulics; at the same time he entered the Academy of Sciences in the mechanical section. He lived six months in Paris, then six months at Mézières, but in 1783, on being made naval examiner, he returned to Paris for good.

He was an ardent revolutionist, and was made Minister of that department in 1792, during which time he unconsciously made a true friend of Buonaparte. In 1794 he helped to found the school in which he was a devoted professor.

In 1796 he and Berthollet and a few artists were ordered to Italy, to collect the numerous objects of art handed over to France by various Italian towns. It was at this time he became great friends with Buonaparte and Berthollet. Afterwards he took part in the Egyptian Expedition. He went with Berthollet, and Berthier in his report says of them: "ils s' occupent de tout et sont partout."

On his return to France, Monge again devoted himself to the Polytechnic School, his affection for the pupils and influence with them being unchanged and quite remarkable. After having worked steadily for forty-five years, he was obliged, on account of bad health, to retire.

The political disturbances, in which he was much engrossed, all tended to affect his health, but the disbanding of the school in 1816 was the final blow. He was never the same again, and died July 18, 1818.

M. Mercadier's address ended with a touching appeal to his auditors to imitate the patriotism and emulate the science of the great man whose useful life and work they had met to celebrate.

We may have to say something of the final *fête* next week.

NOTES.

WE learn with profound regret that Dr. Romanes died at Oxford at twelve o'clock yesterday.

THE first meeting of the International Meteorological Committee, as reconstituted at the Munich Conference of 1891, will be held at Upsala, and will commence on August 20. The programme, as will be seen, consists mainly of the various questions referred to the committee by the Conference. (1) Reports of the President and Secretary; (2) the question of the establishment of an International Meteorological Bureau; (3) Agricultural Meteorology; (4) the establishment of stations for the observation of the direction and velocity of movements of clouds; (5) the construction of a Cloud Atlas (reports from Dr. Hann, Dr. Hildebrandsson, Mr. Rotch, and M. L. Teisserenc de Bort); (6) the possible acceleration of weather telegrams; (7) the observation of the scintillation of stars (a proposal by M. Charles Dufour); (8) the organisation of the next Conference.

PROF. ROBERTS-AUSTEN is to be congratulated on having completed his responsibility for no less than one hundred millions sterling of gold coin. The twenty-fourth annual report of the Royal Mint, which has just been issued, shows that of the long series of holders of his office none could have claimed anything like such a record, as the largest amount of gold coin for which any individual King's Assay Master had previously been responsible was the fifty-nine millions coined during the tenure of office of Mr. Robert Bingley, King's Assay Master from 1798 to 1835. As showing the remarkable accuracy of the standard fineness of coins, the Mint Report states that of the hundred millions sterling of gold coin, seventy-one millions were sovereigns, and that their average fineness as indicated by successive trials of the Pyx proved to be 916·668. The exact legal standard is 916·666, and it must be remembered that the gold coins would be within the "remedy" allowed by law if the amount of precious metal they contained varied between 914·6 and 918·6 parts in one thousand.

THE preliminary programme of the fourteenth Congress of the Sanitary Institute, to be held in Liverpool in September, has now been issued. The meetings of the Congress will consist of three general addresses and lectures. The three sectional meetings, dealing with (1) Sanitary Science and Preventive Medicine, (2) Engineering and Architecture, (3) Chemistry, Meteorology, and Geology, will be presided over by Dr. E. Klein, F.R.S., Mr. G. F. Deacon, and Dr. Thomas Stevenson. Five special conferences will take place: the Sanitation of the Passenger and Mercantile Marine Service, presided over by Sir W. Bower Forwood; Medical Officers of Health, presided over by Mr. Charles E. Paget; Municipal and County Engineers, presided over by Mr. A. M. Fowler; Sanitary Inspectors, presided over by Mr. Francis Vacher; Domestic Hygiene, presided over by the Lady Mayoress of Liverpool. An exhibition of sanitary apparatus and appliances and articles of domestic use and economy will be held, and excursions to places of interest from the point of view of sanitation will be arranged for those attending the Congress. The local arrangements are in the hands of an influential local committee, presided over by the Lord Mayor of Liverpool, with the City Engineer (Mr. H. Percy Boulnois) and the Medical Officer of Health (Dr. E. W. Hope) as honorary secretaries. It appears from the programme that over 100 sanitary authorities, including several County Councils, have already appointed delegates to the Congress, and as there are 1500 members and associates in the Institute, a large attendance may be expected.

A COMMITTEE has been formed at Boulogne for the purpose of making arrangements for an international exhibition of hygiene and hydropathy, which it is proposed to hold there from July 15 to September 15.

A KNIGHTHOOD has been offered to Dr. J. C. Bucknill, F.R.S., not for his scientific work, but in recognition of his services to the volunteer movement, of which he was the originator. Dr. Bucknill was elected into the Royal Society in 1866, and is now in his seventy-eighth year.

THE thirty-ninth annual exhibition of the Photographic Society of Great Britain will be inaugurated by a conversazione on September 22, and will remain open from Monday, September 24, to November 14. Medals will be awarded for the artistic, scientific, and technical excellence of photographs, lantern slides, and transparencies, and also for apparatus. Foreign exhibitors are invited to contribute. The Society will pay the carriage of photographs on the return journey, and provide frames or portfolios during the exhibition for approved photographs. There will be no charge for space. Communications on all matters connected with the exhibition should be sent to the Secretary of the Society, 50 Great Russell Street, Bloomsbury, W.C.

ALL students of science know that a knowledge of German is essential in their work, and no better way of obtaining it can be found than by joining German students in study. Facilities for obtaining this desirable end are now offered in the shape of holiday courses at Jena, from August 1 to 23. The courses have been arranged by a committee representing some of our University Colleges and High Schools, Mr. J. J. Findlay (Rugby) being the secretary. There will be an elementary course for those who have little or no acquaintance with the spoken language. The subjects dealt with in this course include physiological psychology, the hygiene of schools, and pedagogy. Each will be conducted by an experienced teacher, who will speak very slowly and clearly, but will only employ the German language as the medium of instruction. A more advanced course, for those who can follow lectures delivered in German, will be held from August 1 to 16. During this period Dr. Straubel will lecture every day on the microscope, Prof. Detmer on the fertilisation of plants and microscopic botany, Prof. Schaffer on experimental physics, and Prof. Auerbach on modern physical demonstrations. Dr. Knopf will discourse on time and its determination, illustrating his lecture with practical work at the Observatory; Dr. Straubel will give demonstrations on electrical and magnetic measurements; Prof. Wolff will lecture on theoretical and practical chemistry; Prof. Ziehen on physiological psychology; Dr. Römer on zoology; and Dr. Gange on spectroscopic and polarising apparatus. This programme should be sufficient to tempt many students of science to Jena, and they may be assured that the German schoolmasters, who attend similar summer meetings every year, will offer a cordial welcome to their "englische Kollegen."

THE Friday evening discourse at the Royal Institution, on June 1, will be delivered by Prof. Oliver Lodge, F.R.S. The subject will be "The Work of Hertz." On Tuesday afternoon Dr. Dallinger began a course of three lectures on "The Modern Microscope, an Instrument for Recreation and Research," and to-day Prof. Flinders Petrie commences three Thursday afternoon discourses on "Egyptian Decorative Art."

IT has been decided to provide chambers in one of the light towers which will be erected on either arm at the entrance of Madras Harbour, when finished, for the purpose of a tidal observatory, the establishment of which has been approved of by the Government of India.

PROF. VINCENZ CZERNY, of Heidelberg University, has been elected to fill the chair of Surgery left vacant in Vienna University by the death of Prof. Billroth.

THE Midland Railway Naturalists' Society has been established at Derby. The first monthly meeting was held on Monday, 7th inst.

MISS NORTH'S Gallery of Flower Portraits in Kew Gardens has been reopened to the public, the pictures having undergone a thorough inspection and varnishing, under the advice of the President of the Royal Academy.

IT is reported from Auckland, by Dalziel's Agency, that two shocks of earthquake occurred at Wellington on Monday morning. They were preceded by loud concussions, and all the buildings in the town were violently shaken, the public library being considerably damaged. Lesser shocks were also felt at Nelson, Taranaki, and Christchurch.

DR. GILL, the Director of the Cape Observatory, has communicated to the *Times* some significant facts in connection with the recent earthquake at Thebes. He says that the observer on duty with the transit circle, on the evening of April 27, found that the surface of the mercury used in making observations for errors of level was disturbed by continuous and persistent undulations from 6h. 2m. to 6h. 32m. Greenwich mean time. It was not until 6h. 43m. that the undulations ceased sufficiently to permit good observations of nadir and level to be made. No general conclusion can be drawn from these observations, but Dr. Gill thinks it probable that the delicate disturbances of the mercury at the Cape of Good Hope had its origin in the disturbance which produced such disastrous results at Thebes.

A CONSIDERABLE retrocession of temperature has occurred over these islands during the past week, accompanied by strong northerly and easterly winds, and causing much injury to fruit and vegetable crops. Snow or hail fell over the whole of Scotland and a large part of England and Wales on Sunday, while the minimum shade temperature on Sunday and Monday nights fell several degrees below freezing point, and on the grass temperatures of 20° or less have been recorded. For several days the maximum shade temperature did not exceed 45° at places in Scotland, and was below 50° in many other parts. In the neighbourhood of London it was below 50° on Sunday, a value which is about equal to the average maximum temperature of the middle of March. The Greenwich temperatures show that so low a maximum in the second half of May is very rare, having occurred only twice in the last twenty years.

A "MONOCHROMATIC rainbow" is rare enough to deserve record. Mr. Charles Davison writes:—"On the 28th of last November rain was falling shortly before sunset, and a rainbow was formed, though little more than the nearly vertical portion of one limb was distinctly visible. In a few minutes the blue, green, and yellow parts gradually faded away, and only a dull red band remained."

WE have received several numbers of the *British Central Africa Gazette*, published at Zomba, containing interesting articles on the prevention of the coffee-disease, and on the export of india-rubber (*Landolphia*) from the West Shire, Lower Shire, and Ruo districts.

THE *Naturwissenschaftliche Wochenschrift* for May 13 contains an interesting article, with illustrations, on fossil-like structures produced by the action of running water. Some of them present a remarkable resemblance to algæ and to the leaves of ferns; and the author, Dr. T. Fuchs, questions the organic origin of many so-called fossil remains from the older formations.

IN the form of a rectorial address to the University of Basel, Dr. G. Klebs has published an interesting essay on the relationship of the two sexes in nature. The first development and gradual progress of sexual differentiation in the animal and vegetable kingdoms are traced, and the connection between sexual reproduction and the development of new forms of life is discussed. Dr. Klebs sums up strongly in favour of the theory of the inheritance of acquired characters.

AT a recent meeting of the Société Française de Physique, M. Curie read a paper on the magnetic properties of soft iron at temperatures between 20° and 1350°, and for magnetising forces of 25 to 1350 units. He has drawn a series of curves showing the connection between the magnetising force and the intensity of magnetisation at different temperatures. For magnetising forces up to 1300 units the different curves do not differ much, but for higher values of the magnetising force they separate to a more marked degree. For temperatures between 756° and 1375° the curves obtained are straight lines passing through the origin, showing that between these temperatures the susceptibility is a constant and independent of the magnetising force. The author has also plotted a series of curves connecting the intensity of magnetisation (I) and the temperature, the magnetising force being constant. The value of I is at first constant as the temperature rises, then it diminishes faster and faster till the change becomes most rapid at a temperature of about 745°. Above this temperature the rate of change of I diminishes. Between 950° and 1210° the value of I only diminishes slowly, while at a temperature of 1280° it increases suddenly, and then as the temperature goes on increasing it gradually diminishes. The author finds that at any given temperature the value of I obtained is independent of whether this temperature has been reached by warming the body or by cooling.

AN interesting paper by M. van Aubel, on the electrical resistance of some new alloys, was recently read before the Société Française de Physique. In the first place, the author gave some particulars about a form of steel called kruppine, manufactured by Herr Krupp, at Essen. This alloy has a specific resistance of 84·7 microhms $\left(\frac{cm}{cm^2}\right)$ at 18° C., or of 85·5 if the sample has been heated for several days. The mean coefficient of variation of the resistance with temperature decreases slightly with increase of temperature, but is always nearly equal to + 0·0007. This body, although it has a relatively high specific resistance (that of german silver being 20·76), can be heated to a temperature of 600° C. without change of structure, and can be obtained in the form of wire or sheet. The author also gave particulars of the experiments made on some nickel alloys manufactured by Messrs. Fleitmann, Witte, and Co., of Schwerte (Westphalia). One of these alloys (marked $I_a\ I_a$) has when hard a specific resistance at 20° C. of 50·2 microhms and a temperature co-efficient of − 0·000011, while when soft its specific resistance is 47·1 microhms and its temperature co-efficient + 0·000005. This alloy may prove of considerable practical utility, although if it is found that its thermoelectric power with reference to copper and brass is, as is generally the case with these alloys, at all great, this will in a great measure prohibit its use in cases where great accuracy is required. During the discussion on the above paper M. Guillaume mentioned that an alloy of 68·6 parts copper, 30 parts manganese, and 1·3 parts of iron has a specific resistance of 108 microhms, while its temperature co-efficient is very small, even passing from positive to negative as the temperature rises. He also mentioned that the difficulty of the high thermoelectric power with reference to copper could be overcome if the wires are soldered to plates of the same alloy, which are in turn soldered to the copper connectors of the resistance boxes or Wheatstone bridges.

PROFS. RICCÒ AND SAIJA have, after many laborious efforts, succeeded in obtaining a fairly accurate record of the diurnal and annual variations of temperature on the summit of Mount Etna. The results, as communicated to the *Accademia Gioenia di Catania*, form a valuable addition to meteorological thermometry. The impossibility of maintaining a staff at an elevation of 3000 m. above sea-level, at a place difficult to reach and without telegraphic communication, made the employment of automatic recording instruments indispensable. A Richard barograph and thermograph were installed at the Etna Observatory, capable of acting for forty days without further attention. Some interruptions occurred owing to the freezing of the lubricants and irregular unrolling of the register paper, but between August 27, 1891, and February 28, 1894, a total of 357 days were registered automatically, and 137 days by personal observation. With the slight diurnal variation, 3-hour intervals were found sufficient. The highest temperature observed was 16° C., on September 2, 1892; the lowest − 10°·3 C., on March 2, 1893. As a rule, the coldest month was January, and the warmest August. The mean diurnal variation was 1°·6 in winter, and 6°·8 in summer. The climate of the summit of Etna, with its mean annual temperature of + 1°·06 C., resembles that of the North Cape or the Brocken. The uniformity of temperature was to be expected after similar observations in the Alps, and the covering of snow, which usually lies from the middle of November till the end of March, serves to keep the diurnal oscillation in winter below 1°·6 C. The changes of temperature during the year are very similar to those observed at the foot of the volcano, but the daily maximum, instead of being several hours after midday, occurs just about noon at the summit, probably owing to the absence of vapour capable of absorbing and storing up the heat of the sun.

LITTLE is known of the interior of the great peninsula of Labrador, that vast territory estimated to contain two hundred and eighty-five thousand square miles. During the last six or seven years, however, several explorers have visited the region, and returned with interesting geographical results. Mr. H. G. Bryant is one of these, and his description of the journey through Labrador to the Grand Falls on the Grand, or Hamilton River, recently published in a *Bulletin* (vol. i. No. 2) of the Geographical Club of Philadelphia, is full of interest. The greater part of the paper, and all the excellent views that illustrate it, originally appeared in the *Century Magazine*. Mr. Bryant set out with Prof. C. A. Kenaston in June 1891, and they reached the Falls on September 2. A mile above the main leap the river is about four hundred yards wide. Four rapids intervene between this point and the Falls. At the first rapid the width of the stream does not exceed one hundred and seventy-five yards, and from thence it rapidly contracts until, just above the escarpment proper, the water rushes between banks not more than fifty yards apart. Below the Falls the river runs for twenty-five miles between vertical cliffs of gneissic rock, which rises in places to a height of four hundred feet. The water falls through a height of about three hundred and twenty feet, and under favourable conditions the roar of the cataract can be heard at a distance of twenty miles. Appended to the paper is a list of plants collected by Prof. Kenaston during the expedition, and also the results of meteorological observations made at various points. The further exploration of the region traversed by Messrs. Bryant and Kenaston would be of great value to geographical science, and might lead to geological discoveries of scientific and commercial importance.

IN order to satisfactorily identify any particular bacillus with that generally associated with cholera, it is necessary to have recourse to animal experiments. For this purpose it has been customary to use guinea-pigs; and Pfeiffer's method is to take about ·0015 grm. of the surface-growth of an agar-agar culture, distribute it in 1 c.c. of sterile broth, and inject it into the peritoneal cavity. The above quantity is usually fatal with characteristic symptoms to an animal of 300–350 grms. weight. This is, however, by no means a simple or easy operation, but so far no other method of proving the virulence of the cholera bacillus has superseded it. In a recent number of the *Centralblatt für Bakteriologie* (vol. xv. 1894, p. 150), Dr. Sabolotny describes some investigations which he has made on the susceptibility of the marmot to Koch's cholera bacillus. The experiments were carried out in the Bacteriological Institute at Odessa, and Sabolotny mentions that these animals are found in large numbers in the south of Russia. When 0·1–0·2 c.c. of a one-day old broth-cholera-culture grown at 37° C. is introduced into the peritoneal cavity of marmots, they die in from 12–18 hours. Of much interest is, however, the discovery that similar quantities of cholera cultures introduced *subcutaneously* also proved fatal to these animals, the bacilli being found in the blood, liver, spleen, and peritoneal fluid. It was also found that they could be infected *per os* without any preliminary treatment with soda and opium, for marmots fed with materials containing small quantities of cholera bacilli died, and the latter were always found in large numbers in the stomach, as well as frequently in the liver and spleen, and also occasionally in the blood. The identification of the cholera bacillus by animal experiment is thus greatly simplified.

THE Committee that controls the operations of the Kew Observatory, and which in February of last year became "The Incorporated Kew Committee of the Royal Society," have issued their report of the work done during 1893. Under experimental work we note that, to estimate the amount and density of fog and mist, the observation of a series of distant objects referred to in the last report were continued. A note is taken of the most distant of the selected objects visible at each observation hour. An analysis of the results for the period May 1892, to December 1893, is at present being carried out. During the thickest fog experienced in 1893, at one of the hours of observation the most distant object visible was only 12 feet off. Twelve watches, designated "non-magnetic watches," were examined during the year, both as to their ordinary time-keeping and also as to their non-magnetic properties, and although the trial to which they were submitted was severe—the movement being tested in an intense magnetic field, both in vertical and horizontal positions, and gradually approached to and removed from the poles, whilst its behaviour is critically watched—in the majority of cases the watches were found to perform very satisfactorily. Magnetic and meteorological observations were carried on as usual, and sketches of sun-spots were made on 155 days.

It occurred to us while glancing through the "Mémoires de la Société de Physique et d'Histoire Naturelle" of Geneva, of which the second part of vol. xxxi. was recently received, that the custom of inserting, at the commencement of the volume, the President's *résumé* of the communications to the Society during his year of office, is an admirable one. The present bulky tome contains an address by the late C. de Candolle, in which he surveyed the scientific advances of the Society during 1891, and also a similar retrospect in which M. E. Sarasin reviews the growth of knowledge during 1892. It has been said more than once that the abstracts of papers are frequently superior to the originals, inasmuch as they present in a concise form the tenor of an author's work. But however this may be, it is certain that the plan followed by the Presidents of the Physical Society of Geneva (and also by those of some of our own Societies), viz. that of giving terse descriptions of the investigations communicated to the Society during their respective years of office, considerably facilitates reference, and what is more, it enables a worker to know the gist of a paper without reading through and digesting the original. In addition to the two presidential addresses referred to, the "Mémoires" contain a paper by Prof. J. Brun, on a new species of marine diatoms, fossil and pelagic, illustrated by twelve plates, containing 120 of the author's drawings, 40 microphotographs by Prof. van Heurck, and 80 by M. Otto Müller. The volume also comprises the second part of Prof. Chodat's "Monographia Polygalacearum," illustrated by twenty-three plates, and the fifth of his "Contributions à la Flore des Paraguay." Both of these papers will excite the admiration of systematic botanists.

THE address delivered by Dr. Armstrong, in March last, at the annual general meeting of the Chemical Society, is contained in the May number of the Society's journal.

THE papers set at the examinations of the Royal University of Ireland during 1893 have just been published as a supplement to the University Calendar for that year.

MESSRS. R. FRIEDLANDER AND SON, of Berlin, have sent us Nos. 5–8 of "Naturæ Novitates," containing lists of scientific works recently published.

MESSRS. PERCY LUND AND CO. will shortly publish a work entitled "The Stereoscope and Stereoscopic Photography," translated from the French of F. Drouin.

AN excellent feature of the *American Naturalist* is the classified notes of recent work in all of the natural sciences. Dr. W. S. Bayley, of Colby University, edits the section devoted to mineralogy and petrography. His contributions to the journal under that head, during 1893, have now been collected and published separately, and the pamphlet thus created forms a useful summary of progress.

THE "Year-book of the Scientific and Learned Societies of Great Britain and Ireland," published by Messrs. C. Griffin and Co., first appeared in 1884, and has been issued annually since then. It is really an extremely useful and convenient handbook of reference. Lists of the papers read during the year are given under the descriptions of the societies to which they were presented, with the dates of the communications. These have been compiled from official sources, and therefore constitute a trustworthy record of the progress of various branches of science. All the papers read before almost every British society are included in the lists, so the "Year-Book" may claim to be recognised as an important assistant in the organisation of scientific literature.

THE advances made in the study of geology since 1878 have rendered the publication of a new edition of the late Sir Andrew Ramsay's well-known manual on "The Physical Geology and Geography of Great Britain" a necessity, if the book is to retain its place. We are glad, therefore, to learn that a new edition (the sixth) has been undertaken by Mr. Horace B. Woodward, of the Geological Survey. The edition, accompanied by a corrected form of the small coloured map which appeared in the fifth edition, will very shortly be issued by Mr. Edward Stanford.

WE have received the second yearly report of the Sonnblick Society, for the year 1893. The Society now numbers 423 ordinary members, and the report shows that the importance of keeping this mountain observatory in thorough efficiency is fully recognised. The height of the summit has been determined by trigonometrical measurement during the year, and was found to be 10,192 feet, which agrees very closely with that found by barometrical measurements by Dr. Hann. In addition to the regular meteorological observations, special attention is paid by the observer, P. Lechner, to observations of atmospherical electricity, and some interesting results have been already obtained. It is found that the electric condition of the earth at the summit remains nearly constant during clear days throughout the year, so that, owing to its height and configuration, it is free from the daily and yearly fluctuations of electricity which are observed on the earth's surface at lower levels. It would be interesting to know whether this has also been observed at other mountain stations. The observations of St. Elmo's Fire have shown the interesting fact that when snow falls in large flakes, the electricity is almost always positive, but when the snow consists of dust-like particles, negative electricity is developed.

A DIRECT method of preparing the methyl and ethyl derivatives of hydroxylamine of the type RHNOH is described by M. Lobry de Bruyn in the current issue of the *Receuil des travaux chimiques du Pays-Bas*. These so-called β-alkylhydroxylamines have only recently been isolated in the pure condition by Kjellin, by an indirect process, although their formation has been demonstrated by several workers. Goldschmidt and Kjellin some time ago showed that they were produced in the decomposition by hydrochloric acid of the esters of nitrobenzaldoxime. E. Hoffmann and Victor Meyer have also shown that when nitro-ethane is reduced by stannous chloride the hydrochloride of β-methylhydroxylamine, $CH_3 . NHOH . HCl$, is produced: and Kirpal has further proved that the reaction is general, that whenever nitroparaffins are reduced to amines intermediate products are formed which reduce Fehling's solution. Dr. Kjellin has more recently resumed the former work which he carried on in collaboration with Dr. Goldschmidt, and has succeeded in isolating the chlorides of the alkyl hydroxylamines from the products of the reaction above referred to. Moreover, by employing a similar process to that which proved so successful in the hands of M. de Bruyn for the isolation of free hydroxylamine, Dr. Kjellin eventually obtained the pure bases themselves. An account of his work was given in these columns at the time (vol. xlix. p. 38). M. de Bruyn now shows that these simple alkyl derivatives of hydroxylamine may be obtained in the pure state directly from the base itself. In his preliminary account of the isolation of the parent base, he stated that upon agitating a very concentrated aqueous solution of hydroxylamine with methyl iodide and a little methyl alcohol, considerable evolution of heat occurs and a crystalline mass separates. On repeating this experiment with 4·1 grams of a 52 per cent. solution of hydroxylamine, 10 grams of methyl iodide (the molecular proportion), and a smaller quantity of methyl alcohol, mixed together in a flask fitted with an upright condenser, the energy of the reaction was found to be sufficiently great to heat the liquid to the point of ebullition, and crystals soon commenced to deposit. Ethyl iodide reacted in a precisely similar manner. The crystals, after draining and washing with a mixture of alcohol and ether, proved to be those of the pure hydriodides of the β-alkyl hydroxylamines. Their aqueous solutions acidulated with nitric acid do not reduce silver nitrate, so that their analysis is easily effected. In this respect they differ from nitric acid solutions of hydroxylamine, which of course at once reduce silver nitrate. They reduce Fehling's solution, however, instantly at the ordinary temperature. It would appear from this mode of preparation that the action of alkyl iodides on hydroxylamine is similar to their action upon ammonia. The salts are perfectly stable up to beyond 200° C. M. de Bruyn shows finally that it is not essential to have at command such concentrated solutions of hydroxylamine as those obtained during the preparation of the solid base. The weak aqueous or alcoholic solutions obtained in the usual manner from hydroxylamine hydrochloride, may equally well be employed; it is only necessary to decompose the solution of the hydrochloride in tepid water with potash, add an equal bulk of methyl alcohol, filter from the precipitated potassium chloride, and at once proceed to agitate with methyl iodide. The only further point of difference is that the liquid should be finally boiled in the flask fitted with upright condenser in order to complete the reaction.

The additions to the Zoological Society's Gardens during the past week include a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, presented by Mr. H. M. Dodington; a Common Peafowl (*Pavo cristatus*) from India, presented by Mrs. Tannenbaum; a Monteiro's Galago (*Galago monteiri*) from West Africa, two Pinche Monkeys (*Midas œdipus*) from New Granada, deposited; a Maholi Galago (*Galago maholi*), two Japanese Deer (*Cervus sika*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Recent Observations of Jupiter's Satellites.—In the May number of *Astronomy and Astro-Physics*, Dr. E. S. Holden calls attention to some important points in connection with Prof. Barnard's observations of Jupiter's satellites, recently published in that journal and in the *Monthly Notices*. In the first place, the results announced by Prof. W. H. Pickering in 1893 (see Nature, vol. xlvii. p. 519), with regard to the forms and rotations of these bodies, are not confirmed by Prof. Barnard's observations. Next, Prof. Barnard has found that all the Jovian satellites are spherical, whereas Profs. Schaeberle and Campbell announced in 1891 that Satellite I. was ellipsoidal, with its longest axis directed towards the centre of Jupiter. It was also concluded by these observers that the periods of rotation and revolution of the first satellite were equal; but Prof. Barnard says that his observations lead to a different result. Another point upon which Prof. Barnard's recent observations have thrown light, is the appearance of the first satellite when projected upon Jupiter. It will be remembered that the satellite was seen in transit as a double body in 1890, but Prof. Barnard has shown that the apparent duplicity was due to simple contrasts between bright regions on the planet and two extensive dusky polar caps on the satellite (see Nature, vol. xlix. p. 300). Other strange appearances of satellites during transit can be explained in a similar manner. Prof. W. H. Pickering has criticised the statement that the assumed belt on the first satellite is a permanent one (*Astr. Nach.* 3229), and says that it certainly did not exist at the time of the opposition of 1892, during the period covered by the Arequipa observations. He points out that, upon his meteoric hypothesis, it is not unlikely that belts should form and then disappear. It is a fairly common belief among astronomers that the satellites of Jupiter can be seen through the planet's limb during occultation. On this point, Prof. Barnard says: "In my mind this [the observation of the transparency of Jupiter's limb] has been due to poor seeing, a poor telescope, or an excited observer. For nearly fifteen years I have observed Jupiter and his satellites, and with telescopes all the way from five inches up to thirty-six inches have tried to see this phenomenon. I have often watched the satellites under first-class seeing with the 12-inch here [Mount Hamilton] at occultation, but have never seen one of them through the limb of Jupiter, though that phenomenon was specially looked for." It will be seen from these points that Jupiter and his satellites still offer a wide field for investigation.

The Mass of the Asteroids.—Mr. B. M. Roszel contributes to the Johns Hopkins *University Circular* for April a preliminary note on the probable mass of the asteroids. He has investigated the secular perturbations to which a ring of matter, such as the asteroids form round the sun, would give rise. The problem divides itself naturally into two parts—(1) to determine the combined mass of the asteroid belt; and (2) knowing the mass, to derive the secular perturbations of the elements of the orbits of certain of the major planets caused by this elliptic ring of matter. If the total number of the asteroids were known, it would only be necessary to determine the most probable mass of one member of the group to derive the combined mass of the whole group. But this is not the case, so Mr. Roszel has contented himself with determining the mass from a study of two hundred and sixteen of the minor planets at present known. The magnitudes of these bodies vary from magnitudes 6 to 15·5, the greater number lying between magnitudes 11 and 12. From photometric observations, Prof. Pickering derived for Vesta a diameter of 319 ± 10 miles. (Prof. Barnard's recent observations only assign the planet a diameter of 237 ± 15 miles). Now the ratio of the total quantities of light reflected by two planets at the same distance from the observer is equal to the ratio of the squares of their diameters. Utilising this fact, Mr. Roszel has been able to determine the volumes of the two hundred and sixteen asteroids referred to in terms of the volume of Vesta. Assuming Pickering's dimensions of Vesta to be correct, it appears that it would take roughly three hundred and ten asteroids of the sixth magnitude, or twelve hundred of the seventh, to equal our moon in volume. And in round numbers the combined volume of a ring of two hundred and sixteen would be only one two-hundredth part of that of our satellite. Assuming a mean density equal to that of Mars, the mass of the zone of asteroids comes out as about one one-hundred and seventieth part of the mass of the moon. From these considerations Mr. Roszel thinks that the probable mass of the entire asteroid belt is somewhere between one-fiftieth and one one-hundredth part of that of our moon.

Ephemeris of Gale's Comet.—The following ephemeris (for Berlin midnight) is abstracted from one given by Prof. Kreutz in *Astronomische Nachrichten*, Nos. 3227 and 3229:—

	R.A. h. m. s.	Decl. ° ′	Brightness.
May 26	10 44 37	N. 36 11·3	0·80
30	10 57 40	38 10·9	0·60
June 3	11 9 14	39 39·3	0·40
7	11 19 38	40 45·6	0·33
11	11 29 12	41 35·6	0·26
15	11 38 7	42 13·1	0·21
19	11 46 31	42 41·0	0·17
23	11 54 53	43 1·4	0·14

The brightness on April 3 has been taken as unity.

The comet was photographed by the Brothers Henry, at Paris Observatory, on May 5. The photograph was obtained with an exposure of forty minutes, and showed a tail, about four degrees in length, divided, at a short distance from the head, into two branches separated by an angle of about three degrees. The mean direction of the two parts of the tail was very nearly perpendicular to the direction of the comet's motion.

SOME LONDON POLYTECHNIC INSTITUTES.

It is only in recent years that any attempt has been made to supply the demand for technical education in London. Not so very long ago the question as to whether such education was desirable for the working classes was gravely discussed; now the necessity is recognised by everyone, and the subject under consideration is the best method of carrying on the work. The commercial world has begun to realise the importance of training workmen on scientific lines; it has been led to see that the encouragement of science means the advance of industry and increase of trade. These lessons were difficult to learn, and, even at the present time, the connection between science and manufactures is not properly understood. But a beginning has been made. London, the city that prides itself upon being the largest and richest in the world, but which until recently ignored the need for technical instruction, has begun to foster the child it had done its best to kill by neglect. A comparison with the educational work carried on in Polytechnics on the continent has served to accentuate the deficiencies of London, and to create a desire to follow the lead there indicated. The awakening was rather abrupt, and it was thought by some that the time lost could be rapidly made up again. But this mistaken idea has now been given up, and it is seen that the only way to improve our arts and industries is by slowly educating the mind and training the hand of the mechanic.

Goldsmiths' Institute is specially fortunate in having a very strong Governing Body, containing as it does the names of Sir Frederick Abel, Sir Frederick Bramwell, Sir Richard Webster, Sir Walter Prideaux, Dr. Anderson, and Mr. G. Matthey. It will be seen from Fig. 1, which shows a view of the Institute from the back, that the building covers a considerable area. The structure is the old Royal Naval School building adapted and extended to the requirements of the Institute. Some people considered it a disadvantage to take an institute like that of the Goldsmiths' Company into an old building, but, on the whole, there are many advantages in so doing. In a new building, the architect provides everything he is told to provide, but he does not leave room for future exigencies. In an old building, however, there are usually facilities for extensions in the direction which experience shows to be necessary.

The buildings of the Goldsmiths' Institute are considerably larger than those of any of the other London Polytechnics. A technical museum is now being added, which will be a special feature of this Institute.

The Institute differs from most other Polytechnics in the conditions of membership. The Battersea Polytechnic and the

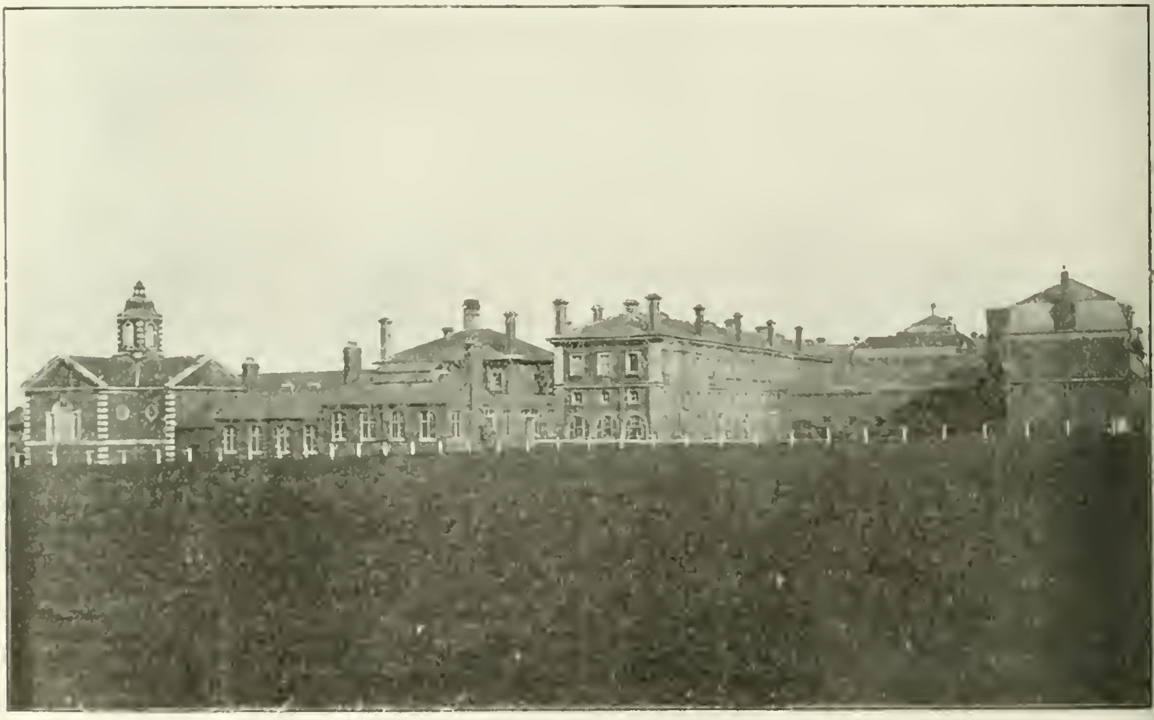


Fig. 1.—The Goldsmiths' Institute (from the back)

It is proposed in this article to give an account of three institutes in London which provide evening education and recreation for persons engaged in various trades and industries during the day. The institutes referred to are the Goldsmiths' Institute, the People's Palace, and the Battersea Polytechnic Institute. Other institutes, however, are referred to incidentally.

To begin with the technical and recreative Institute at New Cross, established and endowed by the Goldsmiths' Company. The expenditure of this Company upon their Institute has amounted to something like £80,000, and they have assigned it an endowment of £5000 per annum. Work was commenced in the Institute in October, 1891, Mr. J. S. Redmayne, of Merton College, Oxford the Secretary, having been appointed about eighteen months previously in order to draw up a scheme of work and get together a strong and efficient staff. His duties are generally to supervise the staff and work, under the direction of the Governors, and generally act as resident representative of the Governors. It is hardly necessary to remark that the success of Polytechnic Institutes from an educational point of view depends very largely upon the Governors. The

People's Palace exclude from membership of the institute, that is, from the social and recreative side, all except students. At the Regent Street Polytechnic, we believe, the rules are exactly the opposite way; those who care to pay for enjoying the social side can also, in virtue of so doing, get their education cheaper, that is to say, the class fees are reduced to members. We have no hesitation in saying that this plan is very bad. The first object of a Polytechnic should be the advancement of technical education. When this purpose is kept more or less in the background, the social and recreative side of the work tends to run rampant. In such cases the "House of Commons," where persons play at Parliament, is one of the most flourishing of the societies, and the "dreary drip of dilatory declamation" constitutes the pabulum of a large proportion of the members. The Governors of the Borough Institute have apparently found that too much attention to clubs and concerts is detrimental to educational work, for they have recently required that all new members should belong to one or more of the classes, and even now there seems to be room for improvement.

At the Goldsmiths' Institute there is one class fee for members and students alike, but a student can get his membership—that is, his social and recreative privileges—at a cheaper rate through being a student. At the same time, people are not excluded from the social side of the Institute, even if they are not students. To put the matter briefly: at the Regent Street Polytechnic studentship is of less account than membership. At Battersea, the People's Palace, and, to some extent, Borough Road, there is no membership without studentship, while at the Goldsmiths' Institute studentship is the main thing, but those who are not students are not excluded from membership—they are only made to pay a little more for their privileges because they are drones.

It must not be supposed that the social or recreative side of Polytechnic Institutes consists entirely of play, for some extremely useful societies belong to it. The mechanical engineering and the chemical societies of the Goldsmiths' Institute are really doing splendid work. At their meetings students read papers of really scientific merit, and important problems in mechanics and chemistry are discussed. Too much praise cannot be given to societies of this kind, and we are glad to find that most institutes recognise their usefulness. They create interest and stimulate research; they help students to realise that scientific attainments must not be gauged by certificates, but by contributions to knowledge. Many institutes put forward as an advertisement of their efficiency the fact that a larger proportion of their students passed certain examinations than those of any other Polytechnic; that their students carried off such and such medals, and so on. This is all very well, but we look to Polytechnics for further evidence of efficiency than that shown by examinational honours. If the mere obtaining of certificates is inculcated into students as the end and aim of their work, the useful results expected from technical education will never arrive. The test, indeed, of the work done in Polytechnics must not be rated according to the list of examinational successes, but by the number and quality of papers published, and inventions made, by its alumni. So far as we know, no London Polytechnic Institute is yet able to produce this evidence of the development of originality, though it is impossible to say what may be done in the future. We would suggest, however, that such institutes should begin to record the additions to knowledge made by their students, and publish the lists year by year in their prospectuses. There would then be no difficulty in determining which of them all had borne the best fruits.

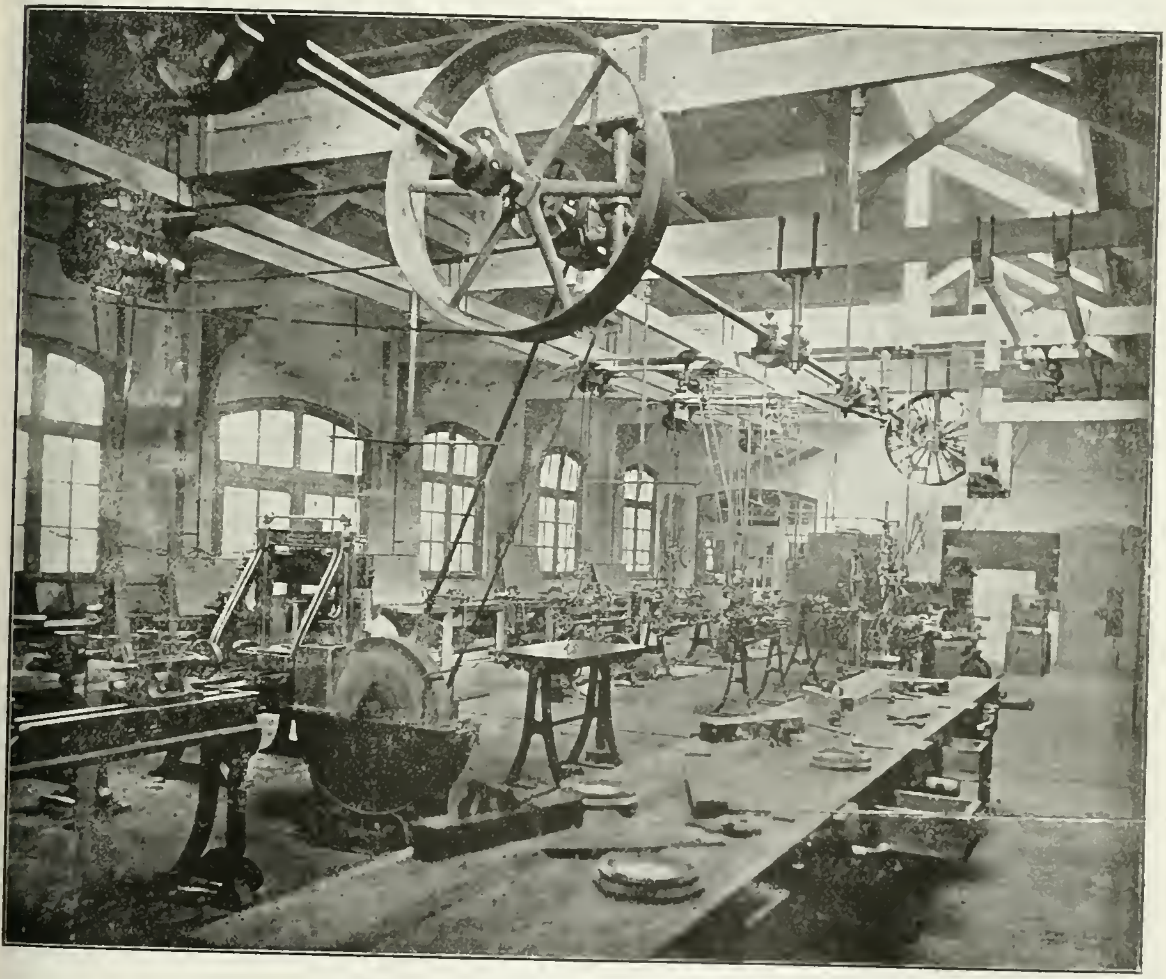


FIG. 2.—Engineering Workshop of the Goldsmiths' Institute.

The engineering department of the Goldsmiths' Institute is one of the best in London. Through the kindness of Mr. W. J. Lineham, the head of this section of work, we are able to give an illustration of the engineering workshop. It will be seen that the workshop is extremely well-fitted with useful machines—far better, indeed, than many of the shops in manufactories. Students who pass through workshop courses are made familiar with almost all the tools and appliances met with in ordinary practice. As for the courses themselves, we can suggest nothing to improve them. Each student is given a rough casting, and is expected to turn out from it a finished product. The first bit of work consists in grinding a cold chisel, both flat and cross cut, and in learning how to do simple marking off. For practice in chipping, filing, and scraping, a cast iron block is worked into a paper-weight. A scribing block is then made, the castings and forgings being provided. This serves as exercise in chipping, filing, drilling, turning, and screwing. The student has afterwards to turn out a surface plate, hexagonal pattern, with handles. This work serves as exercise in planing, turning, drilling and screwing, filing and scraping. During the second year a ratchet brace is made, and a lathe; and third-year students make a shaping and a slotting machine. The course of study for engineering students is worth reprinting, for in it theory and practice are excellently combined:—

First year.	Second year	Third year.	Fourth year.
Fitting and Machining (Shops)	Heat Engines, Advanced.	Smithing (Shops).	Smithing (Shops).
Engineering Lecture (Preliminary).	Mathematics (2nd stage).	Fitting and Erecting (Shops).	Pattern Making (Shops).
Applied Mechanics, Advanced	Fitting and Machining (Shops).	Machine Construction (Special).	Smithing (Shops).
Machine Drawing, Elementary.	Machine Drawing, Advanced	Engineering Lectures.	Engineering Lectures (Special).
Fitting and Machining (Shops)	Engineering Lecture.	Pattern Making (Shops).	Pattern Making (Shops)
The Steam Engine, Elementary.	Applied Mechanics, Advanced.	Finished Drawing and Design (Special).	Finished Drawing and Design (Special).
Mathematics (1st stage).	Fitting and Machining (Shops)		
Drawing Practice (Special).	Drawing Practice (Special).		

The course for building students is just as good. These courses are very popular, and they well deserve the success they have gained. Another successful class is one of carpentry for women; not merely Sloyd or woodwork, but real, practical carpentry. This is, we believe, the first class of the kind that has ever been held. The chemistry classes are specially good, and the laboratories the largest of all the Polytechnic Institutes.

Certain classes of the Goldsmiths' Institute are open to a limited number of *bonâ fide* artisans and handicraftsmen, on payment of half the ordinary fees. This is a rule well worth following in other institutes. Some of the trade classes are open to any one, irrespective of occupation. The clerk who has a taste for machine work may go through the same courses as fitters. If the clerk were allowed to waste his time in dabbling with the lathe and making pretty things, then he ought to be kept out; but when he is compelled to take up routine work, the case is different, for nothing but good can come of it. The young man who is willing to forego empty pleasures in order to obtain technical knowledge, is the one who will develop into an inventor. He works for the pure love of it, and something original may be confidently expected from him in time.

R. A. Gregory.

(*To be continued*).

EXPLORATION OF THE HADRAMUT.

AT the last meeting of the Royal Geographical Society Mr. J. Theodore Bent gave an account of the archæological tour recently made by him and Mrs. Bent in Southern Arabia. On account of the fanaticism of the people, only one European had previously been able to penetrate to the broad valley of the Hadramut, which runs for one hundred miles or more parallel to the south coast of Arabia, gathering in tributary valleys from north and south, and carrying their drainage to the sea at Saihut. Opposition to the expedition was offered, as in the case of Mr. Hirsch, by the British officials at Aden, but in spite of this the Bents, accompanied by the accomplished Indian surveyor, Imam Sharif, and by botanical and natural history collectors, travelled in safety without disguise, and, though there were some hostile appearances, without injury through a large tract of unmapped country.

The region they traversed consisted of three parts, the narrow coast strip or Sahil, backed by the high plateau or Akaba, and the Hadramut and other valleys on the north, which lies between the southern plateau and the high desert land farther north. The whole coast strip from Mokulla to Saihut was extremely arid, only fertilised in patches by occasional hot springs. No traces of antiquities were found along the coast. The plateau of Akaba was ascended by the Wadi Howari, one of numerous short valleys which diversify the southern slope. The plateau presented the appearance of an unbroken plain with only a few flat-topped indications of a previously greater height to break its surface. This district was waterless except for tanks preserving precarious supplies of rain water along the paths. The highest point was found to be Haibel-gabrein, near the southern edge, its elevation being 5300 feet. The plateau was wandered over by a few Bedouins, and on its northern slope considerable numbers of frankincense trees occur, their produce being gathered not by the Bedouins but by Somalis, who come across in the season for that purpose. Where the plateau was trenched by the Hadramut valley the tributary valleys were found remarkably short and steep, cut out of the edge of plateau-like slices from a cake. All these valleys have their floors nearly on the same level as the main valley, and terminate at their heads in steep cliffs 700 or 800 feet high. Their appearance did not seem to justify the theory of water erosion, and Mr. Bent is inclined to consider them as lateral fjords excavated when the Hadramut was an arm of the sea. The rocks were exposed in steep cliffs of horizontally stratified red sandstone. The valley-bottoms are richly cultivated, thronged with villages shaded by palm groves, in effective contrast with the shadeless sterility of the plateau and the desert on either side. In this valley many archæological finds were made, principally in the shape of Himyaritic monuments and inscriptions dating back, in some instances, to B.C. 300. The people of the part of Arabia visited formed four distinct classes. The wild tribes of Bedouins, scattered irregularly, living in isolated houses or caves, rear camels and do all the carrying work. Next are the Arabs proper, who dwell in towns, cultivate the surrounding lands, and engage in extensive trade, sometimes visiting India and the Straits Settlements. Thirdly, the Sayyids and Sherifs form a sort of aristocratic hierarchy, tracing their descent from the Prophet; they are the religious fanatics who object to the admission of foreigners. The last class is that of the slaves, all of African origin, acting as labourers, personal servants, and soldiers to the Sultans of the many independent tribes into which the other classes of the population are divided.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—In connection with the visit of the Royal Agricultural Society to Cambridge next month, the University will bestow honorary degrees on a number of the high officers of the Society and others who have distinguished themselves in promoting agricultural science. The Duke of Devonshire, Chancellor of the University, is President of the Society, and will probably himself confer the degrees. The list of names submitted to the Senate includes H.R.H. the Duke of York, the Duke of Richmond and Gordon, Lord Cathcart, Sir John Thorold, Sir Dighton Probyn, Sir Nigel Kingscote, Sir John B. Lawes, Sir Joseph H. Gilbert, Mr. A. Peckover, the Lord Lieutenant of Cambridgeshire, and Mr. Albert Pell. The Master and Fellows of Trinity College have issued invitations to a banquet in the College Hall for June 26, at which the Prince of Wales, the Chancellor, and the recipients of honorary degrees, will be entertained.

We learn from the *Scotsman* that two important draft ordinances were issued on May 14 by the Scottish Universities Commission. One of these deals with the matter of the regulations for the encouragement of special study in research and for the institution of Research Fellowships. The ordinance provides that the Senatus Academicus of each university may make regulations under which graduates of Scottish universities, or of other universities recognised for the purposes of the ordinance, or other persons who have given satisfactory proof of general education and of fitness to engage in some special study or scientific investigation, may be permitted such study or research in the university. The University Court in each university may establish Research Fellowships, which shall be open to research students only, and may set aside out of the General University Fund such sums as it may think fit to provide for stipends of Research Fellowships. The Court may also provide such sums as it may think fit in aid of the expenses of special research. Research students may be admitted to the degrees of Doctor of Science or of Doctor of Letters of the university in which they have studied as research students, under conditions prescribed in another ordinance of the Commission just issued dealing with the regulations for higher degrees in arts and science. In regard to the degree of Doctor of Science, it is provided that graduates who have taken the degree of Master of Arts with honours in mathematics and natural philosophy, may proceed to the degree of Doctor of Science in the same university after the expiry of five years from the date of their graduation in arts, under the same conditions as if they held the degree of Bachelor of Science. Research students within the meaning of the ordinance relating to the regulations for the encouragement of special study and research may offer themselves for the degree of Doctor of Science of the university in which they have pursued some special study under that ordinance, although they have not taken the degree of Bachelor of Science, or the degree of Master of Arts with honours in mathematics and natural philosophy in that University, under the following conditions:—

(1) That they hold the degree of Bachelor of Science or Bachelor of Medicine of a Scottish or any recognised university, or a degree of any such university, which the Senatus Academicus shall hold to be equivalent to the degree of Bachelor of Science or to the degree of Master of Arts with honours in mathematics and natural philosophy.

(2) That they have spent not less than two winter sessions or an equivalent period as research students in the university granting the degree, and that they produce evidence of satisfactory progress in the special study or research undertaken by them during that period.

(3) That a period of not less than five years shall have elapsed from the date of the graduation required in sub-section (1) of this section.

All candidates for the degree of Doctor of Science have to present a thesis or a published memoir or work, to be approved by the Senatus on the recommendation of the Faculty of Science; provided that, if required by the Senatus, the candidate shall also be bound to pass such an examination as may from time to time be determined. The thesis must be a record of original research undertaken by the candidate, and has to be accompanied by a declaration signed by him that the work has been done and the thesis composed by himself.

It will be noted with regret that no provision is made for the publication of the thesis. This is a serious omission, for scientific work, if worthy of a degree, is surely worthy of publication.

THE name of Dr. D. H. Scott should have been added last week to the list of Oxford men who are among the selected candidates for the Fellowship of the Royal Society.

SCIENTIFIC SERIALS.

American Journal of Science, May.—Observations on the derivation and homologies of some Articulates, by James D. Dana. It is probable that all Articulates are successional to the Rotifers. There is reason for believing further that the types of Annelids, Crustaceans, and probably that of Limuloids, had their independent Rotifer origin. The line to the lower and earlier Arachnoids, that is to the Scorpions, leads up from the early Pterygotus—like Limuloids. A line of succession from Worms to Myriapods and from these to Insects, although not proved geologically, is suggested by the fact that in low-grade insects there is no proper metamorphosis, while in the higher the larval stage is lower and lower in embryonic level. The larval stage would result from an attendant retrograde embryonic change to a line parallel with the Myriapod, and beyond to the memberless condition of a worm.—Notes on apparatus for the geological laboratory, by J. E. Wolff. This paper contains instructions for making diamond saws, for sawing thin sections of rock specimens, and for the management of the arc light for purposes of projection.—An elementary expression in thermoelectrics, by Carl Barus. Two metals are thermoelectrically identical when the sign and the number of available molecular paths which the current (or better, the elementary charge) is free to take, is the same in both metals.—Gases in Kilauea, by William Libbey. Observations of bluish-green flames bursting out from the lava, made with a pocket spectroscope, revealed what was probably carbonic oxide and some hydrocarbons, shown by a band in the green, and bands in the red and blue.—Transformations of mechanical into chemical energy, III. Action of shearing stress continued, by M. Carey Lea. The most instructive experiment was that with mercuric oxide. Half a gram was taken, and after trituration the unchanged oxide was dissolved out by repeated digestions with hydrochloric acid. The reduction products were dissolved out by a few drops of aqua regia, filtered, and precipitated by hydrogen sulphide. The amount of sulphide obtained correspond to the reduction of ·0329 gram of mercuric oxide. The amount of mechanical energy transformed into chemical was found to be 322 gram meters. Silver oxide, potassium ferricyanide, ferric ammonia, alum, silver carbonate and sulphite, and sodium chloroaurate were also successfully reduced by grinding, but not cupric chloride. A porcelain mortar was found much more efficient than one made of agate.

Bulletin of the New York Mathematical Society, vol. iii. No. 7, April 1894. (New York: Macmillan.) Prof. H. Maschke, in a thorough analysis of Harkness and Morley's "Theory of Functions"—it occupies pp. 155–167 of the present number—records the opinion that "the great merits of this valuable work will secure it a high rank in modern mathematical literature." Dr. G. A. Miller, in a note on substitution groups of eight letters (pp. 168–9), makes an important addition to Dr. Cole's list in vol. ii. which is suitably acknowledged by him. Prof. J. McMahon writes on the general term in the reversion of series (pp. 170–2). In the notes the Simson-Lines are printed Simpson's lines. Dr. J. S. Mackay's discovery that no such property has been found in R. Simson's published writings, has not yet "caught on." There is a long list of new publications.

L'Anthropologie, tome v. No. 2, March April, 1894.—M. Ed. Piette contributes some notes to be used for the history of primitive art. The bulk of the accumulations found in caves are composed of broken bones of animals eaten by man, and a cursory examination of the débris suffices to show that whilst the remains of Equidæ predominate in the lower strata, those of Cervidæ are more abundant in the upper strata. Hence, the Glyptic period, as M. Piette calls the age in which quaternary man was in the habit of ornamenting bone, horn, ivory, and stone with sculpture or engraving, has two primary divisions—the Equidian age and the Cervidian age. The former of these may be considered to have two subdivisions, namely the elephantine, or ivory epoch, and the epoch of the horse, called by M. Piette the Hippiquian epoch; two subdivisions are also comprised in the Cervidian age, viz. the epoch of the reindeer and that of the red-deer, or the Rangiferian epoch and the Elaphian epoch.—In a paper on the female deity and the sculptures of the Allée Couverte of Epone, M. Emile Cartailhac describes several blocks and menhirs from various parts of the country on which a female figure is sculptured with more or less detail. On the breast of one of these figures is the representation of an implement or weapon much like the ancient Egyptian boomerang. In a dolmen, excavated by Canon Greenwell at Folkestone, there were found two small cylindrical blocks of limestone, covered with geometrical designs, in the middle of which, in a prominent place, is seen a human face, confined to the forehead, nose and eyes, but, so far, identical with the French sculptures.—M. Maurice Delafosse gives an account of the Hamites of Eastern Africa, in a brief summary of the ethnographical parts of the most recent works that have appeared on the subject. He refers more particularly to the valuable monograph by Dr. Philipp Paulitschke, entitled "Ethnographie Nordost-Afrikas, die materielle Cultur der Danâkil, Galla und Somâl" (Berlin, 1893). The Danakil, Somal and Galla peoples, each comprising a large number of tribes, divide the eastern horn of Africa between them. The Danakil dwell along the coast of the Red Sea and to the east of Abyssinia, the Somal occupy the whole of that point of Africa which projects into the Indian Ocean, while the Galla tribes inhabit the country west of the Somal and to the south of the Danakil and Abyssinia. They are all of Hamitic origin, and differ as much from their neighbours, the Berbers and the Semites of the north, as they do from the negroes and the Bantu of the south. Their hair is not frizzly, but only woolly, and sometimes it attains to a considerable length, especially among the women. The nose is not flat; it is frequently broad and short, but it is sometimes even aquiline. The lips are rarely protuberant, though they are almost always thick. M. Salomon Reinach continues his account of sculpture in Europe prior to Greco-Roman influence; and M. E. Vouga discusses the probable age of the lacustrine stations in Switzerland. M. Vouga calculates that the layer of mud that overlies the bronze bed to the thickness of about 0·12 m. has required 3000 years for its accumulation, that the deposition of the bronze bed itself occupied one or more centuries, a layer of lacustrine mud between the bronze bed and the stone bed (0·12m. thick) took another 3000 years to accumulate, and that the stone bed probably took twice as long in its formation as the bronze bed did. The stations have been suddenly abandoned, with all the personal property of the inhabitants, several times, and completely deserted: once by the men of the pure stone age—the stone of the country; a second time perhaps, but very probably, by other men who possessed nephrite and jade implements, axes and polished hammers, and articles of copper; lastly, by the men of the bronze age. No satisfactory explanation of these facts has yet been offered, but perhaps the frequent change of level of the lake waters may be to some extent responsible for them.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 26.—"On the Specific Heats of Gases at Constant Volume. Part II. Carbon Dioxide." By Dr. J. Joly, F.R.S.

In the former experiments on this gas, recorded in the first part of this research,[1] the highest absolute density at which the specific heat was determined was 0·0378. In the present observations the determinations of specific heat have been carried to densities at which the substance was partly in the liquid state at the lower limit of temperature of the experiments. Observations dealing with true specific heat, uncomplicated by the presence of thermal effects due to the presence of liquid, are limited by the density 0·1444. At this density the mean specific heat over the range, 12° C. to 100° C., is 0·2035.

These observations, combined with those contained in Part I. (*loc. cit.*), afford a well defined line, which rises slowly at the higher densities, turning away from the axis of density.

According to an empirical equation to this line, the specific heat of carbon dioxide at constant volume is given in terms of its variation with density ρ, as follows:

$$Cv = 0{\cdot}1650 + 0{\cdot}2125\rho + 0{\cdot}3400\rho^2$$

"On the Specific Heats of Gases at Constant Volume. Part III. The Specific Heat of Carbon Dioxide as a Function of Temperature." By Dr. J. Joly, F.R.S.

In order to investigate the question of the variation of the specific heat of carbon dioxide with temperature, a steam calorimeter was constructed having double walls of thin brass, between which the vapour of a liquid boiling under atmospheric pressure could be circulated. The vessels used in the experiments were hung in the closed inner chamber. Into this chamber steam could be admitted after the temperature had become stationary and the same as that of the jacketting vapour. In this way the initial temperature could be varied.

Experiments at various densities and over four intervals of temperature were carried out. The densities chosen were 0·0456; 0·0800; 0·1240; 0·1800, and 0·1973. The intervals of temperature over which the gas at each density was investigated were: air temperature to 100°; 35° C. (boiling point of ether) to 100°; 56° (boiling point of acetone) to 100°, and 78° (boiling point of ethyl alcohol) to 100°.

The results are plotted on 5 equi-density lines, in which the precipitation due to the calorific capacity of the gas between t_1, and 100° is plotted against the initial temperature t_1 in each case. If the specific heat is invariable these are right lines. This proves to be sensibly the case for the lines $\rho = 0{\cdot}0456$ and $\rho = 0{\cdot}0800$; those of lowest density.

The next line, 0·124, is nearly rectilinear over the higher ranges, but pursued in the direction of decreasing temperature it rises markedly, thus indicating that the specific heat at constant volume falls in value with increasing temperature. The line $\rho = 0{\cdot}1800$ and the one close above it, $\rho = 0{\cdot}1973$, show this variation very markedly. Their variation below the critical temperature is complicated by the presence of liquid.

[1] "On the Specific Heats of Gases at Constant Volume," Part I. *Phil. Trans.* vol. clxxxii. 1891 (pp. 73-117).

The following empirical equation expresses the line $\rho = 0{\cdot}124$ calculated into a line of variation of specific heat with temperature:—

$$Cv = a\,(100 - t) + b\,(100 - t)^2 + c\,(100 - t)^3,$$

where t is the initial temperature of the experiment in centigrade degrees;

$$a = 0{\cdot}19020000,$$
$$b = -0{\cdot}00006750,$$
$$c = 0{\cdot}00000182.$$

Geological Society, May 9.—Dr. Henry Woodward, F.R.S., President, in the chair. The following communications were read:—Carrock Fell: a Study in the Variation of Igneous Rock-masses. Part I. The Gabbro. By Mr. Alfred Harker. The author opened with an account of the general relations of the intrusive rock-masses of the district, and proceeded to deal more particularly with the gabbro, which forms the earliest intrusion. A petrological description of the Carrock Fell gabbro followed a study of the variations observed in different parts of the mass. The rock becomes progressively more basic from the centre to the margin, passing from a quartz-gabbro with as much as 59½ per cent. of silica to an ultrabasic type with as little as 32½. The latter in extreme cases contains nearly 25 per cent. of iron-ores, partly titaniferous. This was compared with the igneous iron-ores described by Vogt in Scandinavia, &c., and the probable physical cause of the remarkable variation in the gabbro was discussed. Other modifications of the gabbro were briefly noticed, due on the one hand to metamorphism of the rock by a somewhat later intrusion of granophyre, on the other hand to the gabbro-magma having enclosed considerable masses of the basic lavas of the district, which are themselves highly metamorphosed. The paper was commented upon by Mr. Marr, Prof. Judd, Prof. Cole, and Mr. Rutley.—The Geology of Monte Chaberton, by Mr. A. M. Davies and Dr. J. W. Gregory. The importance of the Chaberton district, as affording a key to the general geology of the Cottians, was explained, and the opinions of previous observers referred to. The mountain was examined from three sides—that of the Grand Vallon; the approach from Mont Genèvre by the Col de Chaberton; and that of the Clos des Morts Valley. The following are the conclusions arrived at:—(1) The well-known Chaberton serpentine is intrusive into the calc-schists, and yields fragments to the *cargneules* of the Trias: it is therefore a *pre-Triassic* intrusion. (2) There are on the mountain other fairly basic schistose rocks (quartz-chlorite-schists) which cut the Trias, and are therefore *post-Triassic*. (3) The contorted beds in the Clos des Morts Valley are fossiliferous limestones, and it is from them that the fallen blocks previously recorded were derived. The only recognisable fossil is *Calamophyllia fenestrata*, Reuss, a characteristic coral of the Gosau Beds. In spite, therefore, of the doubts of Kilian and Diener, the opinion expressed by Neumayr as to the existence of Cretaceous rocks in this part of the Alps is confirmed. (4) The earth-movements of the mountain are described: they include ordinary folds, inversions, faults, and an important thrust-plane. (5) It is suggested that in addition to the two series of intrusive rocks above mentioned as pre- and post-Triassic, a third series of late Cretaceous or Tertiary date may be represented in the Mont Genèvre and Rocciavrè masses.—Cone in Cone. How it occurs in the Devonian (?) Series in Pennsylvania, U.S.A., with further details of its structure, varieties, &c., by Mr. W. S. Gresley. The author described cone in-cone structure occurring in the Portage Shales of Pennsylvania, and gave details concerning the nature of the structure as seen in these shales. He criticised the explanation of Mr. J. Young as to the origin of the structure, and concurred in a great measure with the views of those who have suggested that the formation was due to pressure acting on concretions.

Mathematical Society, May 10.—Prof. Greenhill, F.R.S., Vice-President, in the chair.—The following communications were made: On the kinematical discrimination of Euclidean and non-Euclidean geometries, by Mr. A. E. H. Love. The problem of Helmholtz, to lay down axioms concerning motion, by which the Euclidean, elliptic, and hyperbolic geometries shall be distinguished from all other imaginable geometries, has been recently solved by Sophus Lie in the third part of his "Theorie der Transformations-gruppen" (1893), and he adds the remark that the group of the Euclidean motions is distinguished from the two groups of non Euclidean motions by the possession of a real invariant sub-group. This remark obviously refers to translations, and in fact it appears to have been previously noticed that in the elliptic and hyperbolic geometries, the transformations that correspond to translations do not form a group. In the present communication a number of representations of elliptic and hyperbolic geometry are described and illustrated with the object of making this kinematical distinction between the Euclidean and the other geometries intuitively obvious.—Permutations on a regular polygon, by Major P. A. MacMahon, F.R.S.—The stability of a tube, by Prof. Greenhill (Dr. J. Larmor, F.R.S., *pro tem.* in the chair). The difficulties of constructing a theory for the stability of a tube, subject to external pressure and end thrust, have been discussed by Mr. A. B. Basset in the *Phil. Mag.* September 1892. Similar investigations have been undertaken by Mr. Love and Mr. Bryan in the *Proceedings* of the London Math. Society. The analytical difficulties due to the difference of pressure on the two sides of the plate, have not yet been overcome, so that the investigation of the present paper must be taken as provisional, as it proceeds on the old theory, as laid down in Thomson and Tait's "Natural Philosophy." The chief object is to determine the number of segments or waves into which the cross section of the tube will tend to break, as the supporting influence of the ends is made to operate at sections which are brought closer and closer together; the influence of the end thrust is also taken into account. A differential equation is obtained for w, the infinitesimal normal displacement of the tube, of the form

$$A\left(\frac{d^4w}{dx^4} + 2\frac{d^2w}{dx^2dy^2} + \frac{d^4w}{dy^4} + 2\frac{d^2w}{a^2dx^2} + \frac{w}{a^4}\right)$$
$$+ A\sigma\frac{d^2w}{dx^2} + X\frac{d^2w}{dx^2} + Za\left(\frac{d^2w}{dy^2} + \frac{w}{a^2}\right) = 0 \quad . \ . \ (A)$$

where x is measured parallel to the axis of the tube, and y circumferentially; a denotes the radius of the tube, b its thickness, A the flexural rigidity, σ Poisson's ratio, X the longitudinal thrust in the tube per unit length of cross section, and Z the external applied pressure; the inch and pound are taken as units of length, so that the theoretical results may be compared immediately with experimental values; to do this it is assumed provisionally that we may put $A = \frac{1}{12} Mb^3/(1 - \sigma^2)$, where M denotes Young's modules of elasticity. If the tube breaks circumferentially into n waves, we put

$$\frac{d^2w}{dy^2} = -\frac{n^2w}{a^2}, \quad \frac{d^4w}{dy^4} = \frac{n^4w}{a^4};$$

and equation (A) becomes

$$\frac{d^4w}{dx^4} - 2n^2\frac{d^2w}{a^2dx^2} + (n^2 - 1)^2\frac{w}{a^4}$$
$$+ \left(\sigma + \frac{Xa^2}{A}\right)\frac{d^2w}{a^2dx^2} - (n^2 - 1)\frac{Za^3}{A}\frac{w}{a^4} = 0 \quad . \ . \ (B)$$

For cylindrical collapse, when the supporting influence of the ends is left out of account, $\frac{d^2w}{dx^2}$ is zero, and therefore

$$\frac{Za^3}{A} = n^2 - 1, \; nZ = \frac{n^2 - 1}{12}\frac{M}{1 - \sigma^2}\left(\frac{b}{a}\right)^3.$$

But if the ends of the tube are supported or strengthened, the collapsing pressure is obviously increased, so that

$$\frac{Za^3}{A} - (n^2 - 1)$$

is positive. If the supporting influence is due to a series of equidistant strengthening rings, as is a caisson, l inches apart, preserving accurately the circular form at the corresponding section, while permitting slight changes of direction in the longitudinal seams, we put

$$\frac{d^2w}{dx^2} = -\frac{\pi^2w}{l^2}, \quad \frac{d^4w}{dx^4} = \frac{\pi^4w}{L^4};$$

so that (B) becomes

$$\left(\frac{\pi a}{L}\right)^4 + \left(2n^2 - \sigma - \frac{Xa^2}{A}\right)\left(\frac{\pi a}{L}\right)^2$$
$$+ (n^2 - 1)^2 - (n^2 - 1)\frac{Za^3}{A} = 0 \quad . \ . \quad . \ (C)$$

In practice X is proportional to Z, when it is not zero; and to determine the number n of segments into which the tube collapses, we may put $Za^3/A = y$, and $(\pi a/l)^2 = x$, and draw the hyperbolas represented by (C) for values of $n = 1, 2, 3, \ldots$; and the points of crossing of these hyperbolas will represent the separating states when an integral change in n is about to take place. The case of $n = 1$ would only occur when the tube was used as a long cylindrical column, on the point of buckling sideways, without crippling; we now find that the formula assigns a critical thrust which is only $\frac{2}{3}(b/a)^2$ of that given by the usual theory, due to Euler.—Researches in the calculus of variations, Part v., the discrimination of maxima and minima values of integrals with arbitrary values of the limiting variations; Part vi., the theory of discontinuous or compounded solutions, by Mr. E. P. Culverwell.

Physical Society, May 11.—Walter Baily, Vice-President, in the chair.—A mathematical communication on electromagnetic induction in plane, cylindrical, and spherical current sheets and its representation by moving trails of images, by G. H. Bryan (part 1, general equations), was read by Dr. C. V. Burton, who also explained some of the parts in greater detail. After mentioning that the magnetic field due to induced currents in thin conducting sheets placed near moving magnetic poles could be represented by moving trails of images of those poles, the author goes on to say that in the paper, the surface-conditions which hold at the surfaces of the sheets are deduced directly from the fundamental laws of electromagnetic induction. (1) The total current across any enclosed portion of a surface which always contains the same particles is equal to $1/4\pi$ of the line-integral of the magnetic force round the curve bounding the surface; and (2) the rate of decrease of the surface integral of magnetic induction across any enclosed surface which always contains the same particles to equal to the line-integral of electromotive force round the curve bounding the surface. By working with the scalar magnetic potential instead of vector-potential, the investigation is simplified. In addition to the above laws, the author makes the usual assumptions that displacement currents in the dielectric are so small as to be negligible, and that the induced currents are distributed uniformly through the thickness of the sheet. On these suppositions the surface conditions satisfied by the potentials at the two sides of plane, cylindrical, or spherical sheets are determined, and with an additional limitation as to the thickness of the sheet fulfilling certain conditions, extended to current sheets of other forms. In the latter part of the paper a synthetic determination of the images in a plane sheet is given and expressed in the form of a definite integral. In reading the paper to the meeting Dr. Burton pointed out several misprints in the proof.—Prof. Minchin showed that equation (1) of the paper ($\Omega_2 - \Omega_1 = 4\pi\phi$ + constant, where Ω_2 and Ω_1 are the magnetic potentials at the two sides of the sheet, and ϕ the current function), could be deduced by purely mathematical reasoning instead of being based on the laws of electromagnetic induction. Moreover, it was true for any function whatever and did not depend on ϕ being the current function. Equation (2) $\left(\frac{d\Omega_2}{dz} = \frac{d\Omega_1}{dz}\right)$ followed immediately from the fact that the magnetic force was continuous. The latter part of the paper might be simplified by integrating the linear partial differential equation (15)

$$\left(\frac{d^2\Omega'}{dz\,dt} - R\frac{d^2\Omega'}{dz^2} = -\frac{d^2\Omega_0}{dz\,dt}\right)$$

in the ordinary way, for the form was one for which the auxiliary equations are well known. Dr. Burton, in reply, said he thought Mr. Bryan's reason for developing the equations from the laws of electromagnetic induction was to give his work a physical rather than a mathematical basis.—A paper on dielectrics was read by Mr. Rollo Appleyard. In testing the insulation resistance of celluloid, by having a sheet pressed between two metal plates, the author noticed that the resistance, which was very high, *decreased* as the time the testing battery was left on increased. The "electrification" (using the word to indicate the rate of diminution of galvanometer deflection) was therefore *negative*. The resistance also diminished greatly with increase of battery power, and a considerable amount of hysteresis was observed, the resistance at any given voltage, after a minute's electrification, depending on the previous history of the specimen. On making contact with the surfaces of the celluloid by mercury instead of by solid metal, the abnormal results disappeared, little or no resistance-hysteresis or "electrification" being present, and only a small diminution of resistance with increase of voltage. For a sheet 6 mils thick the resistance between opposite faces 5½ inches diameter was of the order 30 megohms, and one specimen broke down at 1200 volts. The celluloid condensers used in the experiments were found to discharge slowly at first, and after a certain time the deflection of the galvanometer became reversed, and attained a steady negative value. This the author attributes to an E.M.F. of about 0·0026 volt between the mercury and celluloid. Similar experiments on gutta-percha tissue showed no such E.M.F., and the "electrification" was normal. The resistance usually attained a maximum for voltages between 600 and 800. Although the tissue had a thickness of only 2 mils (0·002"), it stood a pressure of 1200 volts, and offered a resistance between circular faces 5½ inches in diameter of about 3000 megohms. The opaque white spots seen in celluloid under the microscope, led the author to test the behaviour of mixtures of conducting and insulating materials. A strip of gutta-percha was warmed, and coarse brass filings scattered over it as thickly as possible. In spite of this the resistance was practically infinite even when tested with 750 volts. A number of rods were made from mixtures of brass and gutta-percha in various proportions, and on testing these it was found that if the weight of filings exceeded about twice that of the gutta-percha, the resistance of a rod 20 inches long, ¾ inch diameter, was small (sometimes a fraction of an ohm), whereas a slightly smaller proportion yielded rods having resistances measured in thousands of megohms. Such rods were found to be affected by oscillating discharges in a manner similar to Prof. Minchin's "impulsion" cells and M. Branly's tubes of filings. Experiments were also made on the behaviour of such rods when subjected to high alternating pressures. This caused small local arcs to form along the rods, but did not permanently destroy their high resistance.—In connection with Mr. Appleyard's paper, a note on the behaviour of certain bodies in presence of electromagnetic oscillations, by Prof. G. M. Minchin, was read by Mr. Elder. Referring to the employment of impulsion cells, metallic films, &c., for detecting the modes of electromagnetic vibrations, he says that so far the physical state of such bodies are too variable to be of service. Metallic surfaces formed by embedding fine metallic powders in films of gelatine, shellac, or sealing-wax, are, as described in a previous communication to the Society, found to act as insulators, but become conducting when subjected to strong electromagnetic disturbances. After a current has once passed through such a film its resistance is changed by very feeble impulses, whereas previously it failed to respond to strong ones. On breaking contact by removing the electrode from the surface, the film loses its conductivity, the time necessary to do this depending on the hardness of the matrix. The resistance of a film containing tin powder, measured between the rounded tips of two platinum wires, 1 c.m. apart, varied under the electromagnetic impulses from infinity to 130 ohms. In conclusion, the author points out that with films and tubes the whole phenomenon relates to charge of resistance, whereas impulsion cells may have currents from external sources passing through them whilst in either the sensitive or insensitive states.—Mr. Bright and Mr. Enright asked questions as to the electrification of gutta-percha, and the bridge connections in the resistance tests of the semi-conducting rods respectively, to which Mr. Appleyard replied.

Royal Meteorological Society, May 16.—Mr. R. Inwards, President, in the chair.—Mr. W. Ellis, F.R.S., read a paper on the relative frequency of different velocities of wind, in which he discussed the anemometer records of the Greenwich Observatory for the five years 1888–1892, with the view of ascertaining the number of hours during which the wind blew, with each of the different hourly velocities experienced during the period. The results of this discussion show that the wind blew for the greatest number of hours with the hourly velocities of ten and eleven miles.—Mr. W. Marriott gave an account of a series of observations on the audibility of "Big Ben" at West Norwood, which he had carried on for a period of five years. The clock tower at Westminster is five and a half miles distant from the point of observation in a north-by-west direction. The large bell "Big Ben" was designed by Lord Grimthorpe, and was cast in 1858; its weight is about fourteen tons. It is 9 ft. 5½ ins. in diameter, and 9½ ins. in thickness, its tone being E. The observations were 676 in number, and were made at the hours of 9 a.m. and 9 p.m. The bell could be heard more frequently in the evening than in the morning, and on Sundays it was more frequently audible than on week-days. The direction of the wind most favourable for hearing "Big Ben" was between west and north. The observations were also discussed in relation to temperature, moisture, cloud, and barometric pressure.—A paper by Mr. A. W. Moore was also read on earth temperatures at Cronkbourne, Isle of Man, 1880–1889.

Royal Microscopical Society, April 18.—Mr. A. D. Michael, president, in the chair.—Dr. W. H. Dallinger directed attention to a stereoscopic photomicrograph of Heliopelta, which had been presented to the Society by Dr. W. C. Borden, of New York.—Dr. Dallinger read a short paper from Dr. H. G. Piffard, in reference to a method which he had adopted for the examination of some of the old immersion objectives.—Mr. J. W. Brown exhibited a "home-made" microscope.—Prof. F. J. Bell read a letter from M. C. I. Pound, describing the laboratories of the Stock Institute of Queensland, which had recently been instituted for the purpose of investigating the nature and causes of animal diseases in that colony.—Mr. J. G. Grenfell read a paper on the tracks, threads, and films of oscillatoriæ and diatoms, illustrating his subject by diagrams and specimens. Mr. T. Comber and the President made some remarks on Mr. Grenfell's paper.

Paris.

Academy of Sciences, May 15.—M. Lœwy in the chair.—On the influence of bending in telescopes mounted as coudé equatorials, by MM. Lœwy and Puiseux.—Researches on the augmentation of crops by introduction into the soil of large quantities of carbon bisulphide, by M. Aimé Girard. The author shows that, for at least two years after treating soils with carbon bisulphide, wheat, oats, beetroot, potatoes, and clover yield much heavier crops than on soil not treated. He traces the increased production rather to the destruction of insect pests than to any action on parasites belonging to the vegetable kingdom.—Observation of Tempel's comet (1873 II.) made at Algiers Observatory. A telegraphic despatch transmitted by M. Tisserand.—On the periodic comet Tempel (1873 II.), by M. L. Schulhof.—Observations of comet Denning (1894, March 26) made at Toulouse Observatory, by M. E. Cosserat.—Observations of Gale's comet (1894, April 3) made at Lyons Observatory, by M. J. Guillaume.—Observations of the same comet made with the coudé equatorial at Lyons Observatory, by M. G. Le Cadet.—Graphic ephemerides giving the co-ordinates of the stars for the purposes of navigation, by M. Louis Favé.—On the equations of mechanics, by M. Wladimir de Tannenberg.—Determination of the relative intensity of gravity, made at Joal (Senegal) by the expedition sent out by the Bureau des Longitudes to observe the total eclipse of the sun on April 16, 1893, by M. G. Bigourdan. Taking g = 981 at Paris, at Joal the mean value of g, reduced to sea-level, is 978·437. This result confirms Defforge's law that g has a characteristic value for the littoral of the same sea, of which the variation follows exactly Clairaut's law of the sine squared of the latitude.—On the physical properties of pure nitrous oxide, by M. P. Villard. The author describes the preparation of the pure gas by a liquefaction method, and compares the densities of the liquid and its vapour from 0° to 30°·3. He finds the critical temperature of the pure gas to be 38°·8 as compared with Dewar's value, 35°·4, and Janssen's 36°·4. The critical volume, density, and pressure are respectively 0·00436, 0·454, and 77·5 atmospheres.—On the stability of dilute solutions of corrosive sublimate, by M. Léo Vignon. The stability depends on the absence of alkaline matter which may be present in the water used or derived from the air or the glass of the containing vessel.—On the chemical character and constitution of ethylic acetoacetate, by M. de Forcrand. From a consideration of thermal data, the author concludes that ethylic acetoacetate most nearly resembles phenols, that it is neither an acid nor a ketone, but a tertiary alcohol of a special type, and should be represented by the formula

$$CH_3.C(OH):CH.COOEt.$$

—Comparative study of the isomeric nitrobenzoic acids, by M. Oechsner de Coninck.—The Diptera parasitic on Acridians: viviparous Muscidæ, *à larves sarcophages*. Aptenia and parasitic castration, by M. J. Kunckel d'Herculais.—On the fixity of race in the cultivated mushroom, by MM. Costantin and L. Matruchot. The peculiarities distinguishing the varieties recognised by mushroom growers are hereditary.—Remark concerning a recent communication, by M. Issel, on the Zante earthquakes, by M. Stanislas Meunier.—M. d'Abbadie describes a new method of measuring a geodetic base-line in presenting volume li. of "Memoires de la Section topographique de l'État-Major-Général russe," on behalf of M. Vénukoff.

BERLIN.

Meteorological Society, April 3.—Prof. Hellmann, President, in the chair.—Dr. Rassner spoke concerning the measurements of the height of clouds at the Eiffel Tower, which had given 150 m. as the lowest value, and discussed the different methods of determining the height of clouds by means of artificial illuminants as proposed and used by La Cour, Cleveland Abbe, Jesse, Hasen, and others. The speaker himself on two occasions had the opportunity of measuring the height of clouds; the first, in the summer of last year, was a thunder cloud, whose height he determined, with the aid of an electric lamp, to be about 80 m.; on the second occasion, in January of this year, he was able by the use of an intermittent benzole light, to measure the height of the clouds to 750 m.—Dr. Schubert made a communication concerning the cyclone of February 12 last, which did very great damage in the forest of Freienwalde and Chorin, especially in the pine districts, where the trees were torn up by the roots, and blown down by the storm. A series of beautiful photographs illustrated the devastation produced by the storm.

Physiological Society, April 13.—Prof. du Bois Reymond, President, in the chair.—Dr. Krüger spoke concerning the determination of the uric acid and nuclein bases in urine by precipitation with copper sulphate and sodium bisulphide. With the help of these reagents one can determine exactly the nitrogen of the uric acid and of the nuclein bases. If the nitrogen of the uric acid be now determined by means of the Ludwig-Salkowsky method, one arrives at a quantitative determination of the nuclein bases. On the other hand, the uric acid in the urine may be changed into allantoin by manganese, in which case treatment with the copper sulphate-sodium bisulphide yields only the nitrogen of the nuclein bases. This is then deducted from the total nitrogen which had been found before, and so one obtains quantitative estimation of the uric acid. These reactions were verified in a great number of experiments.—Dr. Jacob reported on a case of leukæmia which he had investigated in conjunction with Dr. Kruger. They first showed that an increase in the nitrogen of the uric acid and nuclein bases of the urine is associated with the increase in the number of the leucocytes. After injection of an extract of spleen, there was observed first a decrease, and later an increase in the number of leucocytes. In proportion to the increase of the leucocytes there was an increase in the quantity of urine excreted and in the amount of uric acid and nuclein bases. When after some days the number of leucocytes decreased the quantity of urine, of uric acid, and of nuclein bases also diminished.—Dr. Lilienfeld communicated the results of experiments which he had made on the condensation of glycocol ether, and on the union of a diamine base derived from glycocol with leucine ether and tyrosine ether. The condensation of glycocol ether and tyrosine ether resulted in a body which gave the reactions of glutin, and resembled glue in appearance, while the union of the above-mentioned three substances gave a proteid-like body, which showed the biuret reaction, and was dissolved by pepsin. The conjectures as to the constitution of these three substances will be tested by further experiments.

April 27.—Prof. du Bois Reymond, President, in the chair. Dr. Ad. Loewy communicated the results of his experiments on the influence of rarefied and compressed air on the circulation. As he showed in earlier experiments a diminution of pressure to about 450 mm. of mercury was tolerated very well and did not lead to any real disturbance, and that the lowered oxygen tension, produced either by still greater rarefaction or by the addition of carbonic acid to the air breathed, is compensated for by deeper respirations. The speaker desired now to determine by experiment whether, with rarefaction of the air, compensating changes can be observed in the vascular system. In particular he determined the velocity of the blood flow by the method recently devised by Prof. Zuntz (NATURE, vol. xlix. p. 168) in animals which respired in rarefied air of about ½ atmosphere, and found that, at each systole of the heart the volume of the blood ejected exactly equals that which the same animal shows under normal pressure. Thus if the tension of the oxygen breathed is reduced one half the effect on the circulation is as slight as it is on the respiration. With still greater rarefaction the oxygen tension in the alveoli can, by deeper respiration, still be brought to the level where the hæmoglobin of the blood is saturated, and no distress appears. Dr. Loewy drew interesting conclusions from his experiments in relation to the meaning of mountain sickness.—Prof. A. Kossel, in his further researches on thymin, a decomposition product derived from nucleic acid extracted from the thymus, has obtained a substance which gave all the reactions of levulinic acid, and produced a salt with silver which possessed exactly the crystalline form of the silver salt of levulinic acid. As levulinic acid originates from levulose, and is viewed by many chemists as proof of the presence of levulose, so from the above reaction the presence of a carbohydrate in nucleic acid is to be deduced. The origin of the nucleic acid is indifferent for this reaction, since it was found with all nucleic acids, a very important fact in relation to the physiology of metabolism. The attempt to discover a carbohydrate in the atom complex of casein, closely related to nucleic acid, led to the discovery of a substance which gave all the reactions of levulinic acid, with the exception of the levulinic acid salts, so that a certain conclusion as to the presence of a carbohydrate complex in casein cannot be drawn.

Physical Society, April 20.—Prof. du Bois Reymond, President, in the chair.—Prof. Koenig reported on a form of colour-blindness lately examined by him, which had not been observed before. The typically colour-blind see yellow in the spectrum where the normal eye perceives red, and the yellow continues with increasing admixture of white until the middle of the spectrum, about $\lambda = 530\mu\mu$, where it commences to change to pale blue which becomes continuously deeper until, at the violet end of the normal spectrum, deeply saturated blue is perceived; in the totally colour-blind, as is well known, every colour sensation has vanished; they see in the entire spectrum only white, which attains its greatest intensity about where the normal eye sees green. The typically colour-blind fall into two groups, which differ only in the position of the greatest brilliancy of the spectrum, the maximum in the one lies where the normal eye sees orange, about $650\mu\mu$, in the other it lies at the yellow, near $580\mu\mu$. The newly investigated case of colour-blindness showed a condition intermediate between typical colour-blindness and total colour-blindness. In the entire spectrum only white was seen, but at the red end of the spectrum the white was mixed with a very weak yellow, and at the violet end with a very weak blue. These colours were first perceived when the two ends of the spectrum lay next one another, and were compared. The maximum brilliancy lay in this case where the second group of typically colour-blind show it—near $580\mu\mu$. The present theories of colour perception are unable to explain this new case. [In the report of the meeting of the Physical Society for March 2 (NATURE, vol. xlix. p. 595), for Roepsel read Koepsel, and for Hulske read Halske.]

SYDNEY.

Linnean Society of New South Wales, March 28.—The following papers were read:—Notes on Australian *Typhlopidæ*, by Edgar R. Waite. Two new species were described—*T. batillus*, from New South Wales, and *T. diversus* from Queensland. Some discrepancies in the published descriptions of *T. unguirostris*, Peters, and *T. affinis*, B'gr. were pointed out. Three aspects of the head of *T. wiedii*, Peters, the only species hitherto unfigured, were given in order to complete the series. The measurements of a gigantic example of *T. polygrammicus* were recorded, the total length being 717 mm. (28¼ inches).—On the fertilisation of *Clerodendron tomentosum*, R.Br., and *Candollea serrulata*, Labill, by Alex. G. Hamilton. The author showed that both plants possess contrivances for the purpose of ensuring cross-fertilisation. *Clerodendron* is proterandrous, and is fertilised by *Sphingidæ*, the pollen being deposited on the legs and underside of the thorax of the insects, a bending of the style keeping the immature stigma at this stage out of the way. After the pollen is shed the stamens curve downwards and the style straightens, bringing the now mature stigma into the position formerly occupied by the anthers. *Candollea serrulata* and its congeners have the anthers and stigma at the end of a sensitive column. This possesses a hinge, which if touched, causes the style to fly over. The anthers mature before the stigma, and at first conceal it. The flower is so constructed that when a bee thrusts in its proboscis, it inevitably touches the sensitive spot, and the style immediately flies over and clasps the bee, which then receives the pollen on its back. Later, when the pollen is all shed, the stigma, which is papillose, grows out, and a bee visiting a flower is struck by the stigma, when the papillæ being glutinous receive the pollen. The author also noted some experiments and observations on the action of the sensitive column.—Note on Bungwall (*Blechnum serrulatum*, Rich.), an aboriginal food, by Thos L. Bancroft. The rhizome of this fern formed, with the nuts of the Bunya Bunya (*Araucaria Bidwilli*), the most important food of the aborigines of Southern Queensland.—On the nests and habits of Australian *Vespidæ*, by Walter W. Froggatt.—Description of *Calliostoma purpureo cinctum*, a new Australian marine shell, by C. Hedley. A small Trochoid, ornamented with beaded sculpture, and coloured orange with a spiral lilac band, was added to the local fauna under the above title.—Note on the habitat of the Naked-eyed Cockatoo (*Cacatua gymnopis*, Sclater), by Alfred J. North. Living specimens caught near Burketown in North Queensland, now on view in Sydney, have been examined; and there are specimens in the Macleay Museum from the Gulf of Carpentaria and from Port Darwin, and in the Australian Museum from Cambridge Gulf. The note of interrogation in the record of the habitat for this species given in the British Museum Catalogue of Psittaci ["South Australia (and also Northern and North-west Australia?")] may therefore be dropped.—Oological notes, by Alfred J. North, (1) *Ptilotis analoga*; (2) *Lamprococcyx malayanus*.—Observations upon the anatomy of the "dumb-bell-shaped bone" in *Ornithorhynchus*, with a new view of its homology, by Prof. J. T. Wilson. The "dumb-bell-shaped" bone is not confined to the palatine region, but both dorsally and posteriorly it is in intimate relation to the nasal septum. From the dorsal part of its hinder extremity it sends backwards a distinct vomerine spur, about 3 mm. in length, which is bifurcated posteriorly and grooved along its dorsal border, forming a splint for the ventral edge of the cartilaginous nasal septum. The tips of this bifid spur are connected with those of the anteriorly bifid end of the true vomer by means of a strong "vomerine ligament," varying in length from about 2 mm. downwards. In coronal sections this ligament is seen to possess the same sectional shape as the vomerine spurs, and to be structurally and morphologically continuous with the bone at either end. The vomerine spur lies quite dorsal to the palatine plate formed by the maxillæ, and it extends backwards to a plane from 2–3 mm. behind the tip of the anterior median process of the latter, from which it is separated by an interval. This interval forms a wide passage of communication (1 mm. vertically), below the nasal septum, between the nasal cavities of opposite sides, and it is lined by columnar epithelium like the neighbouring parts of these cavities. The "dumb-bell-shaped bone" is a true "anterior vomer" formed by the fusion of bilaterally symmetrical halves; and both in its nasal and in its palatine relations it resembles the palatine lobe of the vomer in *Caiman niger*.

DIARY OF SOCIETIES.

London.

THURSDAY, May 24.

Royal Society, at 4.30.—On the Dynamical Theory of Incompressible Viscous Fluids, and the Determination of the Criterion: Prof. O. Reynolds, F.R.S.—Measurements of the Absolute Specific Resistance of Pure Electrolytic Copper: J. W. Swan and J. Rhodin.—On some Voltaic Combinations with a Fused Electrolyte and a Gaseous Depolariser: J. W. Swan.—On certain Functions connected with Tesseral Harmonics, with Applications: Prof. A. H. Leahy.—On the Measurement of the Magnetic Properties of Iron: Prof. T. Gray.—Researches on the Electrical Properties of Pure Substances—No. 1 The Electrical Properties of Pure Sulphur: Prof. Threlfall, J. H. D. Brearley, and J. B. Allen.—On the Influence of certain Natural Agents on the Virulence of the Tubercle Bacillus: Dr. A. Ransome, F.R.S., and Dr. Delépine.

Royal Institution, at 3.—Egyptian Decorative Art: Prof. W. M. Flinders Petrie.

Institution of Electrical Engineers, at 8.—The Cost of Electrical Energy: R. E. Crompton. (Continuation of Discussion.)

FRIDAY, May 25.

Royal Institution, at 9.—The Development of the Astronomical Telescopes: Sir Howard Grubb, F.R.S.

Physical Society, at 5.—On the Passage of Hydrogen through Palladium: Prof. W. Ramsay, F.R.S.

SATURDAY, May 26.

Geologists' Association.—Excursion to Luton, Caddington, and Dunstable. Directors: Mr. John Hopkinson and Mr. Worthington G. Smith.

Royal Botanic Society, at 3.45.

MONDAY, May 28.

Royal Geographical Society, at 2.30.—Anniversary Meeting.

TUESDAY, May 29.

Royal Institution, at 3.—The Modern Microscope: Rev. W. H. Dallinger, F.R.S.

Institution of Civil Engineers, at 8.—Annual General Meeting.

Society of Arts, at 8.—Black and White in Africkanderland: W. A. Wills.

WEDNESDAY, May 30.

British Astronomical Association (University College), at 5.

THURSDAY, May 31.

Royal Society, at 4.30.—The following Papers will *probably* be read:—Propagation of Magnetisation of Iron as affected by the Electric Currents in the Iron: Dr. J. Hopkinson, F.R.S., and E. Wilson.—On the Electrification of Air: Lord Kelvin, P.R.S., and Magnus Maclean.—Note on the Possibility of obtaining a Unidirectional Current to Earth from the Mains of an Alternating Current System: P. Cardew.—The Effect of Mechanical Stress and of Magnetisation on the Physical Properties of Alloys of Iron and Nickel and of Manganese Steel: H. Tomlinson, F.R.S.—The Root of Lyginodendron Oldhamia (Williamson): W. C. Williamson, F.R.S., and D. H. Scott.

Royal Institution, at 3.—Egyptian Decorative Art: Prof. Flinders Petrie.

Camera Club, at 8.30.—Twenty Thousand Feet over the Sea: Mr. Edward Whymper.

FRIDAY, June 1.

Royal Institution, at 9.—The Work of Hertz: Prof. Oliver Lodge, F.R.S.

Geologists' Association (University College), at 8.

SATURDAY, June 2.

Geologists' Association.—Excursion to Finchley and Whetstone Park Director: Dr. H. Hicks, F.R.S.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Twelve Charts of the Tidal Streams on the West Coast of Scotland: F. H. Collins (Potter).—The Tidal Streams of the Isle of Wight: F. H. Collins (Potter).—The Starry Skies: A. Giberne (Seeley).—This Great Globe: A. Seeley (Seeley).—Year-Book of the Scientific and Learned Societies of Great Britain and Ireland, 11th Annual Issue (Griffin).—The Metallurgy of Gold: T. K. Rose (Griffin).—Materia Medica, Pharmacology, and Therapeutics. Inorganic Substances: Dr. C. D. F. Phillips, 2nd edition (Churchill).—Journal of the Iron and Steel Institute, Vol. xliv. (Spon). Manual of Practical Logarithms: W. N. Wilson (Rivington).—Die Anfänge der Kunst: Dr. E. Grosse (Freiburg i. B., Mohr).—Flora der Nordwestdeutschen Tiefebene: Prof. Dr. F. Buchenau (Leipzig, Engelmann).—The Lowell Lectures on the Ascent of Man: Henry Drummond (Hodder).—Royal University of Ireland. Examination Papers, 1893 (Dublin, Thom).

Pamphlets.—Botanical Charts and Definitions: A. E. Brooke and A. C. Brooke (Philip).—The Ethnography of Inishbofin and Inishshark, co. Galway: Dr. C. B. Browne (Dublin).—Scientific Taxidermy for Museums: Dr. R. W. Shufeldt (Washington).—Kew Observatory Report, 1893 (Harrison).—A Summary of Progress in Mineralogy and Petrography in 1893: W. S. Bayley (Waterville, Me.).

Serials.—Materials for a Flora of the Malayan Peninsula: Dr. G. King, No. 6 (Calcutta).—Journal of the Franklin Institute, May (Philadelphia).—American Naturalist, May (Philadelphia).—Journal of the Chemical Society, May (Gurney and Jackson).—Journal of the Polynesian Society, Vol. 3, No. 1 (Wellington, N.Z.).—Journal of the Institution of Electrical Engineers, No. 3, Vol. xxiii. (Spon).—Veröffentlichungen aus dem Königlichen Museum für Völkerkunde, iii. Band, 3/4 Heft (Berlin, Spemann).

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THURSDAY, MAY 31, 1894.

MATHEMATICAL THEORIES OF ELASTICITY.

A History of the Elasticity and Strength of Materials. Vol. II. Parts I and II. By the late Isaac Todhunter, D.Sc., F.R.S. Edited and completed by Karl Pearson, M.A., Professor of Applied Mathematics, University College, London. (Cambridge: at the University Press, 1893.)

A Treatise on the Mathematical Theory of Elasticity. By A. E. H. Love, M.A., Fellow and Lecturer of St. John's College, Cambridge. Vol. II. (Cambridge: at the University Press, 1893.)

Introduction to the Mathematical Theory of the Stress and Strains of Elastic Solids. By Benjamin Williamson, D.Sc., D.C.L., F.R.S., Fellow and Senior Tutor of Trinity College, Dublin. (London: Longmans, Green, and Co., 1894.)

Theory of Structures and Strength of Materials. By Henry T. Bovey, M.A., D.C.L., F.R.S.C., Professor of Civil Engineering and Applied Mechanics, M'Gill University, Montreal. (New York: John Wiley and Sons. London: Kegan Paul, Trench, Trubner, and Co., 1893.)

PROFESSOR KARL PEARSON is to be congratulated on having brought his task, after nine years' hard work, to a conclusion; and the result would surprise Dr. Todhunter, the original projector of the treatise, could he see the three large volumes, of 2200 pages and 1800 articles, which have grown from the notes he made for a modest history of elasticity. The labour in the preparation of this history must have been enormous; it is the sort of work which is best left for a German to carry out; even the cutting of the pages is sufficient to give the reviewer a headache and mental indigestion.

The assistance of Mr. C. Chree is gratefully acknowledged in the preface, also of M. Flamant, Professor at the École des Ponts et Chaussées, Paris; and the Syndics of the Cambridge University Press are thanked for their financial assistance in the production of the book.

The part relating to St. Venant's writings, which forms the first half of part i, vol. ii., was issued separately some four years ago, and received notice in these columns in the number for March 20, 1890.

It is impossible within any reasonable limits to give an idea of the developments which the subject has received at the hands of the various mathematicians whose work is cited in the pages. A mere enumeration of the principal names—St. Venant, Rankine, Kupffer, Wertheim, Zöppritz, Neumann, Kirchhoff, Clebsch, Boussinesq, Thomson and Tait, &c.—and the list of chief elasticians given on p. xv., will show that the subject has attracted the attention of the principal analysts, who seek for the stimulus and directing influence of real physicial problems.

It must be allowed that the mode of attack of some of these problems is, by reason of their extreme difficulty, calculated to shock the mathematical prudery of certain pure analysts; and also that there is not yet complete accord among elasticians in the results they obtain; but then, to quote Rankine's eloquent words from his "Preliminary Dissertation on the Harmony of Theory and Practice in Mechanics": "The question in Practical Science is—*what are we to do?*—a question which involves the necessity for the immediate adoption of some rule of working. In doubtful cases we cannot allow our machines and our works of improvement to wait for the advancement of science; and if existing data are insufficient to give an exact solution of the question, that approximate solution must be acted upon which the best data attainable show to be the most probable."

"In Theoretical Science, the question is—*What are we to think?* and when a doubtful point arises for the solution of which either experimental data are wanting, or mathematical methods are not sufficiently advanced, it is the duty of philosophic minds not to dispute about the probability of conflicting suppositions, but to labour for the advancement of experimental inquiry and of mathematics, and to await patiently the time when these shall be adequate to solve the question."

So far as concerns the analyst who despises the stimulus that arises from the contemplation of the difficulties of an actual problem, the above advice in Theoretical Science amounts very much to what King Paramount says to the wise men of Utopia—"Go and play in the corner."

A distinguished biologist once said to the editor of the present work, that he had for many years given up endeavouring to ascertain what others had done or were doing in his subject. To follow the great mass of contemporary work meant to expend his time in historical investigations rather than in original research (p. 488). But the present volumes on the history of elasticity will save this expenditure of time, and enable the investigator to start where others have left off.

The curious spiral lines, crossing at 45° the circles concentric with a punched hole, called Lüder's curves, and shown in the frontispiece of part ii., vol. ii., are interesting in confirming W. Carus Wilson's theory, that plastic yielding of an elastic metal takes place chiefly by shearing in directions inclined at 45° to the principal tension. The subject has recently been discussed in the *Comptes Rendus*, by M. Hartman, who brings out these curves more clearly by biting into the steel with acid.

Mr. Love's vol. ii. of his treatise on the mathematical theory of elasticity also completes the work, of which the first volume was noticed in NATURE, April 6, 1893.

A valuable historical chapter begins the volume, but we are puzzled to see the authors of a well-known treatise on Natural Philosophy given as Kelvin and Tait; it might as well be said that the Duke of Wellington commanded the British Forces in the Peninsula.

We learn incidentally that the battle over the theory of the curved plate is still raging, and that the rival theories of Lord Rayleigh and Mr. Basset do not yet meet with the author's complete acceptance; the investigations of Mr. Bryan and of the author on the wrinkling of the plating of a ship, and on the collapse of boiler flues, discussed in chapter xxiii., will do much to bring into focus the real points at issue.

The problem of the spiral spring, with Kirchhoff's kinetic analogue of the steady motion of a gyrostat, is treated in an interesting manner; what is the modification and the kinetic analogue when a helical wire is pushed into a helical tube, of a different curve?

A search through Clebsch's article in Crelle, t. 57, would reveal the clue to the construction of pseudo-elliptic cases of the general tortuous elastica, and thus also of its kinetic analogue in the general motion of a Top. The spherical catenary forms another analogue, and the special pseudo-elliptic case, devised by Clebsch, has been constructed in the series of models of Brill of Darmstadt, so that a string of beads can be placed on a plaster sphere in the appropriate curve.

Mr. Love has devoted careful attention to the examination of different cases of elastic stability, familiar instances of which are to be seen around us, in the waving of the cornstalks in the field, the vibration of a fishing-rod or of the mast of a steamer, or the whirling vibrations of a rapidly rotating shaft; an examination of the period of vibration at once assigns the limits of stability, as the place where the period of vibration becomes infinite, and afterwards imaginary. Thus the farmer can tell by the speed of the waves seen over the cornfield the appropriate time for the harvest.

The treatment of the wire generally, in chapters xiii.–xviii., is complete, and the graphical method of Fig. 30 is very elegant; but the period equation for lateral vibrations,

$$\cos m \cosh m = \pm 1,$$

is improved by being thrown into the equivalent form,

$$\tanh \tfrac{1}{2}m = \pm \tan \tfrac{1}{2}m, \text{ or } \pm \cot \tfrac{1}{2}m,$$

of which the solution by a geometrical construction is readily effected.

We miss the theorems of the elasticity of cylindrical bodies required nowadays in the construction of built-up ordnance and in the wire gun; the practical results can be exhibited very simply by geometrical constructions, merely requiring the drawing of a few straight lines.

Prof. Williamson's treatise of 130 pages will serve as a very good introduction to the study of Mr. Love's work. Great attention has been paid to the notation and nomenclature, and a suggestion of Prof. Townsend has been adopted which seems clear and simple; however, we must not wander far from the system laid down in Prof. Karl Pearson's history.

The work concludes with a description of the models, devised by Profs. Alexander and Thomson, for illustrating Rankine's ellipse of stress. This model was exhibited at the Munich Mathematical Exhibition, where it attracted great interest.

Prof. Bovey's theory of structures will provide for Canadian and American engineers the information and exercises which our engineers derive from Rankine's treatises; but Rankine's very condensed method of reasoning has been expanded for the benefit of the average student, so that the present work runs to over 800 pages.

It would be impossible to give a complete account of all the subjects discussed in the treatise within reasonable limits; but many elegant and novel theorems in the treatment of the theory of the beam and cantilever are to be found, illustrated numerically by an appeal to existing structures of the largest scale; in this respect the American engineer is at an advantage, as more bridge work of great dimensions comes under his notice.

Incidentally, Prof. Bovey provides his engineering students with a complete treatment of statics and dynamics, treated episodically as required for a problem in hand; and each chapter concludes with a large collection of examples, by which the student can test the soundness of his knowledge: these examples are based in general upon existing realities, and form a great contrast to the old-fashioned Cambridge mechanical problems, which were generally geometrical or trigonometrical theorems, with only a slight flavour of mechanics. One or two of these problems, for instance, 47, on p. 220, and 60, on p. 221, will doubtless receive revision in a future edition; and Mr. Macfarlane Gray's elegant constructions for the points of maximum piston velocity may then well find a place in p. 205. As the author writes for engineers, the gravitation unit of force is used throughout, and expressions such as $\frac{Wv^2}{2g}$ and $\frac{Wv^2}{gr}$ abound in consequence.

The confusion introduced by writing M for $\frac{W}{g}$ has been carefully avoided, with all its attempted *a posteriori* explanations; and for this mercy the engineering student owes a great debt of gratitude to Prof. Bovey.

A. G. Greenhill.

LAW AND THEORY IN CHEMISTRY.

Law and Theory in Chemistry: a Companion Book for Students. By Douglas Carnegie, M.A. Pp. vi. 222. (London: Longmans, Green, and Co., 1894.)

THE object of this book is to help fairly advanced students "to recapitulate and co-ordinate the more important principles of chemistry before proceeding to more detailed and advanced works." The book makes no claim to be regarded as a text-book; it is intended to be read along with the text-book, which it is meant to supplement, especially in those parts of the subject that are sometimes overlooked, but are needed, in the opinion of the author, for "a liberal understanding of the science," and in some of those parts that are thought to present especial difficulties. In his preface, the author says that "the seven chapters are really short and independent essays on the subjects of which they severally treat"; he also adds that "the attempt has been made to indicate, with due appreciation of perspective, the trend of modern research in its relation to the science as a whole."

The first chapter, on "Alchemy and the birth of scientific chemistry," is evidently to be looked on as introductory to the study of law and theory in chemistry. The second chapter introduces the student to chemical laws and chemical theories by sketching the "Phlogistic period and the beginnings of chemical theory." The other parts of the science chosen for the display of the workings of law and theory are chemical classification, the atomic theory, isomerism, and chemical equilibrium.

The first and second chapters are chiefly historical; they present in a clear and interesting style the chief features in the development of the general conceptions regarding elements, and changes of properties, from the early days to the overthrow of the phlogistic theory by Lavoisier.

The distinguishing marks of this book are, in my opinion, clearness and suggestiveness. There are plenty of facts, and these are lucidly stated; but when the book has been read, the student is not left fact-stuffed to suffer from mental indigestion, but is incited to intellectual activity and imaginative action. Many works on chemistry convey stale truisms to the student; some preach the kind of truth that makes a man drunk when it is "stagnant inside him." This book suggests more than it asserts, and leaves the reader eager and hopeful. Take, for instance, the treatment of the well-worn subject of mixtures and compounds in chapter iii.: the many forms in which the differences between these classes of substances are stated, oblige the reader to think as he reads; and the admirable way in which illustrations of the differences are drawn from the processes of applied chemistry, give an air of reality to the matter, and withdraw it entirely from the sphere of mere academic discussion. The free use which is made of processes employed in manufactures to illustrate the laws and principles of the science, is much to be commended. The book deals for the most part with those portions of chemistry which require to be treated at once soberly and suggestively; and, on the whole, the author has succeeded in combining breadth of view with accuracy of detail. The chapter on "molecular architecture" well exemplifies the combination of these two qualities. But it seems to me that too much space is devoted in this chapter to Guye's views regarding optical activity. The reader is thrown somewhat off the main track, and he does not readily recover the path. The chapter on the classification of compounds is not, in my opinion, so happy as many of the others. The author seems to be too eagerly pursuing definitions, which Hunter said are the most accursed of all things on the face of the earth. Would chemistry be much better off were perfect definitions of acid, base, and salt to be found? I very much doubt it. Indeed, I think one of the great advantages of chemistry is its freedom from definitions. The last chapter, on chemical equilibrium, enables the careful student to grasp the bearings of the recent work in this department that has already profoundly changed the scope and aim of the science. It is just such an introduction to the study of chemical equilibrium as was wanted.

It would be easy to find fault; it is always easy to find fault. I have preferred to point out some of the excellencies of this work. It is exactly what the title-page describes it—a companion-book for students of chemistry. The want of an index, however, is a serious blemish in the book.

M. M. PATTISON MUIR.

CLIMATE AND LUNG DISEASE.

Aero-Therapeutics; or, the Treatment of Lung Diseases by Climate. By Charles Theodore Williams, M.A., M.D. Oxon., F.R.C.P. pp. 186. (London: Macmillan and Co., 1894.)

THIS work affords valuable information, not otherwise easily attainable, concerning distant health resorts. Modern facilities of locomotion have brought the Andes and the Karoo within easier access than Montpelier or Penzance at the beginning of the Victorian era. The world is now at the feet of the health-seeker, and our ocean steamers and trans-continental railways are day by day carrying an ever-increasing number of convalescents. It is not necessary to have a yacht of our own if we would take a trip to the Fiords of Norway, the Grecian Archipelago, the West Indian Islands, or even to Japan; perfectly appointed steamers, with the comforts of a good hotel and the reliableness of an express train, are ever ready to convey us wherever we may desire.

Dr. Williams, who, as President of the Royal Meteorological Society, might be expected to fill his pages with statistics and tabular statements, gives also his own experiences of travel, together with a sketchy outline of cases of disease distributed amongst the varied and world-separated havens of health. It cannot be doubted that, in chronic disease, the wise selection of health stations is often of vastly greater import than physic or even diet, and in these lectures we find a comprehensive epitome of the claims of the most valuable resorts within our reach.

The description of the Riviera, given as it is by one with ample personal and acquired experience, is a valuable part of the work, and is summarised thus:—"The winter climate of the Riviera is clear and bright, with a good deal of wind but devoid of fog or mist; with a mean temperature of 8° to 10° higher than that of England, with half the number of rainy days and four or five times the number of bright ones."

Should the Riviera prove too stimulating, Ajaccio and Corsica are recommended.

Algiers is too rainy in November, December, and January, though the neighbouring desert converts what would be a moist into a dry climate.

Tangiers combines the warmth of the Mediterranean with the equability of the Atlantic, and is regarded as of value in some forms of phthisis.

Among the many attractions of South California (visited by the author in 1892) are the fruits of South Europe and of the tropics, as well as the apples, pears, and apricots of old England, and strawberries all the year round. In the large towns, however, the noise of the cable and electric cars detracts from the comfort and repose so desirable for the invalid.

The Australian health resorts are hot and dry; in inland regions are suited for young men with agricultural tastes, and threatened consumption.

The value of sea voyages is clearly shown, but the author rightly places in a clear light the cruelty of allowing unsuitable cases to start off alone on a long voyage.

The statistics of sea voyages come out well. It must be borne in mind, however, that patients sent to sea by a discriminating physician, and deemed fit to bear the vicissitudes and uncertainties of the voyage, are, on an average, of a more sturdy and hopeful type than those sent to Madeira, Egypt, or the Riviera.

The voyage to the Cape is described as sedative, that from the Cape to Australia as bracing. The voyage through the tropics to the Cape, followed by residence in the South African highlands, is unquestionably great.

It does infinite credit to Dr. C. T. Williams to have kept notes of his cases so systematically as to be able to arrange them as he has done. Among the interesting conclusions at which he arrives is this: that, in cases of cavity in the lung, the saline atmosphere of the ocean promotes antiseptic changes, and so encourages the arrest of disease.

In chapter iii., "On Barometric Pressure in Relation to Health," an interesting account is given of "Caisson Disease" and "Divers' Disease," due to too sudden exposure to change of atmospheric pressure, when working under deep water, as in the construction of the Forth Bridge. The disease begins with pain and sickness; paralysis of the lower limbs sets in, and death may occur speedily. A pressure equal to that of four or even six atmospheres is thus sometimes borne, and, if gradually attained, is not necessarily injurious.

In the "Compressed air bath," at the Brompton Hospital, the pressure rarely exceeds an addition of 10 lb. to the square inch, or $\frac{2}{3}$ of an atmosphere. Half an hour is given to reach this pressure, it is maintained for an hour, and half an hour is occupied in reducing it to the natural pressure; thus all danger of sudden change is taken away, and it is found that, in asthmatic cases, marked benefit is often secured by the compressed air.

The value of rarefied air, as at Davos, St. Moritz, or Denver is great; the analysis of cases thus treated shows an improvement in $\frac{7}{8}$ of the cases.

"In general results, the English home counties yield the smallest percentage of 'improvement,' and the largest of 'worse.' Next comes the Riviera, not much better; then, with a rise of 12 per cent. 'improved,' are sea-voyages, the percentage of 'worse' being still large. 'High altitudes' win easily in all categories, with their 83 per cent. 'improved,' and only $14\frac{1}{2}$ per cent. 'worse.'"

It must be admitted there is strong evidence in favour of high altitude treatment. The value of such comparisons would be enhanced if we could be certain the patients pursuing different forms of climate treatment conformed to the same rules of hygiene and dietetics.

The concluding chapter of the book, "On the High Altitudes of Colorado," gives the results of Dr. Theodore Williams' recent visit to Denver, and is thus epitomised:

"The climate of Colorado is dry and sunny, with bracing and energising qualities, permitting outdoor exercise daily throughout the year. It has rescued many consumptives from a life of invalidism. Its exhilarating influence may be traced in the wonderful enterprise which the Colorado people have shown in developing their country. Thirty years ago Denver did not exist; it is now a well-built and well-organised city of 150,000 inhabitants."

This short survey must suffice to show that in the work before us facts are collected and arranged which cannot but prove of essential service to the public, and especially to the medical profession seeking the newest information concerning aero-therapeutics.

OUR BOOK SHELF.

Histories of American Schools for the Deaf, 1817–1893. Edited by Edward Allen Fay, Ph.D. In three volumes (Washington, D.C.: the Volta Bureau, 1893.)

Four hundred years ago the great double-continent of America was discovered, and almost contemporaneous with that event was a second discovery of, perhaps, less apparent but no less real importance. In the fifteenth century Rodolphus Agricola recorded the first instance of a deaf mute who learned to read and write, and not long afterwards Girolamo Cardano, a fellow-countryman of Columbus, insisted that the instruction of individuals thus afflicted was possible though difficult, and, going farther, stated clearly the principle on which such instruction depends.

Like many another beneficent discovery, that of Cardano was long in finding recognition, and, although there were isolated cases instructed in Spain, England, Holland, France, and Germany, it was but a century and a half ago that the theory began to be put into practice. Paris claims the merit of giving the first start to the work of benevolence, Abbe de L'Épée there establishing his school in 1760, similar institutions rising in Dresden and Edinburgh about the same time. From such a beginning has sprung a work which, though carried on for the most part in silence, stands foremost in the philanthropic labours of the world—a work that must have brought light and happiness to many thousands of our less fortunate brethren, and been the means of developing valuable intellects which might otherwise have been lost to the community. Some idea of its quiet but steady progress may be gained from the following facts:—In 1836 there were 134 schools for the deaf in the world, in 1883 there were 397, and in 1893 the number had risen to 435. In the United States fifty years ago there were but six schools, in Canada and Mexico none, while in the three volumes before us are the histories of 79 schools in the United States, seven in Canada, and one in Mexico, which instruct, respectively, 7,940, 682, and 34 pupils.

True charity works, as a rule, in the dark; the outside world knows little as to its achievements, and seems to care as much. Here, however, can be learned something of its labours in one direction and its untiring energy appreciated. We hear little about similar institutions in this country, although they certainly exist, and a volume compiled on similar lines to the one at present under review would be welcome to all who have to do with deaf persons. This book, prepared for the Volta Bureau in commemoration of the four-hundredth anniversary of the discovery of America, contains, as we have said, the histories of eighty-seven schools for the deaf and dumb. These histories, which fill three large volumes, were nearly all prepared by the heads of the schools, and, many of them being written by the deaf and dumb themselves, they form a lasting monument of the excellence of the work done. By the help of excellent portraits and photographs the information to be gained is made exhaustive, and the reader becomes acquainted not only with the work done, but with the lives of many of the workers, lives which are worthy of a place among those who truly follow in the footsteps of Him who "made the deaf to hear and the dumb to speak."

P. Macleod Yearsley.

Monograph of the Stalactites and Stalagmites of the Cleaves Cove, near Dalry, Ayrshire. By John Smith, Vice-President of the Geological Society of Glasgow. (London: Elliot Stock, 1894.)

The author has taken advantage of the opportunity afforded by the exploration of a cavern in the Lower Carboniferous Limestone, to study the various forms of deposit produced by the percolating waters. He appears, from his preface, to be under the impression that nothing has been previously written on the subject of stalagmitic deposits, and no references to any earlier literature occur in his pages. This is unfortunate, as a study of the writings of Cöhn, and others who have investigated the action of plants in promoting the deposition of calcium carbonate, would have helped him to solve some of the difficulties he has experienced.

The author classifies the different forms of deposit as "a stalactite" (when it is a pendent icicle-like mass), "a stalagmite" (when a similar mass, rising from the floor), "sheet stalagmite," "wall stalagmite," "tear-bands," "ribs" and "combs," all of which terms explain themselves. He would have done well to consult a botanist before applying the name *Gallionella* to the "confervoid filaments" found in the chalybeate water.

The 18 pages of text are illustrated by 36 plates, including 107 figures, roughly drawn, but characteristic. They show most of the common and seemingly capricious forms assumed by stalagmitic deposits. Certain of the observations are somewhat trivial, such as the reference to the "profile of Gladstone" in the centre of one stalactite, and the comparison with the "hind-quarters of an elephant" in another. The author has not availed himself of the assistance which would have been obtained by examining thin sections of the deposits under the microscope.

Botanical Charts and Definitions. By Miss A. E. Brooke and Miss A. C. Brooke. (London: G. Philip and Son, 1894.)

IT is notorious that examinations in elementary practical chemistry are frequently little more than tests of capacity for remembering analytical tables. This little book will serve the same purpose in botany that tables of analysis do in chemistry. In thirty-four pages the authors summarise the work required for the South Kensington (Elementary) and the Oxford and Cambridge Junior Local Examinations in Botany. Charts and definitions are given of sub-kingdoms, classes, orders, and floral whorls; of root, stem, leaf, inflorescence, and fruit. These, with definitions of terms of cohesion and adhesion, enable the student to classify a plant on the lines of the table of analysis with which the book concludes. We are afraid that the compilation will induce cramming for the examinations for which it is intended; but if this be avoided, and the charts are only used as supplementary to oral teaching and demonstration, they will help students to acquire a clear view of the relation and arrangement of the parts of a plant.

The Great Globe: First Lessons in Geography. By A. Seeley. (London: Seeley and Co., 1894.)

A SIMPLY worded and instructive primer of geography, printed in clear type, and illustrated with numerous cuts and diagrams. The book does not merely consist of lists of lengths of rivers, heights of mountains, populations of cities, and similar statistics, but is a compendium of facts calculated to interest the young reader, and, at the same time, to add considerably to his knowledge. There is a little too much of the goody-goody style of writing about missionary enterprises, but that is the only point we are inclined to criticise. Tales of the torturing of converts and murdering of missionaries are apt to create in children a morbid state not at all desirable, and they can very well be omitted without making a work on geography any the less interesting.

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.*]

Trituberculy and Polybuny.

IN all the speculations on the original type of the mammalian molar, beginning from Rütimeyer (1863), we find that a simple cusp or cone is, with perfectly logical reasoning, considered to be the primitive form from which all others are derived. The error, fatal in its consequences, consisted in the fact that all the teeth possessing such a simple form, whether recent or fossil, high or low in the system, have for a long time likewise been considered to be primitive; so that the only problem remaining to be solved, seemed to be to trace back the intermediate stages between the more or less complicated molars of recent mammalia and the "simple reptilian cone."

The cretaceous deposits having long failed to throw light upon the obscure relations between the comparatively scanty mesozoic mammalian teeth and the tertiary and existing forms, we were reduced to make the best of the oldest tertiary faunas. It is from the discovery of the lower eocene Puerco beds that the establishment of the tritubercular theory dates, Cope having traced the superior molars of placentalia to a "tritubercular," and their inferior molars to a "tubercular sectorial" type, both of which he found to be of overwhelming preponderance in the Puerco beds, the oldest known deposits of tertiary mammalia.

I have elsewhere [1] raised objections to the inferences drawn from the Puerco fauna, and now one of the most strenuous defenders of trituberculy has, with his own hands, undermined the stronghold of the theory, by denying the Puerco fauna the claim to be in ancestral relation with later faunas, for he considers this old fauna to be merely "an independent radiation of placentals, like the Australian radiation of marsupials." [2]

Owing especially to the perseverance of Prof. Marsh, cretaceous mammalia were discovered in due time. The principal characters of their molars can be grasped at once by a single glance at the two beautiful and highly instructive plates published by Prof. Osborn, in December last. [3]

Whoever examines with an unbiassed mind the molars figured in the latter plate, must receive the impression that the term "trituberculate" applied to them can stand only upon the *lucus a non lucendo* principle. Speaking for myself, I cannot consider to be tritubercular, molars which consist of from five to ten tubercles; therefore the teeth represented on Pl. viii. in my opinion are polybunous (multitubercular), as well as those of Pl. vii., though in a different manner. Prof. Osborn informs us that the former "include a variety of forms *just emerging from the primitive tritubercular stage*" (the italics are mine), "lending overwhelming proof, if any more were needed, of the unity of origin of the molar types of the higher mammalia, from a tritubercular stem instead of from a multitubercular, as Forsyth Major has suggested." [4] I suppose that by "primitive tritubercular molar" we are intended to understand a molar which is in fact tritubercular *sensu strenuo*, namely, composed of no more and no less than three cusps arranged in a triangle; but I fail to discover in the pages which follow the above quotation, the proofs for the various assertions it contains.

In order to explain why for such complicated molars as those on the precited Pl. viii, the designation *tritubercular* is maintained, it must be recorded that this name is said to be meant to imply that the two outer cusps (paracone, metacone) and the single inner one (protocone) in upper molars, as well as the three anterior cusps (two inner and one outer) in lower molars, generally the best developed of all the cusps, are to be considered as typical, primitive; whilst the remainder, namely, the intermediate and all the others of superior molars supposed to play a subordinate part, as well as those composing the heel of inferior molars, are considered to be later additions to the crown.

It has not, however, been shown, and I deny, that the predominant cusps have always been such, and that the intermediate ones, as well as the inferior heel (talonid), are of later origin than the former, and have always been in a subordinate position with regard to them. Without searching farther than what is to be seen on Pl. viii., I state that the figures F are not in favour of the assumption that two of the supposed primitive cusps, the paracone and metacone, are always the best developed; externally to them, we have here two superadded cusps, the "parastyle" and "metastyle," [5] which are in a much better state of development than the reduced two "primitive" cusps. The latter, as the other figures of the plate suggest, may only gradually have acquired their predominance by supplanting the "styles," which in other patterns have become more or less obsolete. On the whole, the superior molars of these "tritubercular" cretaceous mammalia can best be compared with those of *Didelphyidæ*, as was done by Marsh, or to speak more guardedly, rather with the *Polyprotodontia* in general, the principal differences between the two consisting in the fact that the cretaceous forms are more complicated.

From the seemingly subordinate condition of the "heel" of lower molars, as compared with their anterior portion, it does not follow that the former is of later origin; the difference between the two in vertical extension obviously depends on one or more of the cusps of the so-called trigonid having secondarily become more elongated, for brachydonty and not hypsodonty is the original condition. If the heel were a later addition to the

[1] *P.Z.S.* 1893, p. 198-199.

[2] H. F. Osborn, "The Rise of the Mammalia in North America," pp. 30-31. (Boston, 1893.)

[3] H. F. Osborn, "Fossil Mammals of the Upper Cretaceous Beds." (*Bull. Am. Mus. Nat. Hist.* v. 1893, pp. 311-330, pl. vii.-viii.)

[4] *l.c.* p. 32.

[5] Of their homologues, by the way, may be found traces in the molars of many existing mammals: see *e.g.* *H. Winge*, Om Pattedyrenes Tandskifte 1882, Table III

crown, we ought to find it in a more or less incipient stage in such remote forms as the cretaceous mammals, whereas the very reverse is the case, as admitted by Osborn himself;[1] in them the heel is mostly better developed than in such of later forms, marsupial or placental, which morphologically most closely approach them.

So that, in conclusion, the superior as well as the inferior molars, far from "just emerging from the primitive tritubercular stage," are more remote from it, both morphologically and chronologically speaking, than the tertiary and living forms.

According to the tritubercular theory, the so-called quadritubercular superior molars (composed of four principal cusps), were derived from the tritubercular pattern by the addition of a postero-internal cusp (hypocone). In order to test the value of this hypothesis, let us see what relation the cusps of the superior bear to those of the inferior molars. In a "quadritubercular" mammal, *e.g. Erinaceus*, the antero-internal cusp (protocone) of a superior molar works as a pestle in its mortar, below which is the posterior valley, formed chiefly by the talonid, whilst the hypocone functions in a similar manner in the hinder molar's anterior valley, formed by the trigonid. According to the theory, the superior "talon" (hypocone) and the inferior "talonid," are later additions to the crown: from this it would follow that the phylogenetically older of the two superior pestles, the protocone, was preformed before its mortar, and *vice versâ*, the posterior of the two mortars was in existence long before its pestle, the hypocone; so that the second pestle and the second mortar would make their appearance only in a distant future or never appear at all, the function of *their* respective mortar and pestle thus remaining for ages sinecures. The following reasoning, which appears to me more logical, may, however, be not unworthy of consideration. Starting from the assumption that the more complicated pattern, in our special case, the "quadritubercular" molar, is primitive as compared to the tritubercular, we had originally, viz. in the ancestral form of tritubercular molar, two superior pestles working in the two inferior mortars, as in the case of the recent *Erinaceus*. According to this view, the tritubercular type is derived from the quadritubercular, by the gradual suppression of the posterior pestle (hypocone), *pari passu* with the reduction or suppression of its mortar, the anterior valley, formed by the trigonid.

The impropriety of the term *tritubercular*, as applied to many patterns which in reality are multitubercular, is apt to create not a little confusion. Partially to this circumstance I ascribe some obviously contradictory statements to be met with in Mr. Goodrich's recent letter in this journal: *On the tritubercular theory*,[2] as well as in a previous paper by the same author,[3] to which he refers us for further information as to his views on the primitive mammalian molar.

On looking at the conclusions contained in the appendix ("On the primitive mammalian molar") to Mr. Goodrich's valuable paper on the mammalia from the Stonesfield slate, I felt gratified to find that he considers it extremely probable that the molars "of the ancestors of both Monotremes and Ditremes were of an indefinite multituberculate pattern," because I had for years advocated the view that the mammalian molar is derived from a polybunous form, a view in favour of which I have reopened the discussion on a recent occasion.[4] So, I naively believed at first that it was for this reason my paper was recorded in Mr. Goodrich's List of References. My gratification was, however, considerably abated on finding that I am merely alluded to in a footnote, where I am stated to have expressed views which are the very reverse of those which every attentive reader will find in my paper to which he refers.

In his letter on the tritubercular theory, Mr. Goodrich states:—"There is much evidence for the view that the upper molars of the pro-mammalian ancestors were of the tritubercular, and the lower molars of the tubercular-sectorial types; in fact, I think, we cannot do better than accept Prof. Cope's generalisation, if not as a definitely established theory, at all events as an excellent working hypothesis . . . that the superior molars of both ungulate and unguiculate mammalia have been derived from a tritubercular type; and that the inferior true molars of both have been derived from a tubercular-sectorial type."

[1] H. F. Osborn, "Fossil Mammals of the Upper Cretaceous Beds." (Bull. Am. Mus. Nat. Hist. v. [illegible], p. [illegible]
[2] NATURE, May 3, 1894, p. [illegible]
[3] "On the Fossil Mammals from the Stonesfield Slate" (Quart. Journ. Micr. Science, vol. xxxv. 1894, pp. [illegible]).
[4] P. Z. S., [illegible], pp. [illegible]

I would put the following questions:—(1) How does this last statement agree with the one above quoted from Mr. Goodrich's former paper, referring to "the ancestors of both Monotremes and Ditremes?" For these alone can be alluded to by the term "Pro-mammalia." (2) How does the acceptance of Cope's "generalisation," quoted by Mr. Goodrich, and which is the very quintessence of the tritubercular theory, agree with his criticism of this same theory in the beginning of his paper, where he exclaims, "Never before have its weaknesses been so obvious, its errors so plain"?

I leave Prof. Cope to reply to Mr. Goodrich's implication, that he extends the tritubercular and tubercular-sectorial types to the molars of the "Pro-mammalian ancestor."

C. I. FORSYTH MAJOR.

Natural History Museum,
S.W., May 10.

The Determination of Latitude and Longitude by Photography.

LATITUDE and longitude may be determined on shore with considerable accuracy by means of an ordinary photographic camera; and this method will, I think, prove useful for several reasons. The observation part of the business, which consists in taking the photographs, is separated from the measuring and calculating part, and may be performed by different persons at different times and places. For taking the photographs no scientific apparatus is wanted besides the camera and a watch, the latter to measure intervals of not more than a few hours with an accuracy of a second or so. Anyone may easily be instructed to take the photographs, as no mathematics and very little astronomical knowledge are wanted, only the measuring of the plates and the calculation requiring some scientific training.

I will first describe the determination of latitude. The general plan is well known to astronomers; it is here only adapted to the use of an ordinary camera.

If the lens is directed to the zenith, and the stars are allowed to draw their trails over the plate, it will evidently be possible to determine the latitude from the plate, provided the point of the plate is known which corresponds to the zenith. Now this point may be found in the following manner:—Let the camera float and be turned while floating. It will turn exactly round a vertical axis. The zenith will then be the only point of the sky whose corresponding point on the plate will remain unaltered. The way I arranged the experiment was this:—I placed the camera in a rectangular tin box, lens upwards, fixing it firmly by wedges. The box was ballasted so as not to be capsized when floating. Photographic plates will do as ballast, but it is better to take a plate of lead, which brings the centre of gravity lower down, and thereby increases the stability. I then filled a second rectangular box, somewhat larger than the first, with so much water, that when the first box floated in it, the rims of both boxes were in the same plane. Two opposite points on the rim of the inner box were fastened to the rim of the outer one, each with two strings, forming an obtuse angle. This prevented the inner box from turning during an exposure. The strings need not be tight, as the forces they have to resist are small.

Having placed the whole apparatus on a firm table in the garden, I removed the cap from the lens. As the trails of brighter stars may generally be measured more accurately than those of faint ones, I exposed long enough for a star of the third magnitude to pass sufficiently near the zenith to appear on the plate. After replacing the cap, I turned the whole apparatus carefully through an angle of 180°. For this purpose I had pressed a row of flat nails into the board along one edge of the outer box, and having turned it, I let the same edge of the box touch the row of nails from the other side. Before again removing the cap, I waited about three minutes to allow the oscillations of the water and the inner box to subside. The second exposure I made long enough for the image of a star of about the third magnitude to be thrown on the plate during the star's culmination near the trail of the star of the first exposure. In order to see that it is possible to determine the latitude from this plate, imagine first the trails of the two stars to touch. That would be a proof that they had passed the meridian on different sides, but at the same distance from the zenith. The mean of their declinations, taken from the almanacks, would therefore be equal to the distance of the zenith from the equator that is equal to the geographical latitude. If, on the other hand, the trails of the two stars do not touch, their shortest distance may be measured. Now the distance of the trails of any other two stars, which appear during the same exposure, will, when their declinations are taken from the almanacks, enable us to calculate what angle approximately corresponds to a certain length, the approximation being close for small lengths. Thus we are enabled to calculate what the declination of the second star would have been, if its trail had touched the trail of the first star, and thus the latitude may be found.

Generally there will be the trails of several stars in both exposures available, so that one plate will allow of several determinations, and thereby of an elimination of errors. The results of seven plates, taken on different nights in my garden in Hannover, Germany, will give an idea of the accuracy.

	52° 22'·50
	52° 22'·56
	52° 22'·47
	52° 22'·78
	52° 22'·90
	52° 22'·93
	52° 22'·90
Mean:	52° 22'·72 (mean error of a single plate = 0'·2).

According to the *Preussische Landesaufnahme* the latitude should be—

52° 22'·84

The same plate may also serve to determine the deviation of a watch from local mean time, if the time of the watch is noted each time the cap is withdrawn and replaced. Imagine, first, that a star was photographed whose declination coincided with the geographical latitude, and imagine that the box could be turned infinitely quickly without any oscillations being started. If we then found that the two trails of the star corresponding to the two exposures touched each other at one end, the end corresponding to the moment the box was turned, we might conclude that the star at this moment was in the zenith. For there alone the image of the star would remain unaffected by the turning of the plate. Now, we can calculate from the almanack the local mean time of the moment when this particular star culminates, and this would give us the deviation of our watch from local mean time. Imagine now the box had not been turned at the moment the star culminated, but, say, ten minutes later. Then the two trails would not have one end in common. The ends corresponding to the moment when the box was turned, would be on opposite sides of the zenith at the same distance from it. Now we should be able by the length of the trails to determine what interval of time corresponds to a given length, and so the plate would show us that the culmination of the star took place ten minutes before the box was turned. If the box is not turned very quickly, the interval after replacing and before removing the cap must be taken into account. But it is evident that we can calculate where the ends of the trails would have been if the box had been turned infinitely quickly. If there is no star that passes exactly through the zenith, we must take one that passes near the zenith. This will also do. By the ends of the trails we find which point of the plate corresponds to the zenith, and at the same time we can, by the trails and their ends, find out the line representing the meridian. This gives us the necessary data for finding the deviation of our watch from local mean time. For a star near to the zenith a small error in the direction of the meridian will make very little difference. I have spoken of the ends of the trails as a means of determining local mean time only for the sake of simplicity. It is far preferable to proceed differently, and to interrupt the first and the second exposure a number of times, thus causing as many interruptions of each trail. Five seconds or less will do very well for the length of an interruption. These interruptions are preferable to the ends, because they are symmetrical, and their middle can with more accuracy be brought under the cross-hairs of a micrometer. My lens having a focus of about 24 cm. made one minute about equal to 0·6 mm. on the trails of stars that culminate near the zenith. With a micrometer it is not difficult to measure exact within 0·01 mm. which is equivalent to one second of time.

If by the help of a chronometer Greenwich mean time were known at the place where the photograph was taken, the longitude would thus also be determined. But a chronometer can be dispensed with if another photograph is taken of the moon and the stars. For this purpose the camera is taken out of its box, directed to the moon, and fixed as firmly as possible. A number of instantaneous photographs of the lunar disc are then taken, all on the same plate, at intervals of not less than two minutes, to prevent the images from overlapping. The camera must be touched as little and as gently as possible, so that it may remain in the same position. After a number of exposures, say six or eight, the camera is shut until the moon has quite gone out of the field. The cap is then again removed, and the stars draw their trails over the plate, interrupted here and there, the lens being now and then covered for five seconds. If the local mean time of the instantaneous exposures of the lunar disc and of all the interruptions is known, the Greenwich mean time may be found from the plate. One may apply three different methods. Either one can determine the right ascension of the moon or the declination, or one can measure lunar distances. I have tried all three, and prefer the second, provided the moon is not near the maximum or minimum of her declination. For the slower rate of change of declination is made up by the greater accuracy with which it can be measured, on account of the trails being lines of constant declination. Each image of the lunar disc allows a separate determination, so that the final value is the mean of a number of determinations. (For the details of measuring, see my article in the *Zeitschrift für Vermessungswesen*, August 1893.)

The results of one plate for the difference of Greenwich mean time and local mean time were by the three methods—

	39·1 minutes
	39·1 ,,
	38·6 ,,
Mean	38·93 ,,

while the true value is 38·943. This very close coincidence must be considered accidental. But I think one can well rely on the determination from one plate not differing more than 0·2 minute from the real value. When exposing for a longer time, the dew will sometimes condense on the lens, and render it opaque. To prevent this, I place a screen before the lens with a hole in it a little larger than the lens. The screen keeps the lens from cooling below the temperature of the surrounding air, and thus removes the cause for the condensation of dew. When determining the latitude the screen was arranged as a lid of the outer box, and served at the same time to protect the camera from gusts of wind. C. RUNGE.

Technische Hochschule, Hannover.

Sodium and Uranium Peroxides, &c.

IN your notes of May 17 you give an account of work done by Prof. Poleck on the action of sodium dioxide on the salts of various metals, from the *Berichte* of May 8.

Some of this work has been already recorded by other observers who used either sodium dioxide or hydrogen dioxide in alkaline solutions.

In the *Journal* of the Chemical Society, 1877, pp. 1-24, and pp. 125-143, I gave papers on the reactions of hydrogen dioxide, and described its action on uranium salts both in acid and in alkaline solutions. I do not wish, however, to say anything on a mere question of priority, but simply to point out inaccuracies in the formulæ given in NATURE from the *Berichte*.

Prof. Poleck gives for sodium peruranate the formula $Na_4U_2O_8 . 8H_2O$. This either involves the use of the old atomic weight of uranium, half of that now adopted, or it means that his salt is exactly like that prepared by me in every respect, excepting that it contains twice the proportion of uranium. Assuming the atomic weight at approximately 240, the correct formula of sodium peruranate is $Na_4UO_8 . 8H_2O$ (*Journal* of the Chemical Society, 1877, p. 139).

I also showed that hydrated sodium dioxide is readily obtained on adding alcohol to mixed sodium hydrate and hydrogen dioxide solutions (p. 125), so that the materials used by Prof. Poleck and myself are practically the same.

The uranium compounds are interesting as examples of a special highly oxidised type (see Mendeléeff's "Principles of Chemistry," vol. ii. p. 244), also as throwing light on the nature of certain analogous but unstable bodies, such as perchromic acid. (*Journal* of the Chemical Society, 1877, pp. 7-8). This was further confirmed by Dr. C. Haussermann last year, who has isolated a definite crystallised sodium perchromate, as described in the *Journal fur Praktische Chemie*, quoted in NATURE in the notes given July 27, 1893, p. 300. THOMAS FAIRLEY.

Cataloguing Scientific Papers.

THE recent circular issued by the Royal Society anent the indexing of scientific literature affords me a pretext for suggesting in your columns a reform which I have long thought to be urgently required. It is that henceforward all scientific publications should be issued in only one volume per annum—in parts, if necessary, but consecutively paged and with only one index—and that this volume should be primarily referred to by the year of its publication, *not* by its number since the first issue of the publication. Two advantages would accrue from this system. In the first place, the date of all quoted work would be fixed; in the second place, the finding of the abstracts of papers published elsewhere, printed in the journals of scientific societies, would be rendered more easy. A little reflection will show that these benefits are not trivial. For example, suppose an author refers to a paper by Smith published in NATURE, vol. xi. I have not (may I be pardoned for saying so!) the slightest idea when NATURE was first issued, nor do I remember whether one or two volumes of this periodical appear per annum. I am therefore totally in the dark as to whether Smith's work is one year old or twenty years old, and consequently I am ignorant whether he is likely to have used the most modern appliances in his research, and whether he is likely to have been contradicted by subsequent observers. Again, I am referred by an author to a paper by Schmidt, in the *Berichte* of the German Chemical Society, vol. xx. Not possessing this journal, I hope to be able to find an abstract of the paper in question in the *Journal* of the Chemical Society, to which I subscribe; but as I have no notion in what year vol. xx. of this *Berichte* was published, I have to search through numerous indexes in order to find the abstract. A search for previously published work is already sufficiently difficult to cause many to shrink from the task; ten years hence it may be expected to be the most laborious and thankless work which the investigator has to perform. A. G. BLOXAM.

May 19.

Clavatella Prolifera.

THIS hydrozoan may be added to the list of the Jersey marine fauna. It occurs in rock pools on the higher littoral between the Point des Pas and Gorey, and probably at other places round the coast. I often found three or four colonies in one small pool; but the number of polypites in a colony was very small—generally two or three, rarely four, and only in one case five. The stolon runs along in the chinks of the Melobesia that grows over so many of the pools, hence it is not an easy matter to obtain specimens there. The walking-buds, however, were fairly plentiful.

May I ask if any correspondent of NATURE has ever seen the walking-bud of *Eleutheria*, in which both extremities of the bifurcated arms are said to consist of a ball of thread-cells?

May 22. HENRY SCHERREN.

THE DESTRUCTIVE EFFECTS OF SMALL PROJECTILES.[1]

THE effects of small projectiles when driven at high velocity through the tissues of the brain have always excited the deepest interest, for very obvious reasons.

This interest must always be two-sided, namely: (1) Physical; (2) Pathological; and it is upon these two points of view that I propose to speak to you this evening.

Conceive a cylindrical bullet with a conical head flying through the air some ten or fifteen times faster than an express train.

We have now to study what it is doing in its aerial flight, and what will happen when that terminates by the projectile striking both hard and soft substances.

This embodies the matter for the purely physical side of the work.

But imagine, further, that the hard and soft substances just mentioned are the skull and brain respectively, what will happen then?

This is the pathological part of the question, and it is one of the greatest moment; for whereas it is true that a few persons do survive being shot in the head, the large majority die; and it is my object to show you how a combination of physical and pathological experiments has revealed the reason why the majority do die, and revealed it, fortunately, so distinctly as to suggest means for warding off the fatal result.

(1) *Physical Considerations.*—First take the case of a bullet flying through the atmosphere. Here in this extremely beautiful photograph, kindly lent me by Prof. Boys, you observe that the bullet drives before it a wave of compressed air. Now this compressed air-wave is what is popularly called the wind of the shot, and to it used to be ascribed by military surgeons a certain proportion of deaths. The origin of this theory is difficult to discover, as the only case I am aware of in which the *post mortem* examination did not reveal hæmorrhage, fracture, &c. indicating that the shot had actually struck the body (though without injuring the highly elastic skin) is the instance given by the great Russian military surgeon Pirogoff, in his interesting surgical experiences of the Crimean war. Even this instance finds *à priori* a more reasonable explanation in syncope, and we shall see directly that the wind of the shot not only cannot, under any circumstances, kill a man, but also that its energy is far too slight for it to have any destructive effect whatever. It is rather curious to find that but few attempts have been made directly to estimate the wind of the shot, and those by Pelikan and others are only for large shot and by too coarse methods to be applicable in the case of a bullet, as the following experiment shows.

An extremely light vane of paper carrying a delicate mirror is suspended to a cocoon fibre, and carefully protected from currents of air in the room. A very gentle puff causes the vane to fly out most vigorously, yet we shall find that the ·380 bullet moving a thousand feet a second may pass within eight inches of it without causing the least deviation of a ray of light reflected from the mirror. It is only when the bullet passes within an inch or two of the edge of the vane that there is some slight rotation. The ·303 magazine service rifle, with a velocity of twice that of the larger bullet, produces little more than the same result. It is therefore obvious in this case that the far higher velocity is more than compensated for by the lesser sectional area of the projectile displacing the air. Although there was no proof of much displacement of the air, it was pretty generally held that when the bullet entered any substance the compressed air driven before it exercised an explosive effect. This opinion was more particularly supported by the Belgian physicist Melsens, who actually described it by the term "projectile air." The matter was taken up from the point of view of pure physics, and Magnus demonstrated that if a body like a bullet entered water, *e.g.* in falling the funnel which the displaced water makes in the axis of the body as soon as that is fully immersed, entangles air, and that it is this air which is carried by the body into the fluid, rather than that any air is forced in in front of the bullet. In answer to Magnus, Laroque invented the following ingenious experiment. He allowed a long body, incapable of wholly sinking, to drop into the water, and then found that there was air driven in in front of it; while, by the nature of the experiment, he had, of course, excluded the possibility of any air following the base of the projectile. I have repeated all these experiments (employing in Laroque's a slender rod of wood) and found that while his contention that air is driven in front of the bullet is completely substantiated, yet Magnus' observation is so far correct that air is also

[1] A [illegible] at the Royal Institution [illegible], by Prof. Victor H[illegible], F.R.S.

driven in after it, the fact being that the two conditions are not opposed but simultaneous. Magnus' view was further supported by the adverse criticism of the theory of projectile air of the celebrated French artillerist Morin, which criticism amounted to this, that when a projectile was directed against a *solid* body it must necessarily follow that so elastic a substance as air should be completely reflected from the surface. I should like to draw your attention to this word *solid*, because I believe that in that we find the key to the difficulty, and the apparent paradoxes presented to us are to be explained by the fact that the results are wholly dependent upon the simple question of the relative viscosities of the substances entered. To solve this, I employed the same falling bodies, and examined their entanglement of air in water and glycerine respectively, and found that whereas in the case of water, Laroque's non-floating rod drove air in front of it as well as probably at the side, yet when the same rod was caused to fall into glycerine of high concentration there was no air in front, but air-bubbles could be seen clinging to the sides of the rod. Further, in glycerine the entanglement of air in the funnel formed by the base of the bullet, as described by Magnus, was very striking. It appeared to me that whatever air was driven in front of it was wholly reflected by the sufficiently viscous fluid, and hence it must be, *à fortiori*, still more completely reflected from the surfaces of hard and soft solids like the skull and brain respectively.

To sum up, the so-called projectile air can have no real bursting effect, since, as I have demonstrated, in the first place it exerts very feeble pressure, as tested on a delicate vane, and in the second place it is certainly easily reflected from surfaces of but moderate density.

The Influence of Rotation produced by Rifling.—It is commonly thought that the spin of the bullet communicated to it by the rifling of the barrel, and which is very great, causes a considerable amount of the disturbance created in the interior of moist substances, which is usually spoken of as the bursting or explosive effect. Kocher thought that this would not be appreciable, and that the rotatory movement would only cause the displaced particles to take a course tangential to the surface of the bullet rather than perpendicular. Although the smooth surface of the bullet of course adds force to the idea that its rotation is not very effective, it is obviously a matter of both interest and importance that the matter should be more closely studied. Colonel Henrad made plaster casts of the tracks of shots, and obtained distinct spiral markings indicative of the rotation in question. Acting on this suggestion, it was easy to institute a series of experiments of the following kind. Pure modelling clay of firm consistence (for the influence of the water present *vide infra*) was rendered homogeneous by kneading, shaped into square blocks of varying length, and supported in a hard flat surface or in a box, the ends being open. The cavity made by the bullet in entering and traversing the mass was then filled with liquid plaster-of-paris, and a cast obtained. Examples of such casts are before you, and they completely display the rotation in question.

The first point which has to be borne in mind is the relation of the rotation to the projection or forward movement of the bullet. In passing through a body of little resistance like the air, it is clear that for every given unit of distance travelled, the displacement evoked by the rotation must be something very small, because although the bullet turns one and a half times in traversing the barrel, that is nearly a yard in length consequently, so far as the rotation is concerned, that for a unit, say one inch, of the flight of the bullet would be extremely small, namely about one-twentieth of the circumference of the bullet, which, roughly speaking, would be (for the ·380 bullet) about one-twentieth of an inch, the insignificance of which is obvious. The matter, however, assumes a somewhat different aspect when a bullet is engaged in a solid substance through which it is forcing its way with rapidly diminishing velocity. In such a case, where the projection journey of the projectile is quickly coming to an end, it becomes of special importance to see what is becoming of the factor of rotation. The plaster casts obtained in the manner indicated show clearly enough the interesting fact that the rotation persists to the end, when the bullet has simply taken its course through the atmosphere, and then entered the soft clay. Further, the casts also show what is a necessary deduction from our earlier considerations on this matter, namely, that as the rotation is preserved till the end of the trajectory, the twist is proportionately more pronounced as the forward movement is lost.

It is for our present purpose important to see whether the rotation is well marked when the projectile is completely deformed. To examine this point a new series of experiments were undertaken, in which the bullet was first caused to penetrate a flat bone before entering the clay. It is very clear that the rotation is still present. In discussing this question I have left unnoticed the fact that owing to the resistance of a body like clay, the cohesiveness of which of necessity varies slightly from point to point, there will be a great tendency for the bullet to change its direction, more especially as the base is heavier than the apex, and to this change of direction must be attributed in part the change of surface simulating the rotation effects due to the rifling. The two conditions, however, can be distinguished readily on careful examination.

So far as destructive effects in the brain are concerned, it is therefore clear that relatively little is to be ascribed to rotation.

Projection Destructive Effects.—The destruction by the bullet moving forward through a solid body is the most important matter for us to consider. There are two sets of factors determining the degree of destruction in any given substance.

(1) Factors due to the bullet.

(2) Factors due to the *physical constitution* of the solid.

(1) Factors due to the bullet. So far as the projectile is concerned, the chief considerations are (*a*) its momentum; (*b*) its sectional area; (*c*) its becoming heated.

(*a*) *Momentum.*—Although it will of course be generally understood that the greater the velocity the greater the damage for the same weight of shot, still, in connection with the small-bore service rifles of the present day, some seem to think that the small bullet, by virtue of its travelling at a great pace, would pierce the tissues without causing much general damage. The fallacy involved in this belief we shall see directly; but a single glance at the casts arranged in order of the velocities of the bullets, shows immediately the unreality of the notion. In every case the particles of the substance are hurried forward (particularly evident in the casts before mentioned) in front of the bullet, and thus by increasing the size of the moving mass such particles practically constitute a larger projectile. Much destruction is due to this, as Delorme has more particularly demonstrated in the well-known case of firing a bullet into a book, wherein one may see the laceration of the pages successively increased, although the momentum of the bullet is steadily diminishing and in proportion to the increasing laceration, so discs of increasing diameter are found in the cavity, having been cut from the preceding pages. The hurrying forward of the particles is very beautifully shown by Prof. Boys in his photographs of the débris of glass plates after a bullet has passed through them. In one case a large fragment of glass is shown to be moving parallel to the bullet, *i.e.* with the same velocity. This question of accessory damage is of much importance to the pathological problem how much damage is effected in the brain. I have found discs of bone forced through the brain, such discs (as will appear directly being larger than the projectile itself. Small fragments are also hurried forward with the same velocity as the bullet, as these casts show, the plaster method thus confirming Prof. Boys' photographic record.

(*b*) *Sectional Area.*—From what has just been said, it is plain that the crushing effect of the bullet will be greatly increased if its diameter is enlarged: and it is understood that this was the reason why the Duke of Wellington opposed the introduction of the smaller bore weapon for the old musket called "Brown Bess." But few words, therefore, are requisite in dealing with this point. I wish, however, to draw attention to an extremely common result of the employment of leaden bullets, and a result which is wholly dependent on the principle just enunciated. In a photograph of the penetration of an iron plate by the magazine rifle bullet, it will be noticed that the diameter of the holes is almost twice that of the bullet as it leaves the muzzle of the rifle. When the bullet is picked up, however, after it has passed through the plate, the reason of this seeming absurdity is at once recognised, for the bullet is compressed into a hard mass of lead and nickel by its first impact on the front of the plate, of the size of the hole shown. It is important, therefore, for the military surgeon to consider what proportion of the damage is due to deformation of the projectile on its striking the body, but the sectional area demands very little attention when compared to the velocity as a source of destruction.

(*c*) *Heating.*—The notion that a bullet produced some of its destructive effects in consequence of its being raised in temperature, as a natural result of some of its momentum being converted into heat, has always been before scientists ever since the invention of fire-arms, and endless have been the suggestions put forward to support this idea. I am not going to waste your time on the matter because, in spite of the plausible papers of Hagenbach and Socin, there are certain facts plain and simple enough which, to my mind, completely dispose of the notion put forward by those authors, namely that the bullet undergoing deformation on striking a hard substance like bone becomes heated so intensely that it partly fuses. The simplest observation of all is that, I think, made by von Beck, and which I have often confirmed, namely that a bullet, though completely deformed by impact, may enclose a hair or piece of wood without these being in the least degree altered by heat; while as for its being heated in the barrel, &c., that cannot amount to 40 C., for Messner has shown that a bullet traversing dirty clothing carries with it living microbes, and deposits them in the object it strikes, still in a living state, so that they grow therein if the soil is a suitable one; and these observations have been fully confirmed by Delorme and Laveran. It is to be hoped that we have heard the last of this unquestionably exaggerated idea of the heating of a bullet.

(2) Factors due to the physical constitution of the solid.

We now enter upon the discussion of the most interesting of all the physical considerations determining the well-known bursting effect which a bullet produces on certain substances, *e.g.* clay, brain, &c., while simply perforating others, *e.g.* wood, iron, &c. The reason why a bullet behaves apparently quite differently when it is forcing its way through solids of different kinds, has been, as a matter of fact, answered ever since 1848, when Huguier made some remarkable, but little known, researches of the effects of bullets on soft tissues, after he had observed the results of the wounds inflicted in the fighting in Paris in 1848. It will be remembered that in that struggle, as in others, the appearance of bursting within the tissues was very noteworthy, and gave rise to the notion of explosive bullets having been employed by the combatants contrary to the received opinions of international comity. The whole question is a perfectly simple matter, and resolves itself merely into the proposition that destructive effects vary in direct proportion to the cohesiveness, *i.e.* the fluidity of the particles composing the body. Ever since the observations of Tresca, Roberts-Austen, and others, we have been made familiar with the phenomenon of the flow of metals when these are subjected to powerful pressure, and the mode of the displacement of the particles has always been compared to the displacement observed in viscous fluids. The extreme case in which fluidity is least present is that of the substances which we term brittle. In these, while much pulverisation occurs, the displacement of particles laterally is very slightly marked. Contrast the penetration of an example of this class, namely a flat, thin bone, with the effect produced on a more or less plastic solid like brain, and a striking difference presents itself, for whereas the bone is simply penetrated in the long axis of the bullet, the brain is thrown aside in every direction. Huguier made observations on certain dead organs, *e.g.* lung, liver, &c., and suggested that the reason why there was so much lateral disturbance was that the tissues contained water in large quantity, and that the energy of the moving projectile being imparted to the particles of water, caused the dispersion of these in a hydrodynamic fashion. Kocher, in 1874 to 1876, was the first who thoroughly dealt with this question in the manner shadowed forth by Huguier, and he proved, in a series of interesting experiments, which Dr. Kramer and myself have fully confirmed, that the effect is really a hydrodynamic one. One of the simplest of his observations you see before you, and is made as follows:—Two tin canisters are taken of precisely the same size and strength, and are filled with equal quantities of lint; but in the one case the lint is dry, in the other saturated with water. When a bullet of moderate velocity is fired through these canisters, it simply perforates the dry one, but causes the wet one to burst explosively. It is, however, not a simple question in dealing with these artificial schemata merely to provide a porous substance the cavities of which are filled with water, for I have found that if the intervening septa are strong, as, for instance, in the case of sponge, that the bursting effect is not so great. In fact, the water must be thoroughly incorporated with the substance, or, to speak more correctly, the substance must be more perfectly fluid. This can be easily demonstrated by taking dough containing different percentages of water, and since dough is a substance in which the incorporation of the water is very complete, it affords a particularly good example to employ. By firing bullets of precisely the same velocity through these samples, you see that the destruction is effected strictly proportionally to the fluidity of each specimen. This is the reason why it is really of no absolute value to make experiments on dead tissues, for the brain in a state of *rigor mortis* is practically a solid, since both its living protoplasm and blood in the blood-vessels has coagulated, whereas in the living condition the first is semi-fluid, and the second quite fluid. It was to investigate this point, as well as the previous questions, that I have paid more especial attention to the proportionate relation existing between the velocity and the explosive effect. The results are very obvious in the casts before you. This work has been immensely facilitated by the kindness of Sir Andrew Noble, who caused to be constructed at my request a modification of a 22-calibre rifle, whereby I can fire a 40-grain bullet with any velocity I wish from a few hundred feet per second to over 3500 feet per second.

The casts show that the effect in the clay is proportional to (1) the velocity of the bullet, (2) the wetness of the clay.

The method of proof is so convincing I need not detain you further in this discussion.

Since the question is, we now see, all-important, it becomes a matter of no small moment to study the effect exerted by bullets entering fluid (for example, water). In the first place, as may be seen by these experiments, the effect of the perforation of a skull, filled with water, by a bullet, as was first done by Kocher, is to cause the burst of the sutures. I would draw your attention to the fact that the separation of the bones is most marked on the side of the entry of the bullet. It was the observation of this latter point which led me to think that it might be possible to automatically record the disturbance of the fluid, and this was effected in the following way.

A long trough having been prepared, with one end closed with rubber one-eighth of an inch thick, and a tall, white, flat surface lowered vertically into the trough, the latter is filled with a solution of methylene blue. A small bullet of low velocity (600 feet per sec.) is fired in the long axis of the trough, 1 cm. below the surface of the water. As a result, a wave is thrown up against the white screen, which is consequently marked with a blue splash, the same describing a curve, indicating, firstly, that the disturbance is greatest where the velocity and resistance, increased by compression, are both at their highest, *i.e.* soon after the bullet enters the fluid; and, secondly, that the displacement diminishes gradually as the momentum lessens.

Complete confirmation of the parallelism between soft solids and fluids in their behaviour to the rapidly-moving bullet is seen in comparing the cast of the track made by a bullet moving through clay, with the curves obtained by the water record.

In both, the maximal displacement occurs shortly after the bullet has entered the substance, and in both the diminution of disturbance is much more gradual than its development, and is evidently proportional in the main to the loss of momentum. A final proof is afforded by suspending columns of methylene blue in clear water, or salt solution, and then firing through the whole. With the ·380 bullet and three grains of smokeless powder the last column in the 4-foot trough was not disturbed.

This doubtless is a result which would be generally foreseen, but it was worth while to test it experimentally, and it certainly very strikingly demonstrates how localised the bursting disturbance is, which completely explains the limitation of the explosive effect on the skull on the side of entry. Sundry interesting subordinate points arose in the course of these experiments, and have served to afford the necessary control of the method, *e.g.* the peculiar splash of the bullet striking the rubber end of the trough alone, *i.e.* not penetrating; and, again, the tracing made by a bullet which, being fired a little too superficially, records the elevation of successive waves as it ricochets along the surface; and, finally, the record of a bullet deflected by the resistance of the water (as well as by want of horizontality), showing a long, oblique splash where it has carried up the fluid into the air.

From all these experiments on the pure physics of this subject we are justified in believing that when a bullet is fired against the head (whether that of a man or any other warm-blooded animal), so as to penetrate the cerebral hemispheres in a transverse direction, the following series of phenomena occurs. The impact of the bullet on the bone causes depression of that bone over an area larger than the diameter of the uninjured bullet, this causing a slight rise of tension in the skull, since that cavity is completely filled with fluid, *e.g.* the cerebrospinal fluid and blood in the blood-vessels, together with the living brain, which, as has already been stated, is a semi-viscous substance. In the next instant the bullet enters the cavity, and the slight rise of tension is instantly converted by the universal displacement (explosive effect) of the contents, into a very severe rise of pressure, most marked on the side of entry. The lines of force which this pressure takes is shown in this diagram, and it will be obvious to you that these forces will on meeting the rigid skull tend, as I have already shown, to burst it, and if they fail in that, then they will certainly be reflected on to the brain, a matter, as we shall presently see, of special pathological significance. As you see from the diagram, the brain substance must be driven against the internal surface of the globular cranium. This driving of the brain against the hard bone is exemplified in every post-mortem examination. A good instance is seen in the accompanying specimen, in which, although the bullet traversed the extreme tips of the frontal lobe and the olfactory bulbs, numerous bruises are seen on the hinder portions, where they have been crushed against the bone. Similarly evidences of the direct transmission of the pressures are to be found at the base of the brain in the longitudinal fissure, &c., wherever, in short, the brain can be pressed against an unyielding substance. The final proof of the correctness of this interpretation is to be referred to directly, in which the vault of the cranium is removed before the shot, so that the energy of the pressure is expended in ejecting portions of the brain into the air, and not so much on the basal regions, as just described. So, too, the energy of the bullet is communicated in the same way to the fluid in the ventricular cavities (Duret's "choc cephalo-rachidien"), which tunnel the brain down to the medulla oblongata. The medulla oblongata is thus subjected to pressure from two sources: (1) the hydrodynamic displacement of the brain *en masse*; (2) the direct crushing effect due to the movement of the cerebrospinal fluid in the ventricles.

We are now brought to the aim and object of these preliminary considerations, namely, the reason why these disturbances within the skull cause death, and how the fatal issue is produced; in short, we must pass from the questions of pure physics to the more complex problems of pathology.

(2) *Pathological Considerations.*—The experiments, the results of which I now wish to lay before you, constitute a long series which was carried out last year by Dr. Kramer and myself. We arranged the experiments as follows: A dog was placed under ether, and one femoral artery connected with a mercurial manometer to give record of the heart beats and pressure of the blood in the trunk arteries of the circulatory system. Another similar manometer was connected with the peripheral end of an artery so as to record the changes of pressure in the small capillary vessels, changes which I may remark incidentally are usually due to those disturbances in the central nervous system which we call vaso-motor. Thirdly, the movements of respiration are traced on the recording surface by means of rubber tambours known as Bert's and Marey's, respectively. If the pressure within the skull was also to be recorded, then a steel tube was fixed into a trephine opening filled with the salt solution, and connected by a rubber air-tube also with a Marey's tambour. Occasionally we put on the same paper a record of the contraction of the rectus femoris muscle, this latter being directly connected with a Fick's spring myograph. At the bottom of the tracing is given, firstly, the record of the movements of an electro-magnet signal (Smith's) interrupted by a metronome beating seconds. The last line traced is that from a Smith's signal in the circuit of a single cell, and one of the wires from which is made of very slender brass, and fixed across the muzzle of the pistol or rifle, so that when the shot leaves the muzzle it cuts it and breaks the contact (Woolwich method).

When a bullet of low velocity (600 f.p.s.) strikes the skull in a glancing fashion, there is only a trifling disturbance of respiration, but when the bullet enters the cranial cavity and sets up the powerful hydrodynamic pressure before referred to, a very severe effect is produced, namely, complete arrest of the respiration and a slight fall of the central blood pressure, this causing a similar feeble fall in the peripheral blood pressure. A little later (5–10 secs.) than the arrest of respiration a remarkable rise in the blood pressure occurs, this rise continuing until the normal tension is exceeded. These observations prove beyond doubt that the first cause of death is not what it is usually supposed to be, and as taught in the text-books, namely arrest of the heart and syncope, since, as you see, the heart goes on beating although the respiration has completely stopped. Furthermore, if we quickly perform artificial respiration we obtain recovery from the otherwise fatal arrest.

This suggests very strongly that the police and persons who are trained in giving the first aid to the wounded should be taught that with a gunshot wound of the cerebral hemispheres, the proper thing to do is to employ artificial respiration rather than the giving of stimulants, &c. But, as you may well expect, the matter does not stop here, nor is it so very simple, because we find that there are certain conditions under which the secondary rise of blood pressure does not occur.

It is now quite evident that the fatal phenomena of the gunshot wound of the cerebral hemisphere is in the first instance cessation of the breathing, and I have now to indicate in detail how this is produced by the hydrodynamic disturbance evoked within the skull cavity by the energy of the bullet. It is perhaps necessary to first remind you that the upper part of the spinal cord or medulla oblongata contains the chief centre for the movements of respiration. I would also draw your attention to the fact that therein is also the centre of origin of the vagus nerve, which nerve has the power of slowing the heart. Thus there are two important centres in the medulla which are liable to be affected by changes of tension around them induced, as above stated, when the bullet traverses the cerebral hemispheres in a transverse direction. It may be that the centres are principally affected by the mechanical pressure of the explosive effect, but this latter of necessity produces a certain amount of anæmia of the nerve centres; some of the effect may also be produced by that condition too. Supposing that the artificial respiration has been properly carried out, and the respiratory centre is revived into activity, there is yet another condition to be overcome, without which the animal or person dies, and for a long recognised reason, namely, that the bullet having in its passage cut through various blood-vessels, blood is poured out within the skull, and consequently raises very severely the intra-cranial tension. This constitutes, as a matter of fact, a second cause of death, for under these circumstances the accumulated blood causes such severe compression, that it not only again paralyses the respiratory centre but also irritates the vagus centre, causing a marked slowing of the heart. The proof of the truth of this statement is given at once the moment we cut the vagi nerves, for if these are divided the heart immediately resumes its former rhythm. The next curves are to exhibit the increase in the intra-cranial tension, which occurs the moment the bullet enters the skull. The line drawn by the Marey's tambour shows a violent increase of pressure at the moment of shot (first or explosive effect) and a certain recoil therefrom, this recoil being directly changed for a steady increase in tension brought about by the secondary cause of death, namely, the hæmorrhage, of which I have already spoken. To treat such hæmorrhage only ordinary surgical measures are requisite, but these will be impossible if the activity of the respiratory centre has not previously been restored in the manner already indicated.

To sum up, the basis of scientific discussion of the nature and causation of the phenomena evoked by bullet wounds of the cerebral hemispheres must rest on two principal factors—the velocity of the projectile and the development of hydrodynamic movement in the wet living tissues.

I am glad to have had the opportunity of laying before you the facts on a subject which combines the pleasure of pure physical research with the interest inseparable from the resolution of pathological problems.

GEORGE JOHN ROMANES.

ANOTHER of our not too numerous band of English biological investigators has been taken from us in the prime of life. The list is a heart-rending one, and its full share of sadness surrounds the fate of this last dear friend and companion. Garrod, Frank Balfour, Moseley, Herbert Carpenter, Milnes Marshall—all were younger at death than Romanes, and he only reached the age of forty-six just three days before he died. For some two years his friends have watched with anguish the progress of the disease—a condition of the arteries resulting in apoplexy—which has now ended his pain. Marvellous was the activity of mind and the eagerness with which he pursued his favourite discussions even to the day of his death. Nothing, perhaps, more touching was ever witnessed by those who knew and loved his kindly earnest nature than the calm conviction with which he realised that the hand of Death was laid on him, the pathetic smile with which he would say, as he puffed his cigarette, "Of course my life is only hanging by a thread, and I shall never be able to finish the experiments which would, I think, convince you."

George John Romanes was the son of the Rev. Prof. Romanes, and was born in Kingston, Canada, on May 20, 1848. He studied at Caius College, Cambridge, took honours in the Natural Sciences Tripos (1870), and was Burney Prize essayist in 1873. Having private means, he determined to devote himself to the study of psychology, which he proceeded to attack from two sides—that of physiology, and that of the doctrine of evolution. He further equipped himself for his task by mastering the teachings of modern writers on "philosophy." To contribute to a knowledge of the evolution of Mind was the ultimate aim of his numerous researches and discussions. He was fortunate as a young man in forming an intimate friendship with Mr. Darwin; and it was his ambition not merely to carry the application of Mr. Darwin's methods and principles into the great field of mental evolution, but also to strengthen and, where possible, supplement the Darwinian theory itself. Mr. Darwin assisted Romanes in this enterprise by leaving to him unpublished work of his own on "instinct" and similar subjects.

Romanes first became known to the larger public as a gifted and capable exponent of scientific doctrine by the lecture on "Animal Intelligence" which he gave in Dublin during the meeting of the British Association in that city in 1878. He was subsequently appointed Fullerian Professor in the Royal Institution, and gave numerous lectures both there and at the London Institution. He contributed a series of papers describing his researches on the nervous system of the Medusæ to the *Philosophical Transactions*, and was elected a Fellow of the Royal Society fifteen years ago. His literary activity was very great, and resulted in the publication of several large and well-known books, as well as in numerous essays and short articles of a controversial character published in the reviews and in this journal. His chief books are "Animal Intelligence," "Mental Evolution in Animals," "Mental Evolution in Man," "Jelly-fish, Star-fish, and Sea-urchins," "Darwin and after Darwin," and "An Examination of Weismannism." He had a keen love of public discussion and a native skill in dialectic, which may sometimes have led him to seek too eagerly an argumentative triumph. But his writings bear evidence of the most extensive knowledge and of a conscientious examination of all sources of information, combined with independence of judgment and much subtlety of analysis. The high estimation in which his work is held may be judged of from the fact that all his books have been translated into French and German, and that the book on which he was engaged when the first symptoms of his fatal illness appeared—namely, that entitled "Darwin and after Darwin"—was published simultaneously in the United States and in this country under special conditions highly satisfactory to him.

Four years ago, in order to enjoy greater quietude and the facilities of the newly erected physiological laboratory of the University, Romanes removed from London and took up his residence with his wife and family in a fine old house in Oxford, facing the cathedral house of Christchurch. Here he has left his name and memory not only to be cherished by the numberless friends who mourn his early death, but to be carried forward to all future generations of Oxford scholars by the lectureship founded by him three years ago. Gladstone, Huxley, and Weismann have been the first three "Romanes lecturers" nominated successively by the founder. Hereafter it will be the duty of the University to elect annually a lecturer worthy to follow them.

Whilst it would be premature to claim for Romanes the merit of a great discoverer or originator in psychology or in the philosophy of evolution, it is nevertheless true that by his keen criticism, careful mastery of details, and great literary fertility, he has exercised a most important influence stimulating the thought and research of others by his example and enthusiasm, and by those contests in the arena of the "reviews" with Wallace, Spencer, and Weismann, which have made his name so widely known.

It is not generally known, though a fact, that Romanes produced, in addition to his numerous scientific writings, a considerable volume of verse, which was printed for private distribution, as well as occasional poems. These poems deal with philosophic and emotional subjects, and are often of great beauty. It should be mentioned (although it is not possible here to record every fact of importance in his life) that Romanes was for some years honorary secretary of the Linnean Society of London, and a member of the Council of University College, London; he was Rede lecturer in the University of Cambridge, an honorary LL.D. of the University of Aberdeen, twice Croonian lecturer of the Royal Society of London, and Rosebery lecturer in the University of Edinburgh, when the courses delivered by him formed the substance of his book, "Darwin and after Darwin."

One word before this too hasty notice is concluded as to his personality. His unaffected good-nature, and almost boyish simplicity and gaiety of character, endeared him to every man and woman with whom he came into contact. He has left behind him numberless friends, not one enemy.

E. RAY LANKESTER.

NOTES.

THE fourth volume of that very useful work of reference, the "Minerva Jahrbuch," which goes to press in July next, is to contain an engraved portrait of Lord Kelvin. If the portrait is as good as that of L. Pasteur, which adorned the third volume, it will be well worth having.

WE regret to note the death of Dr. B. H. Hodgson, at the advanced age of ninety-five. He was elected into the Royal Society in 1877.

DR. S. J. HICKSON, Fellow of Downing College, Cambridge, has been appointed Professor of Zoology in the Owens College, Manchester.

COLONEL LAUSSEDAT has been elected an "Académicien libre" of the Paris Academy of Sciences, in succession to the late General Favé.

THE Société des Arts de Geneve have opened a subscription list for the purpose of raising a fund to erect a bronze bust of the late M. Colladon somewhere in Geneva.

THE gold medal of the Linnean Society has this year been awarded to Prof. Haeckel, of Jena, for his important contributions to zoological science.

THE new buildings of St. Thomas's Hospital Medical School will be opened on Saturday, June 9, at 4 p.m., by the President, H.R.H. the Duke of Connaught.

A GENERAL meeting of the Federated Institution of Mining Engineers will be held in the rooms of the Institution of Civil Engineers on Thursday and Friday, June 7 and 8. Arrangements have been made for a visit to Messrs. Siemens Brothers and Co.'s works at Woolwich on Saturday, June 9.

AN international photographic exhibition will be held in Arnhem, Holland, from July 14 to 29. The exhibits will be divided into six classes, one of which will include scientific photographs. Mr. G. S. de Veer is the Secretary of the Exhibition Committee; his address is Velperwege 94, Arnhem, Holland.

THE annual meeting of the Photographic Convention of the United Kingdom will be held in Dublin in July. The President for the year will be Sir Howard Grubb, and the committee of reception includes, among others, the Earl of Rosse, Viscount Powerscourt, the Lord Mayor, and the Astronomer Royal of Ireland. The proceedings will open on Monday, July 9, with a reception and conversazione in the Museum of Science and Art.

IN these columns on March 8 and May 10, we noted the gigantic landslip that had occurred in the Gurhwal district in India, and blocked up the valley of the Bihri Ganga river. The disaster that was expected to result from this has happened. A Reuter's telegram reports that the dam has burst, and the immense volume of water that had been kept back has flooded the district, sweeping away villages, and causing the loss of about two hundred lives.

LAST year was a critical one in the history of the Zoologica Society of Philadelphia. We learn from the twenty-second annual report that an effort was made early in the summer to raise a fund by private subscription for the purpose of meeting a large financial deficit. This, however, met with little success, and all hopes of saving the Garden of the Society had been given up, when the Commissioners, who hold the ground upon which the Garden is situated, asked from the City Councils a sum of 10,000 dollars for purposes of maintenance, in addition to the 5000 dollars which had for several years been granted. This sum was promptly voted, the Zoological Society placing in the hands of the Board of Education fifty thousand tickets for free admission of pupils of the public schools to the Garden. This liberal and broad-minded action has prevented the closing of the Garden and the dispersal of the collection.

IN the House of Commons, on Thursday last, Mr. Strachey asked the President of the Board of Agriculture whether it was proposed to repeat the experiment of transmitting the weather forecasts to telegraph offices in rural districts, for exhibition during the time of harvest; and, if so, what were the arrangements to be made for the purpose. In reply, Mr. Gardner said it was proposed to repeat the experiment of last year, and that the counties of Cambridge, Somerset, Carnarvon, the East Riding of Yorkshire, Haddington, and Ayr had been selected for the purpose. The forecasts will be despatched to rural telegraph offices at such periods as will suit the agricultural conditions of hay and corn harvest in the respective counties, and Mr. Gardner hoped that those interested in the matter would supply information as to the results of the experiment, so that it could be determined whether the system was of sufficient utility to justify its continuance and extension. The forecasts are, of course, prepared at the Meteorological Office, which has for many years issued hay harvest forecasts to a limited number of stations, and has had them properly checked by the recipients. The results of these forecasts are regularly published in the Reports of the Meteorological Council, and they show that the percentage of success has been remarkably good in nearly all the districts.

The weather over these islands has continued very unseasonable during most of the past week; the maximum shade temperature readings have been as low as 55° in many parts, and below 50° at some of the northern stations, while on Tuesday morning, the 29th inst., the minimum shade temperature fell below freezing point in the Midland counties. On the 26th a deep depression was situated over Germany, and caused very stormy weather over the south of England; in London the wind blew from the north-north-west with great force during Saturday night, the pressure amounting to 11½ lbs. on the square foot at Greenwich. The fall of rain which accompanied this disturbance was very great. On the Kentish coast it amounted to over 2 inches, and more than 3 inches fell at the Helder. Slight thunderstorms occurred in the Midland counties and southern parts of England in the early part of this week.

The influence of ancient village communities on the map of England is made the subject of an interesting paper by Mr. H. T. Crofton in the last number of the *Journal* of the Manchester Geographical Society. Mr. Crofton reproduces a portion of the six-inch ordnance survey map with the parishes coloured, and thus brings out the curiously complicated manner in which the boundaries are drawn, and the frequency with which portions of one parish are scattered in isolated patches through the neighbouring parishes. In order to explain these curious forms he points out that the ancient village communities of the primitive Celtic people, with their complicated adjustment of arable and pasture land, were not wiped out by the Roman conquerors, but gradually assimilated to the new distribution of property. Thus, acquiring a recognised character, the lands of separate tribes or families retained their ancient names and groupings, and to the present day the parishes of Manchester and its neighbourhood bear witness in their irregular boundaries to the primitive customs of the pre-Roman inhabitants of the land. The question of county and parish boundaries is one so full of interest for the student of primitive populations, that he must be grateful to the proverbial conservativeness of parochial authorities. Still, intending students in this interesting field would do well to set to their task speedily before the changing of the old order destroys landmarks which can never be restored.

The report of the Hydrographer to the Admiralty, published a few days ago, describes the work performed under the direction of the Lords Commissioners of the Admiralty during last year, in the examination and charting of seas and coasts in various parts of the globe. The necessity for accurate surveys on a large scale is strikingly illustrated by the number of rocks and dangers to navigation annually discovered, this number being steadily on the increase, no less than 201, which it has been deemed necessary to notify by notices to mariners, having been reported during the year 1893. Of these, 26 rocks were reported by H.M. surveying vessels; 35 by others of H.M. ships; 22 by various British and foreign vessels; 13 were discovered by vessels striking on them; and 105 were reported by colonial and foreign Governments. Ten vessels were employed in the surveys during the year covered by the report—four on home and six on foreign stations. The English stations were Plymouth Sound, the south coast, east coast, west coast, and the east coast of Ireland. On the west coast of Newfoundland the portion surveyed comprises from Cape St. George to a point 16 miles eastward of Cape Anguille, nearly 100 miles of coastline. An area of about 500 square miles was closely sounded. Of this locality there is at present no chart in which the navigator can place any confidence, and the new work will be especially useful. As might have been expected, a certain number of uncharted dangers were discovered, and no fewer than nine rocks with a less depth of water than five fathoms over them were found round the shores of the bay. A plan of Isthmus Bay, on a scale of 6 inches to the mile, was also completed. Dr. Bassett-Smith accompanied H.M.S. *Egeria*, and during the sounding of the Macclesfield coral bank in the China Sea was enabled to obtain a very valuable collection of corals from the deeper slopes of the bank, special attention being paid to the zone lying between the depths of 30 to 40 fathoms, from which he was able to prepare a highly interesting report on his investigations. The collections have been sent to the British Museum. The Solomon Islands, Queensland, Tasmania and the New Hebrides, and the Mediterranean were also the centres of marine surveys during 1893. The marine survey of India was carried out under the direction of officers of the *Investigator*.

An ethnographic expedition to the islands of Inishbofin and Inishshark, County Galway, was made by Dr. C. R. Browne in the autumn of last year, and the results of his observations, communicated to the Royal Irish Academy in November, have now been published. A similar expedition was made to the Aran Islands in 1892, and both were undertaken in connection with the Dublin Anthropometric Committee. These local investigations in selected parts of Ireland are as important as the results are interesting. The people visited, on the whole, much resemble the inhabitants on the opposite coast of Connemara, and their appearance testifies to a mixed origin. The average height is 5 ft. 6½ in., which falls short of the Irish mean stature as found by Gould, and the Anthropometric Committee of the British Association, by about two inches. Sight and hearing are very acute, and Dr. Browne says that the distance at which the islanders can make out a sail or a bird on the wing is amazing. The proportional measurements of the face and upper limb with reference to the stature differ in some respects, not only from those of the Aran islanders, but also from the accepted canons, and form the proportions obtained by Quetelet, Gould, and others, in their investigations on several European peoples. Though a large proportion of the marriages are consanguineous unions, the uniformity of strain does not appear to have produced any effect except a great similarity of appearance; no cases of malformation or congenital diseases are ascribed to it. Marriages are arranged by the parents from considerations of suitability of families, not, as in many other places, by money bargains. If the bridegroom be the eldest son, who usually inherits the parent's house, &c., the bride goes to live with his family. Sometimes, on the occasion of a wedding, "strawboys" go round with long straw masks on, and if they do not get either money or liquor will threaten to break the windows and furniture of the house. Many other customs are described by Dr. Browne, and his notes on the legendary lore of the islands will be read with interest. The Dublin Anthropological Laboratory is to be commended for extending its work by these local investigations.

THE description of the external anatomy of the brain of a Chinaman, contributed to the current number (part lxv.) of *Brain*, by Mr. C. H. Bond, is noteworthy, for only seven Chinese brains had previously been reported upon. Several decided differences from what is looked upon as the normal are pointed out as existing in the Chinese brains. First of these stands out a greater prominence given to furrows running transversely as compared to those in the antero-posterior direction. As to convolutional complexity, the Chinese brains were up to the normal standard, and in the frontal lobes rather beyond the average. The weight of the brain studied by Mr. Bond was 1182 grammes, that is, 176 grammes less than the weight of an average male adult brain. The proportion of the cerebral hemispheres to the cerebellum was as 5 is to 1. In the case of the average man the proportion is $8\frac{1}{2}$ to 1, and for the chimpanzee it is $5\frac{3}{4}$ to 1. It is pointed out that if the brain investigated was at all typical of the race to which it belonged, then the small size and weight of the cerebrum as compared to the cerebellum is a point worthy of special emphasis. The number which includes Mr. Bond's description also contains the presidential address to the Neurological Society, delivered by Dr. D. Ferrier, F.R.S., last January, his subject being "Recent Work on the Cerebellum and its Relations."

THE current number of the *Journal de Physique* contains a discussion of the metals suitable for the manufacture of standards of length, from the pen of M. C. E. Guillaume. Those of iridio-platinum, originally proposed by M. H. Sainte-Claire Deville, have fulfilled all expectations as regards durability, but the price of the metals brings the cost of a metre rule up to about £400. The conditions to be fulfilled are a comparatively low price, hardness and good polish, constancy of length at a certain temperature, power of resisting moisture and ordinary laboratory chemicals, and, for large rules, a high modulus of elasticity. The condition of constancy excludes all alloys containing zinc. The metals studied by M. Guillaume were nickel, white bronze, aluminium bronze, and phosphor bronze. Ferro-nickel, although much less oxidisable than steel, and harder and twice as rigid as bronze, could not be used owing to its feeble resistance to the action of water. Bars of the above four metals were submitted to repeated heating in steam and cooling. A comparison with standard No. 17 of the Conservatoire gave a shortening of $0{\cdot}3\,\mu$ (thousandths of a mm.) in the case of nickel, the amounts for the bronzes being 2, 5, and $-0{\cdot}3\,\mu$ respectively. The nickel was lengthened to the same amount by magnetisation. Phosphor and aluminium bronze were blackened by the steam, and are therefore not suitable. White bronze (consisting of 35 parts nickel to 65 parts copper) was found suitable for engraving a scale on, though it might be attacked by traces of sulphur or chlorine. Contact with mercury only leads to amalgamation after several hours, thus showing a great superiority to silver. Nickel is, on the whole, the most suitable metal. But it is difficult to obtain bars of the commercial metal free from numerous small punctures. Until this difficulty is surmounted, an alloy of equal parts of nickel and copper may render good service at moderate cost.

"THE DANGERS OF MILK" is the title of a useful little article in the April number of *Modern Medicine and Bacteriological Review*. Whilst the boiling or Pasteurisation of milk is advocated, it is pointed out that too much reliance must not be placed on this treatment as regards the entire removal of germs enabling the milk to be kept for any considerable time before use. Spores of bacilli may still be present, which, after some hours, may develop to such an extent that the bacilli may become so numerous as to render it acid and unfit for consumption. It is suggested that people entrusted with the feeding of infants on cow's milk should be supplied with litmus paper, by which the acidity of the milk should be tested before use. An interesting account will also be found in this number of a paper by Dr. Ledoux-Lebard, on the action of light on the diphtheria bacillus. Amongst the conclusions arrived at by the author, we read that whilst the direct rays of the sun arrest the development of these germs, and sterilise the culture medium in a few days, diffused light has no bactericidal action on diphtheria bacilli in *neutralised bouillon*, but has a markedly deleterious action on them when immersed in *distilled water*. Hitherto it has been found that micro-organisms are less sensitive to light in water than in culture media, but possibly Dr. Lebard's results may be explained by the fact that he used *distilled* water, which is well known to act prejudicially in itself on many bacteria.

ON the occasion of the celebration, last May, of the 150th anniversary of the foundation of the American Philosophical Society, Mr. S. H. Scudder presented a paper entitled "Tertiary Tipulidæ, with special reference to those of Florissant, Colorado." This important memoir has now been issued separately, and it will direct attention to the remarkably well preserved and numerous remains of insects, found at Florissant, in a lake deposit supposed to be of Oligocene age. Several hundred specimens of the family of "Crane-flies" or "Daddy Long-legs" have been collected there, and the nine finely drawn plates which accompany the paper completely represent many species. It is remarked that previous illustrations of fossil Tipulidæ rarely represent more than the wings, so that, merely as illustrations of fossil remains, Mr. Scudder's plates far surpass all that have gone before. The new forms described in the memoir number twenty-nine species of ten genera of Limnobinæ, and twenty-two species of five genera of Tipulidæ. No such extensive addition to tertiary Tipulidæ has been made since Loew first indicated the riches of the amber fauna of Europe. A careful study of the remains leads the author to several conclusions, some of which can be expressed as follows: (1) The general facies of the Tipulid fauna of the western territory is American, and agrees best with the fauna of about the same latitude in America. (2) All the species are extinct, and though the Gosinte Lake and the ancient lacustrine basin of Florissant were but little removed from each other, and the deposits of both are presumably of Oligocene age, not a single instance is known of the occurrence of the same species in the two basins. (3) No species are identical with any of the few European tertiary Tipulidæ. (4) Of the fifteen genera described, eight are not yet recognised among the living, these genera including about one-third of the species. (5) With one exception all the existing genera which are represented in the American tertiaries are genera common to the north temperate zone of Europe and America, and are generally confined to these regions.

THE second part of "The Natural History of Plants," from the German of Prof. Kerner, by Dr. F. W. Oliver, has just been published by Messrs. Blackie and Son.

THE report of the Trustees of the South African Museum for the year 1893 has been distributed. The accessions to the collection during the year included 367 new species, of which two were mammals, eight reptiles, three fishes, six molluscs, and 348 insects.

THE paper on "The Genesis of the Chalk," read by Dr. W. F. Hume before the Geologists' Association in January last, appears in the May number of the Association's *Proceedings*, together with the presidential address on "Geology in the Field and in the Study," delivered by Mr. H. B. Woodward.

The late Prof. Milnes Marshall's little book on "The Frog," known to be a most concise introduction to anatomy, histology, and embryology, has reached a fifth edition. A note by Dr. Hurst informs us that the preparation of this edition for the printer was Prof. Marshall's last professional act, and was completed only a week before his death.

The Marlborough College Natural History Society, founded just thirty years ago, has issued its report for 1893. The report chronicles the work of the sections of astronomy, botany, entomology, geology, microscopy, zoology, and meteorology during the year. It also includes an anthropometrical report containing the statistics of weights and measurements of members of the school. This is a feature that other societies in our schools and colleges would do well to take up, for the anthropological information thus collected is very useful.

It is well known that many amateur photographers send their negatives to professionals to be printed. The Indian amateur, however, has usually to make his own prints, as there are few professional photographers in the far East who undertake the work. To make up for this dearth of available assistance, the *Journal of the Photographic Society of India* reports that the society of which it is the official organ have established a printing department for its members. Though such a departure might be adversely criticised in the case of a British society, it may be pardonable in India.

Volumes viii. and ix. of the *Annalen der k. k. Universitäts-Sternwarte in Wien*, edited by Prof. E. Weiss, have recently been issued. The former volume contains the results of meridian observations made at Vienna Observatory during 1886 and 1887, of comet observations made between 1890 and 1892, and of observations for positions of planets, comets, and comparison stars. In vol. ix. are given the zone observations made by Dr. Palisa during 1884 in connection with the Vienna star catalogue. This volume also includes the results of observations of planets during 1890, and meteorological observations made in 1887 and 1888.

Messrs. J. and A. Churchill have published a new edition of "Materia Medica, Pharmacology, and Therapeutics," by Dr. C. D. F. Phillips. The work originally appeared in 1882, but was out of print for some years. Dr. Phillips has made numerous emendations and additions in order to bring his book in touch with the present state of knowledge of the physiological and therapeutical actions of remedies. More than usual space has also been devoted to pharmacy. The present volume deals with the actions of inorganic substances, and a new edition of its companion volume on the vegetable, animal, and organic compounds will be published to supplement it.

The tidal streams round the Isle of Wight can be found at any hour on any day by means of an arrangement devised by Mr. F. Howard Collins, and published by Mr. J. D. Potter. A plan of the island, with arrows showing the directions of tidal currents, is drawn in each of twelve sections of a cardboard circle pivoted at the centre. This circle is capable of being moved round inside another, upon which the hours from one to twelve are marked. When the inner circle has been set to the time on the outer one at which high water occurs at Portsmouth, the directions of the arrows opposite any hour on the latter show the direction of the tide at that hour. Yachtsmen in the Solent and round the Isle of Wight should find the chart useful.

In the June number of *Natural Science* Dr. A. R. Wallace compares the Palæarctic and Nearctic regions, as regards the families and genera of their mammalia and birds. It has been suggested by several zoologists that these two regions should be united so as to form one new region—the Holarctic—coextensive with the extra-tropical northern hemisphere. Dr. Wallace finds, however, that the two regions, instead of being so much alike that they should be united to form a single region, are really exceptionally distinct, and that their union would not be an improvement upon Dr. Sclater's system of zoological regions. The journal also contains articles on the distinguishing of sex in ammonites, by Messrs. S. S. Buckman and F. A. Bather; problems in experimental psychology, by Prof. E. B. Titchener; the mode of formation of ground ice, by Mr. R. D. Oldham; the significance of the bird's foot, by Mr. F. Finn; and cell-division, by Mr. M. D. Hill.

The new series of *Science Gossip* is really an improvement upon the old one. Each month pages are specially devoted to astronomy, notes and queries, science abroad, zoology, geology, botany, and transactions of scientific societies. The articles in the June number include one by Mr. A. T. Tait, on the beautiful dendritic crystals sometimes found on the pages of books. The author remarks that he has never seen a specimen of these arborescent crystals in a book older than 1835 or younger than 1882, and that rather more than twenty years are usually required for their fullest development. He has examined a large number of volumes of foreign origin, but has never discovered any of the crystals upon their pages. The crystals are supposed to owe their formation to chemical action set up by the accidental deposition of minute fragments of copper upon the surfaces of paper during the processes of manufacture or printing, so it is suggested that differences between British methods of paper-making and printing, and those in vogue in America and on the continent, may account for the absence of the crystals.

In a communication to the Société Chimique, M. Girard explains the interesting fact that when wood charcoal is heated with sulphuric acid, for the purpose of preparing sulphur dioxide, colourless crystals are frequently observed to form. M. Terreil has previously pointed out the occurrence, but without offering any evidence as to its nature. M. Girard now finds that if excess of carbon is used, and the operation is continued until the complete cessation of the evolution of gas, so large a sublimate of the crystals is obtained as to cover the sides and neck of the flask, and to almost obstruct the delivery tube. In order to purify the substance it is only necessary to dissolve it in water, boil until sulphur dioxide is expelled, precipitate any sulphuric acid by the necessary quantity of barium chloride, evaporate to dryness, and recrystallise from alcohol. The well-formed colourless crystals obtained are found to consist of pyromellitic acid, $C_6H_2(COOH)_4$, one of the isomeric tetrabasic acids of the benzene series, and the acid whose anhydride is produced when mellitic acid is heated. Mellitic acid is a substance well known from the fact of its occurrence in combination with alumina in honey-stone. The crystals of pyromellitic acid obtained in the interesting manner above indicated are soluble without decomposition both in boiling sulphuric and boiling nitric acids. Their aqueous solution reacts like an ordinary dilute acid, decomposing carbonates with effervescence. The crystals themselves are efflorescent in the air, and upon heating they volatilise with production of a sublimate of long needles, melting about 280°, and which prove to be pyromellitic anhydride. M. Girard further shows that when sulphuric acid reacts upon wood charcoal which has previously been well calcined at a white heat, or upon coke, no production of pyromellitic acid is observed. On the other hand, substances richer in hydrogen and oxygen than wood arcoal, such as the denser varieties of cellulose, yield it in atively large quantities. It appears, therefore, to be proiced by the action of sulphuric acid upon that portion of the od charcoal which is least carbonised and retains a larger poortion of hydrogen and oxygen. Now it is well known ıt pyromellitic acid may be obtained by the action of sul-uric acid upon mellitic acid. M. Verneuil has recently own, while these experiments of M. Girard were in progress, t when sulphuric acid acts upon wood charcoal a certain iount of mellitic acid is produced. It is therefore practically tain that by the action of sulphuric acid upon wood charcoal, addition to the production of the gaseous dioxides of sulphur l carbon, mellitic acid is produced which in turn is converted a further quantity of sulphuric acid into pyromellitic acid, l the latter is deposited in crystals in the cooler portion of the k in which the reaction occurs.

THE additions to the Zoological Society's Gardens during the t week include two Brown Capuchins (*Cebus fatuellus*, ♂ ♂) m Guiana, presented respectively by Mr. Charles Gordon zer and Miss Florence Marryat; two Four-horned telopes (*Tetraceros quadricornis*, ♂ ♂), from India, pre-ted by Mr. W. F. Sinclair; four common Swans (*Cygnus r*), British, presented by Lord Braybrooke; two Jameson's lls (*Larus novæ-hollandiæ*), from Australia, presented by Ferdinand von Mueller, K.C.M.G.; two Hoary Snakes (*ronella cana*), a Crossed Snake (*Psammophis crucifer*), Infernal Snake (*Boodon infernalis*), from South Africa, sented by Mr. J. E. Matcham; two Natterjack Toads (*ufo calamita*), British, presented by Miss Peckham; ee Stock Doves (*Columba ænas*), British, presented by Mr. nel A. Williams; a yellow-cheeked Amazon (*Chrysotis umnalis*), from Honduras, two Alligator Terrapins (*Chelydra pentina*), from North America, deposited; a White-bellied Eagle (*Haliætus leucogaster*), two Wonga-Wonga Pigeons (*ucosarcia picata*), from Australia, purchased; a Reindeer (*angifer tarandus*, ♀), a Japanese Deer (*Cervus sika*, ♀), n in the Gardens.

OUR ASTRONOMICAL COLUMN.

SUN-SPOTS AND WEATHER.—The first part of vol. vi. of ndian Meteorological Memoirs" (Calcutta, 1894) contains aper by Mr. W. L. Dallas, Assistant Meteorological Reporter the Government of India, on the relation between sun-spots l weather, as shown by meteorological observations made on rd ships in the Bay of Bengal during the years 1856 to 1879. e region selected offered peculiar advantages for such uiry. The annual periodic changes in it are small, and the riodic changes are very slight. There is also comparatively le horizontal air motion, and, being a sea surface, the area is liable to the sudden changes which affect a land observatory, l result from irregularities in the elevation of the land sur-nding an observatory. The discussion of the pressure servations shows that there are certain points of similarity ween barometer readings and the number of spots on the . The number of years during which the number of sun-ts exceeded the normal average coincides with the number years during which the pressure was below the average, *vice versâ*, while the maximum pressure differences, whether ove or below the average, occur one year after the maximum -spot variations in both directions. The same general agree-nt is disclosed by the discussion of temperature observations, here again there is the same want of exact relation. In the e of pressure the curves show that a defect of pressure pre-led during the years in which the relative number of spots s excessive; and an excess of pressure during the time they re at or about their minimum. So in temperature, it appears m Mr. Dallas' investigation, that there exists a general defect en the number of spots is low, and a general excess when number of spots is high. The indications are, therefore, t years of maxima and minima in a solar cycle are also years maximum and minimum solar radiation.

Another paper on sun-spots and weather has also recently been received (*Bulletin de la Société les Amis des Sciences et Arts de Rochechouart*, 1894), the author being Prof. J. P. O'Reilly. By extracts from the annals of Ireland (*Annala Proghacta Eireann*) and those of Ulster (*Annala Uladh*), it is shown that remarkable years of dryness and of cold in Ireland and in Europe are connected with the cycle of solar activity.

EPHEMERIS FOR TEMPEL'S COMET.—The following positions are extracted from the search ephemeris for Tempel's comet, given by M. Schulhof in *Astr. Nach.* No. 3219:—

Ephemeris for Paris Midnight.

1894.	R.A.	Decl.
	h. m. s.	° ′
June 2	1 0 16	S. 0 22·8
4	5 58	S. 0 3·9
6	11 37	N. 0 14·5
8	17 11	0 32·3
10	22 41	0 49·6
12	28 8	1 6·3
14	33 31	1 22·4
16	38 49	1 37·9

The comet is not in a good position for observation, but it may possibly be picked up in the east shortly before sunrise.

JUPITER'S SATELLITES IN 1664.—Under this head we reprinted, on February 1, a letter from the New York *Nation* upon a supposed observation of five satellites of Jupiter, made by John Winthrop in 1664. The note led Mr. Frank H. Clutz to determine whether there was any "fixt starre with which Jupiter might at that tyme be in neare conjunction" (*Johns Hopkins University Circular*, May). He finds that the date of observation in our present reckoning was August 16, 1664, and on that date the star B.A.C. 6448 (R.A. 18h. 46m. 55·6s. Decl. – 23° 21′ 33″·04) was at a distance from Jupiter of about 10′·5, which is approximately the distance that the outer satellite may reach. In brightness the star is about the same as the three smaller satellites—between the sixth and seventh magnitudes. Mr. Clutz thinks, therefore, that this star was the object which Winthrop took for a fifth satellite.

ANNIVERSARY MEETING OF THE ROYAL GEOGRAPHICAL SOCIETY.

THE report of the Council of the Royal Geographical Society was presented at the annual meeting on May 28. The total number of Fellows at May 1 was 3775, a net increase of 29 during the year.

The President and Council for the ensuing year were ballotted for and elected. The principal changes are the retirement of the honorary secretary, Mr. D. W. Freshfield, and the retirement from the Council by rotation of Mr. Francis Galton, Generals Sir W. D. Jervois, J. T. Walker, and Sir Charles Wilson, and Mr. Delmar Morgan. Mr. Clements R. Markham was re-elected as President, the Hon. G. N. Curzon was added to the list of Vice-Presidents, Sir John Kirk was elected Foreign Secretary, and Major Leonard Darwin to co-operate with Mr. H. Seebohm as Secretary. The following new Councillors were elected:—Dr. Robert Brown, Right Hon. Hugh Childers, General Goodenough, Lord Lamington, Admiral A. H. Markham, Admiral E. H. Seymour, and Colonel J. K. Trotter.

The Society's medals were presented in the absence of their recipients, Captain Bower and M. Reclus; the minor awards, already announced in NATURE, were also given, and a series of educational prizes to students from the training colleges.

The President then delivered his annual address, reverting from the recent custom of dealing with the progress of geography during the year to the earlier practice of devoting special attention to some prominent features of exploration.

The greater part of the address was devoted to the polar expeditions of the present year, the facts regarding which have already appeared in NATURE. Mr. Markham is a high authority on Arctic travel, and his views will carry much weight. He professes a strong preference for large expeditions organised by government, and commanded by naval officers, believing that men combining high scientific attainments, great experience of ice-navigation, and the rare qualities of a leader of men, all of which are necessary for a great polar explorer, are seldom to be found except in the service of a government with a wide range of selection. Still he would encourage all enterprise and every carefully planned expedition, on however small a scale. Without expressing any confidence in the correctness of Nansen's theories, he felt no doubt as to the great scientific results which must accompany his journey. With regard to Mr. Jackson's projected exploration in Franz-Josef Land, Mr. Markham did not favour Austria Sound as the best approach to Petermann Land, and he pointed out the drawback of the winter quarters of the expedition being so far south as Eira Harbour, between which and the point where really new ground can be broken, there intervenes a space of nearly 200 miles to be traversed each season; but with wise management and favourable conditions of ice and weather, a good measure of success appeared quite possible. In his scheme for retracing Parry's footsteps north of Spitzbergen, Mr. Wellman transgresses the best established canon of Arctic travel, which is never to enter the drifting pack away from land; but as he has started early, Mr. Wellman may possibly enough beat the record of the farthest north, a motive which was deprecated by the Austrian explorer, Weyprecht, as the bane of good Arctic work. Little service to geography is to be looked for from this expedition, unless there are islands north of Spitzbergen which may be explored. In speaking of Mr. Peary's journeys in the north of Greenland, Mr. Markham said: "For my own part, I look upon Peary as an ideal explorer. He chose one of the greatest and oldest of the geographical problems that remain to be solved, and he set to work as if he really intended to find the solution. Every detail of equipment was thoughtfully considered, gear was tried and tested before being used, a brilliant preliminary journey over the inland ice was made. All was done in the workmanlike style of a true discoverer. I therefore believe that Peary will succeed. I am sure that he deserves success." There is, in Mr. Markham's opinion, ground to hope that Bjorling and Kalstenius may be still alive; "the two Swedish lads are the stuff of which heroes are made, and every civilised people must be interested in their rescue." Want of funds has prevented a search expedition from being sent out, and the two Swedes who have left for Ellesmereland trust to be landed there by the good offices of whalers. No efforts on the part of the Council were spared to inaugurate a great Antarctic expedition, the promotion of which is now under consideration by the Royal Society.

In the evening the anniversary dinner of the Royal Geographical Society was held in the Whitehall rooms of the Hôtel Métropole.

THE MAGNETIC DEFLECTION OF CATHODE RAYS.

THE current number of the *Electrician* contains a translation of a very interesting paper by Herr P. Lenard, on the deflection of the cathode rays by a magnet. It is well known that when the cathode rays traverse a magnetic field they are deflected from their otherwise rectilineal path, and in the form of tube ordinarily employed this deflection increases with an increase in the pressure of the residual gas in the tube. In this particular the cathode rays behave just like a current of negatively charged particles projected from the cathode. The paths of such particles would be curved in a magnetic field, and the curvature would increase with a decrease in the speed with which the particles travel, *i.e.* they would be more curved in a denser and more resisting medium. The above explanation is not in accord with the results of the experiments the author has made, and which have led him to consider the cathode rays as phenomena in the ether. In fact, the author finds that when the observation tube and the tube in which the rays are generated, are separated by a gas-proof aluminium partition, so that the gaseous pressure can be varied in the two tubes independently, that the above explanation entirely fails, and that everything confirms his previous view that these rays are phenomena in the ether, and not electrically charged particles. For instance, if the pressure of the gas in the discharge-tube be kept constant, while that in the observing tube be lowered from 33 m.m. to 0·021 m.m. it is found that the deflection produced remains constant. Higher pressures than 33 m.m. could not be employed, as under these circumstances the medium became so turbid to these rays as to entirely destroy all definition in the phosphorescent spot. If, however, the pressure of the gas in the observing tube be kept constant, while that in the discharge tube is varied, a marked influence on the position of the deflected spot is at once observable. Thus, if the pressure is altered so that the sparking distance in the discharge tube changes from 2 cm. to 4 cm. there is an alteration in the deflection of from 12·2 m.m. to 8·5 m.m. Thus it would appear that the difference in the deflection observed with varying gas pressures in the ordinary form of tube is not caused by difference of the medium in which the deflection is observed, but in the difference of the rays themselves, which are produced with varying pressures of gas. A curious deformation in the shape of the deflected phosphorescent spot was observed, for while the undeflected spot was always circular in form, the distribution of light being dependent on the turbidity (*i.e.* density) of the gas in the tube, in very turbid gases the edge of the spot is undefined. If the gas becomes rarer there appears in the centre of the spot a more or less sharply defined kernel, surrounded by a less bright penumbra. After deflection the spots become elliptical in shape, which may be due to the fact that the rays no longer met the screen at right angles, but when the gas was so rarefied that there was a central bright spot and a penumbra, the appearance of the spot was subject to sudden changes. While the position and shape of the central spot remained constant, the penumbra changed both in shape and position, sometimes even being quite separate from the bright spot. The penumbra was in every case more deflected than the bright spot, thus showing that the penumbra contains rays of greater deflectibility than the core, but never of less. This is borne out by previous experiments, which had shown that it is the rays that are most easily diffused that are most deflected.

SOME LONDON POLYTECHNIC INSTITUTES.[1]

II.

ON account of a mistaken idea as to the true end of education, the object of technical instruction is often defeated. Many young operatives take up courses of study in order that they may become clerks in manufactories where technical knowledge is desirable. This notion causes the ranks of the mechanic class to lose many of their brightest men, while the supply of clerks increases. What has to be impressed upon the minds of students in trade classes is that the object of the instruction is to enable them to perform their duties in a more efficient manner, not to remove them from one sphere of life to another. This point was very well expressed by Sir Benjamin Baker at the beginning of this year, in presenting the prizes and certificates to students at the People's Palace. "It is necessary," he said, "for teachers and students alike to remember that a certain amount of scientific or theoretical knowledge in the future, still more than in the present, must be considered as an indispensable element of success in the great battle of life, but not as a thing having necessarily any more market value in itself than a knowledge of reading and writing, nor must the facilities in acquiring knowledge now enjoyed by students be carried to such an extent as to incapacitate them from acting in an emergency promptly and reliantly without help from books or professors, or the benefits of scientific and technical education would be too dearly bought, and the self-education system of our predecessors would turn out the better men."

The People's Palace owes its existence almost entirely to the Drapers' Company. In the year 1890 this company took the entire management of the educational work, which was carried on under the supervision of Mr. William Phillips Sawyer, the clerk to the Company. Two years later, on the Drapers' Company having offered an annual contribution of £7000 to the Palace, a new scheme was drawn up by the Charity Commissioners, which provided for an annual grant of £3500 from the City and Parochial Charities' Funds, in addition to the Drapers' Company's contribution, and a new body of Governors was formed, of which the Master of the Drapers' Company acts as chairman. This body, besides representatives of the Drapers' Company, consists of members appointed by the London University, the London County Council, the London School Board, the Trustees of the City and Parochial Charities' Funds, and the Lord President of the Council.

The educational work consists of (1) the day technical

[1] Continued from p. [illegible]

chool, under the management of Mr. D. A. Low, head master, vhich is largely recruited from the public elementary schools, .nd to which the Drapers' Company have contributed yearly £1000 to be expended in scholarships. (2) The evening classes, ınder the management of Mr. J. L. S. Hatton, Director of Evening Classes.

The evening classes are conducted with a view to giving tudents a practical and theoretical knowledge of the arts and ciences, and to prepare them for the examinations of the)epartment of Science and Art, the City and Guilds of London nstitute, and of the Society of Arts. It will be concluded, herefore, that instruction is given in a large number of subjects; n fact, the time-table includes more than fifty classes in pure and .pplied sciences, and further, the Governors offer to consider he formation of classes in any similar subjects provided a ufficient number of students offer themselves for admission. Thus the subjects taught at the institution are those for which here is a demand. It would hardly be expected that purely cientific subjects would be in favour in the East End of London. The object of the majority of the students in such a district must e a desire to command better wages as workmen rather than he simple pursuit of knowledge. Some, however, are actuated y a higher spirit. Among the classes conducted by Mr. Hatton is one on the differential and integral calculus, another n analytical conic sections, and a third on the theory of deterninants. And many, if not most, of the students of these ubjects are not pupil teachers merely aiming at the obtaining f a certificate and nothing more, but young men who after assing their days in grimy workshops find recreation in mathematical exercises of no mean order. It is such ardent spirits as hese that bring credit upon the institutions assisting in their evelopment, not the mercenary "pot-hunter."

Strange as it may appear, there are numbers of young men in London who are unable to pay the small entrance fees to classes t these institutes. While at the People's Palace a short time go, the writer had pointed out to him a young mechanic who, hough he had been a student, found himself in circumstances o low that he could not pay the entrance fees for the classes in vhich he desired to continue his studies. He pleaded with the Director of studies for free admission, and, it need hardly be aid, his request was granted. That young man is now in his eventh heaven of delight, for he attends classes six nights a veek, and revels in the privilege that has been extended to him. To all who are desirous of democratising knowledge, this case —and it is not an isolated one—must appeal very strongly. The nan who wishes to work but finds his labour unwanted is an object of everyone's sympathy. But his claims for assistance are no tronger than those of the man who craves for knowledge and as not the means of attaining his desire. The London Polytechnics are doing an excellent work by reducing the tolls that or many years barred the ways of wisdom. But though the ees to classes represent only a small part of the income of these nstitutions, it is doubtful whether any very great educational dvantages would accrue from their abolition. "That which is asily gained is lightly prized," is an old saying and a true one, nd if all students were admitted free to Polytechnic classes, they vould possibly not appreciate the instruction so highly as they o at present. Perhaps the best way to meet the case of poor tudents would be for private benefactors to bestow a small sum pon Polytechnics for the purpose of paying their fees. It is ot suggested that these free studentships should be competed or, but that they should be obtainable by any who desired to oin classes, and were prevented by the inability to pay the fees; rovided only that the Director of studies satisfied himself as to he poor circumstances of the applicant.

The engineering department at the People's Palace is nder the control of Mr. Robert Holt. Students are ermitted to enter any of the classes in engineering subjects, but are always strongly advised to take up theoretical courses at the same time. For the first year the ubjects thus recommended are mathematics, geometry, and nachine construction; for the second year, more advanced nathematics, geometry, and machine construction, with heoretical and applied mechanics and steam; while thirdear students take still higher developments of mathenatics, machine construction, steam, and applied mechanics, nd also mechanical engineering. It will be seen, herefore, that by following this line of study a theoretical raining is obtained which must be of the greatest advantage in the engineering workshop. Only when a knowledge of theoretical principles is regarded as an essential qualification for entrance into the workshop, can the teaching be sound, and when this is more generally recognised among engineering students we may expect to see some results of technical education.

For some time Prof. Holt had in his mind a scheme for the erection of a machine shop, a pattern-making shop, a smithy, and an experimental workshop, but the necessary funds were not available. It has just been announced, however, that the Drapers' Company, supplementing their former benefactions, have voted the sum of £4000 for the erection of a new engineering laboratory with workshops.

The creation and extension of workshops such as exist at the People's Palace for various trades will do much to bring the workmen to a higher degree of efficiency. But in order to discover if the teaching is suitable for the students, and whether they make satisfactory progress, it is necessary from time to time to hold examinations which completely cover the work done. At present, however, there is only one general examination in technical subjects, namely, that of the City and Guilds of London Institute, which covers only a small range of the subjects usually taught, classes of such importance as those in practical engineering and practical carpentry finding no place in this examination. To remedy this defect, the educational committee of the People's Palace have taken steps to form a joint examination board of the London Technical Institutes. It is proposed that the examination consist of three parts:—(1) An inspection of practical work certified to be the unaided work of

FIG. 3.—Engineering Workshop of the People's Palace.

the student; (2) a *viva voce* examination; (3) a written examination. The intention of the committee is to make the examination more a mechanical qualifying one than one of general technical theoretical character, as will be gathered from the subjoined extract:—

"It is proposed to lay more stress on the *viva voce* part of the examination than is usually done, for the following reasons. It has been found that one of the great difficulties in conducting an examination on the above basis is to place the workman—unaccustomed to express himself in writing—on an equality with the clerk, who has not the same practical knowledge and experience. On paper, the workman frequently finds himself defeated by the clerk, and consequently looks with suspicion on such examinations as the City and Guilds, the results of which he, with justice, considers to be no just criterion of the merits of the candidates. In our Universities, in olden days, *viva voce* and written examinations were held concurrently, so as to afford those who had no facility for expressing themselves in writing an opportunity of showing the extent of their knowledge. With the advance of learning and the ever-increasing opportunity for expressing oneself in writing, the need of the *viva voce* examination at the University has died away, and it is at present little more than a useless formality. In the case of the workman, however, who has the greatest difficulty in expressing himself on paper, it is eminently desirable to revive the old system."

Examinations conducted in this manner have already been carried out at the People's Palace with some success, and it certainly seems desirable to extend them. After all, the majority of the students in Polytechnics desire certificates which guarantee that the holder, when applying for work, is a thoroughly competent workman. By enlisting employers of labour, and representatives of various trades, as examiners, the work done is truly tested from a practical point of view, and the certificates awarded by them is of use in obtaining employment. In all probability there will be a difficulty in arranging a joint examination board on the lines suggested by the People's Palace committee, but however this may be, it seems desirable that some provision should be made for determining the amount of directly useful knowledge obtained in the Polytechnic workshops.

Before passing to another Polytechnic, a few words must be said with regard to the extent of the work carried on at the People's Palace. The number of class tickets issued for the current session is 7408. Such subjects as light, sound, physiology, botany, and physiography attract comparatively few students, the reason evidently being that they do not directly bear upon industries. Though we cannot but regret this lack of interest in subjects most of which are necessary for a proper scientific education, it is not strange that in the East End, where the battle of life is so keen, people should only be interested in matters which they think may assist them to earn a living. Engineering subjects are greatly favoured, as many as 300 students attending the class in machine construction and drawing. The average attendance each evening at classes in all subjects is about nine hundred.

Dr. Macnair, who until recently was the head of the chemistry department, made that branch of science very popular among students, and Dr. Hewitt, who has succeeded him, will doubtless sustain the character of the work. The research laboratory, which it is proposed to arrange, will help to this end.

We come now to the Battersea Polytechnic Institute, formally opened last February. The Institute has been built and equipped at a cost of nearly £53,000, the greater part of which was raised by voluntary subscriptions. It is at present in possession of a fixed endowment of £1500 per year, but this will be raised to £2500 when the sum of £60,000 has been collected. As only £2200 is now wanted to complete this figure, the Institute will probably soon be in possession of the further endowment. The London County Council will also eventually contribute to the Institute an annual sum estimated to amount to about £1500. The Institute contains workshops for various trades, physical and chemical laboratories, and numerous rooms for classes and lectures. Instruction is provided in technological subjects, in general science; art, including wood-carving and metal chasing; music; and in commercial and general education. The principal is Mr. Sidney H. Wells, and Dr. W. E. Sumpner is the head of the electrical engineering department. Mr. S. H. Davies has charge of the chemistry department, and Mr. W. E. Walker carries on the engineering work in conjunction with Mr. Wells.

For the first time in the history of London Polytechnics, the Governors appointed a Principal, and by selecting for the post a man in whom theoretical and practical knowledge are happily combined, they did their best to secure a well-balanced scheme of instruction. Without expressing an opinion upon the advisability of putting each Polytechnic under the control of a Principal, we would point out that an educational head who teaches is bound to be prejudiced in the direction of his special branch of study to the detriment of other branches. By placing at the head of affairs a man who is not a specialist, and properly arranging each department of the educational work under a competent head, each branch is sure of its right share of attention. At the Goldsmiths' Institute there are ten departments, each under a head who, with Mr. Redmayne, arranges the details of work. The system has been proved to work well, and there is no friction between the departmental heads and the head of the Institute, owing doubtless to the fact that they feel that he is not unduly prejudiced in favour of any one department. The system of putting the whole Institute under a Principal is being tried at Battersea. Time will show whether this manner of control, or that adopted at New Cross, best furthers the interests of all branches of an Institute's work.

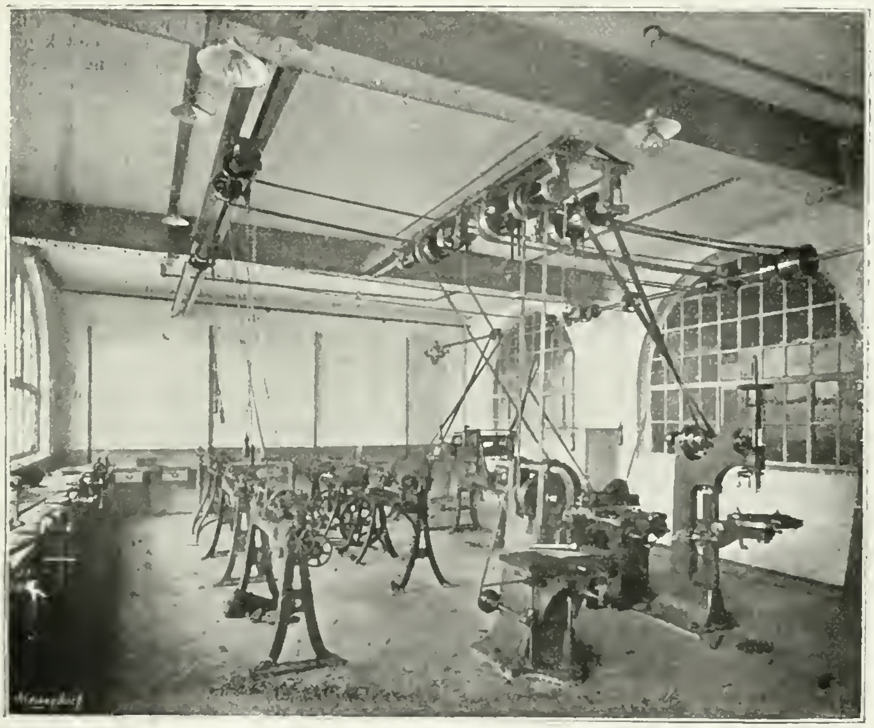
A few remarks with regard to the lines adopted at Battersea should be of interest. The Battersea Institute is open to persons

FIG. 4.—The Battersea Polytechnic Institute.

of either sex, without limit of age, who are students of any class in it. Persons who wish to join a trade class are required to satisfy certain conditions before permission is granted them. There is a reason for this stipulation. By attending a course in a trade subject, it is possible for men to become dexterous enough to do jobbing work without serving an apprenticeship in that trade. This is not only detrimental to the interests of the skilled workman, but it also encourages inefficient labour, for though the way to do a thing may be picked up in a workshop course, the way to do it well can only come by practice. In order to prevent this rapid manufacture of workmen, many Polytechnics in the provinces make each trade class a close preserve for the instruction of apprentices and workmen belonging to that trade. Thus, a carpenter would not be permitted to join a class in bookbinding. Something can be said both for and against this preservation. There is the possibility that the smattering of knowledge obtained in a Polytechnic workshop may be thought by some sufficient to qualify as a workman, but this is very doubtful. On the other hand, if a person wishes to learn it seems a pity to place any barrier in his way. Many young men are apprenticed to trades for which they have no taste whatever, and an institute which enables them to follow their inclination is doing a good work.

Membership of the Institute is open to any student between sixteen and twenty-five years of age, upon the payment of a nominal fee. Among the privileges to which members are entitled are: admission to ordinary evening classes, lectures, and entertainments at reduced fees, use of reading-room, and facilities for joining clubs and societies. This system of membership is calculated to develop an *esprit de corps* among the students, which will do much to make the Institute a success. Only by such means can a Polytechnic earn the title of a People's University. The establishment of these institutes has certainly put an end to many small science classes, and objections have been raised to this concentration of work. Teachers who for years have shown the "young idea" how to pass South Kensington examinations, have found their occupation gone when such an educational and social centre as now exists at Battersea has been started. But while everyone condoles with the teachers upon their misfortune, we must point out that the mode in which most sporadic classes under the Department of Science and Art are carried on is capable of improvement. Usually a teacher rushes to his class-room, gives an hour's instruction, and then leaves the students until the following week. A Polytechnic Institute, however, is looked upon by the students in it as their *alma mater*. The teachers are generally in the building ready and willing to help the inquiring mind, instead of being merely periodic visitors.

The classes at the Battersea Institute are chiefly intended for persons engaged in earning their own livelihood. Special courses at reduced fees are arranged applicable to various trades and industries, and students are strongly urged to take these courses in preference to single classes; indeed, everything is done to give the students a thorough and scientific education. In order to encourage students to take up mathematics, the fees in that subject are lower than for any other science or trade class. Some inducement of this kind is necessary, for very few workmen recognise that mathematics is a subject of immense importance, and forms the groundwork of all applied sciences. An excellent departure from stock subjects is the formation of a class in technical mensuration, in which the needs of students attending the trade classes are met, and engineers, builders, plumbers, bricklayers, masons, carpenters, joiners, and other operatives are taught the application of mensuration to the practical problems which occur in their work. Another class worthy of special mention is one in graphic statics, designed to teach the application of graphics to architectural, building, and engineering construction. A course of experimental work is carried on in a fine mechanical laboratory, only those who possess a knowledge of elementary mathematics, mechanics, and drawing being admitted to it. The electrical department, under Dr. Sumpner, is provided with a well-equipped laboratory, and the electric lighting plant of the Institute is available for experimental purposes. The chemical laboratory is also well-equipped and arranged. Altogether, we are of opinion that the Battersea Institute has started well. Its sphere of usefulness is limited for want of a larger endowment than it at present possesses, but doubtless further funds will be received when the important work it is doing for the quarter of a million inhabitants of south-west London is more widely known.



From a Photograph by Russell & Sons, 17, Baker Street, W.

FIG. 5.—Engineering Workshop of the Battersea Polytechnic Institute.

This survey would not be complete without a few words on the admirable day schools in connection with these institutes. Until recent years there were no facilites for the education of boys who had passed through public elementary schools, and desired further training in preparation for the workshop and manufactory. Continuation schools, such as those at Battersea Polytechnic, the People's Palace, and the Goldsmiths' Institute, supply the needful knowledge of science and technology, and, at the same time, carry on the subjects of general education. They represent a most important rung in the educational ladder, and every encouragement should be given to them.

At Battersea the same teachers conduct the day and the evening classes. The Institute thus possesses a permanent staff, all the members of which give the whole of their time to the work. There can be no doubt that this system of organisation is far preferable to that in which visiting masters are employed.

It may be well to briefly state the conclusions to be drawn from an examination of the work of London Polytechnics. In the first place, the funds at the disposal of the Institutes are usually not sufficient to permit the educational needs to be properly supplied. In order to supplement the sum arising from endowment, grant-earning classes have to be held, which means that subjects come to be considered for what they will bring to the Institute's exchequer rather than for what they are worth. The Technical Education Board of the London County Council have taken steps to remedy this evil by contributing maintenance grants, and capital grants for equipment, apparatus, &c., the former being allotted according to a scale calculated to promote educational efficiency, and regularity of attendance. The Department of Science and Art, and other Examining Bodies, should consider the advisability of treating Polytechnic Institutes in a similar manner, instead of regarding them as mere collections of classes. The less an institute of this kind depends upon payment by results, the more likely is it to develop in the proper direction.

Very little provision is made in the institutes for really advanced work or research, but this will probably come, for in London, technical education is only in its experimental stage. Many years of work will have to be done before any London institute will be able to find students for instruction of such an advanced character as that given in continental Polytechnics. Mr Ll. Smith recommended, in his report to the London County Council, that a grant should be made "towards the maintenance of an advanced department of applied science, bearing on some local industry, under the control of a well-qualified instructor who gives all his time to the work of the institute." The Technical Education Board have promised a contribution for this purpose when a Polytechnic desiring it shall have drawn up a detailed scheme of work, and the Board is satisfied that the proposed class will be of value to the industries of the district.

As to the recreative side of the institutes, little need be said. The desire for physical exercise is so much stronger than that for mental development, that there is a possibility of recreation swamping education in one or two cases. Generally, however, the two sides are very well balanced, and admirably assist one another in the development of men of thought as well as men of muscle.

For the rest, Polytechnic Institutes have aroused the interest of the working class, and men now realise the necessity of a scientific grounding for every trade. To have done this in so short a time promises well. In a few years, perhaps, London Polytechnics will be able to compare favourably with those in other European capitals, and when that day arrives a generation of workmen will have sprung up which, for aptitude and efficiency, should be able to hold its own against the world.

R. A. GREGORY.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. V. H. Veley and Mr. G. C. Bourne have been appointed Examiners for the Burdett-Coutts Scholarship.

The sixth annual report of the Curators of the Botanic Garden shows a deficit of nearly £200 on the close of the financial year. This is due principally to the decrease of income derived from rents and profits of estates. The Curators report that the existing endowment is inadequate to maintain the Garden, and that it will be necessary to call on the University at no distant date, to consider whether a moderate annual subvention should not be made to place the Garden on a satisfactory basis. The deficit would have been greater but that the Professor of Botany has made, *proprio motu*, a contribution of £50 towards the funds of the Garden. The new range of glass-houses, including the palm house and the succulent house, has been completed and proves satisfactory.

Elections to Scholarships in Natural Science will be held at the following Colleges:—Balliol College, examination to begin on November 20, a scholarship in Natural Science worth £80 a year, on the foundation of Miss Hannah Brakenbury. Balliol, Christ Church and Trinity College. At Balliol two Scholarships of the value of £80 a year and one Exhibition of the value of £40 a year. Christ Church, one Scholarship of the value of £80 a year and one Exhibition of the value of £85 a year. Trinity College, one Scholarship of the value of £80 a year. The examinations for these Scholarships will begin on Tuesday, November 20.

CAMBRIDGE.—Dr. Bradbury, the Downing Professor of Medicine, has appointed as his assistant in Pharmacology Mr. C. R. Marshall, Research Fellow of Owens College, Manchester.

The Rede Lecture will be given in the Anatomy School by Mr. J. W. Clark, Registrary, on June 13 at noon. The subject is "Libraries during the Middle Ages and the Renaissance."

A considerable number of courses in scientific subjects, including Chemistry, Mineralogy, Geology, Anatomy, and Pathology are announced for the ensuing Long Vacation, which is more and more assuming the character of a regular term.

No less than twenty-three women are announced as having "deserved Mathematical Honours" in Part I. of the Mathematical Tripos.

By the election of Dr. Hickson to the Professorship of Zoology at Owens College, Manchester, a vacancy is created for a University Lecturer in Invertebrate Morphology.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 5.—On the measurement of surface tension of water and mercury in capillary tubes, by G. Quincke. In accurate measurements of the surface tension of water by elevation in capillary tubes the marginal angle must be taken into account. It is different from zero, and generally increases with the age of the tubes. For the same kind of glass the surface tension of water at 18° is generally found to increase with the diameter of the capillary tube. For wide tubes of normal Jena glass or English flint glass the surface tension at 18° was 7·846 and 7·776 mgr.—On the magnetic deflection of cathode rays, by Philipp Lenard. The magnetic deflection is not affected by the medium in which the rays are observed, but remains the same for a given species of cathode rays, whatever may be the gas, the intensity, and the pressure. But at different pressures within the generating apparatus different cathode rays are produced, showing varying amounts of deflection.—On a sodium-nitrogen compound, by L. Zehnder. Sodium mirrors deposited electrolytically in vacuum tubes gave rise to strong absorption and rapid fall of pressure, accompanied by the formation of a brown mirror during the glow discharge. A detailed investigation showed that this action takes place as soon as metallic sodium has been transferred to the cathode. The compound formed, probably NNa_3, is not deposited on the cathode, but on the glass walls near the anode.—On the elliptic polarisation of reflected light, by K. E. F. Schmidt. In the case of glasses of equal refractive indices and different dispersive powers the glass with the higher dispersion shows the wider range of angle at which ellipticity is observed.—On the spectra of tin, lead, arsenic, antimony and bismuth, by H. Kayser and C. Runge. The authors have continued their efforts to find uniformities in the structure of the metallic line spectra through the periodic series of the elements. The above metals were taken as convenient representatives of the fourth and fifth rows. The spectrum of tin may be reconstructed by superimposing three equal spectra differing by a constant oscillation frequency. The same law applies to the spectra of lead and arsenic. In the case of antimony, six such spectra are superposed, and in bismuth four.—Line spectra, by J. R. Rydberg. This is a comparison of the spectra of calcium and strontium.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 10.—"Preliminary Report on the Results obtained with the Prismatic Camera during the Total Eclipse of the Sun, April 16, 1893." By J. Norman Lockyer, C.B., F.R.S.

During the total eclipse of 1871 observations were made by Respighi and the author with a spectroscope deprived of its collimator, and a series of rings was seen corresponding to the different rays emitted by the corona and prominences. A similar instrument, arranged for photography, was employed during several succeeding eclipses, but the photographs were on so small a scale that none of the results came up to the expectations raised by the observations of 1871. As the Solar Physics Committee is now in possession of a prismatic camera of 6 inches aperture, the prism having a refracting angle of 45°, it was determined to employ it during the eclipse of 1893. The instrument was placed at the disposal of the Eclipse

Committee by the Solar Physics Committee, and was entrusted to Mr. Fowler, who took the photographs at the African station.

It also seemed desirable that a series of similar photographs should be taken at another point on the line of totality, even though an equally efficient instrument were not available. A spectroscope with two 3-inch prisms of 60°, used in conjunction with a siderostat, accordingly formed part of the equipment of the expedition to Brazil, and was placed in charge of Mr. Shackleton.

The present preliminary report is intended to indicate the kind of results obtained, and some of the photographs are reproduced for the information of those specially interested, as it will be some time before the complete reductions are ready for publication.

The most conspicuous lines, or rather portions of circles, seen in the photographs taken during totality, are the H and K lines of calcium, and in these rays the images of the various prominences are very clearly outlined.

The lines of hydrogen, extending far into the ultra violet, are also very prominent, and numerous other lines are seen in addition.

Isochromatic plates were used for some of the exposures, and on some of these the ring formed by the characteristic line of the coronal spectrum (1474 K) is clearly depicted, especially in the Brazilian photographs. A comparison with the photographic records of the corona shows that the prismatic camera has picked out the brightest parts of the corona in this way. All the photographs show a bright continuous spectrum from the inner corona.

"On the Leicester Earthquake of August 4, 1893." By C. Davison, M.A., King Edward's High School, Birmingham.

On August 4, 1893, at 6.41 P.M., an earthquake of intensity nearly equal to 6 (according to the Rossi-Forel scale) was felt over the whole of Leicestershire and Rutland and in parts of all the adjoining counties. The disturbed area was 58 miles long, 46 miles broad, and contained an area of about 2066 square miles. The direction of the longer axis (about W. 40° N. and E. 40° S.) and the relative position of the isoseismal lines show that the originating fault, if the earthquake were due to fault-slipping, must run in about the direction indicated, passing between Woodhouse Eaves and Markfield, and hading towards the north-east. The anticlinal fault of Charnwood Forest, so far as known, satisfies these conditions, and it is highly probable that the earthquake was caused by a slip of this fault; greatest in the neighbourhood of Woodhouse Eaves, and gradually diminishing in amount in either direction, rather rapidly towards the north-west and much more slowly towards the south-east. The total length of the fault-slip may have been as much as twelve miles or even more, and there can be little doubt that it was continued for some distance under the Triassic rocks on which Leicester is built.

Royal Society, May 10.—"The Stresses and Strains in Isotropic Elastic Solid Ellipsoids in Equilibrium under Bodily Forces derivable from a Potential of the Second Degree." By C. Chree, Superintendent of Kew Observatory.

The problem solved in the present memoir, viz. that of an isotropic elastic solid ellipsoid under the action of bodily forces derived from a potential

$$\tfrac{1}{2}(Px^2 + Qy^2 + Rz^2),$$

is the most general case of equilibrium under forces derived from a potential of the second degree. The above potential covers forces arising from mutual gravitation or from rotation about a principal axis in an ellipsoid of any shape.

The solution obtained satisfies without limitation or assumption of any kind all the elastic solid equations. It enables the variation in the effects of gravitation and rotation with the change of shape of the ellipsoid to be completely traced.

The results obtained for the very oblate and very oblong forms seem to show that in many cases of bodily forces the assumptions usually made in the treatment of thin plates and long rods would not be justified.

By comparison with the author's previous researches, a close similarity is shown to exist between the phenomena in rotating flat ellipsoids and thin elliptic discs on the one hand, and rotating elongated ellipsoids and long elliptic cylinders on the other.

Royal Society, May 24.—"On certain Functions connected with Tesseral Harmonics, with Applications." By A. H. Leahy, late Fellow of Pembroke College, Cambridge, Professor of Mathematics at Firth College, Sheffield.

Royal Society.—*Correction*.—In the abstract of the paper "On the Specific Heats of Gases" (Part III.), by J. Joly, F.R.S., read (in place of the formula given):—

$$Cv = a + 2b(100 - t) + 3e(100 - t)^2.$$

Royal Microscopical Society, May 16.—Mr. A. D. Michael, President, in the chair.—Mr. C. Lees Curties exhibited and described a microscope which had been specially made for photographic purposes. The leading feature of the instrument is that the nose-piece is removable, so that an ordinary photographic lens can be substituted for the objective if required. He also exhibited a new form of apparatus for obtaining instantaneous photographs of objects under the microscope; as examples of what could be done with this apparatus, he showed photo-micrographs of blood-corpuscles taken with powers × 306 and 600 diameters, and also some low-power photos of living specimens of *Lophopus* with tentacles extended. Dr. W. H. Dallinger thought the photomicrographs were extremely good. He noted in the immediate vicinity of the *Lophopus*, there were some vorticellæ, and this suggested that it might be possible to take them in the act of closing, so as to get an idea how the movement was performed.—Mr. Shrubsole said he had brought to the meeting a few living specimens of *Gromia*, which were shown under the microscopes on the table. One peculiarity of these specimens was that instead of possessing but one aperture, there was a zone of small apertures round a central one. This he thought was a good reason why this object should be removed from the Monostomia. After describing a naked rhizopod closely allied to *Lieberkuhnia*, and an organism resembling *Shepheardella*, Mr. Shrubsole said he had on the previous day obtained from the water off Sheerness some masses of a dirty-looking substance containing all sorts of forms of gelatinous objects, in which were imbedded a number of granules; they were the cause of what the fishermen called "foul water," or "May water." They were only seen for certain seasons and for a short time, and it would be an interesting inquiry to find out what became of them.—Prof. Jeffrey Bell said that he had just been present at the annual inspection of the Marine Biological Laboratory at Plymouth, and he found that one of the greatest troubles there had been the condition of the water. Only two fish had died during the last twelve months, but the Director was desirous of obtaining information as to the diatomaceous and desmidaceous condition of the water in the tanks. Inquiries naturally suggesting themselves would be what the organisms really were which caused this "foul water"; was the "foul water" due to their presence, and were they a great number of larva undergoing transformation?—Prof. Bell called attention to the three frames of photo-micrographs which formed the Society's exhibit at the Chicago Exhibition, and which had just been returned. The Fellows would have now the opportunity of seeing them and determining whether they were worthy of the medal which they were told had been awarded the Society.

Quekett Microscopical Club, May 18.—Mr. A. D. Michael, Vice-President, in the chair.—Mr. C. L. Curties exhibited a new instantaneous photo-micrographic apparatus, and explained the method of using it. Some excellent pictures of pond-life, and fresh human blood corpuscles, &c., taken by this apparatus, were handed round for inspection, and one group of *Lophopus*, fully extended, surrounded by vorticellæ, was particularly admirable and life-like. The Chairman thought this apparatus would be especially valuable for obtaining representations of quickly-moving organisms, which were almost impossible to draw in a natural way because of their rapid volutions, and they might get composite pictures which would throw some light on this difficult subject of locomotion in minute animals, such as had been done by Muybridge and others with the horse, for instance. Mr. G. Western read some interesting notes of foreign rotifers which had since been found in Britain, amongst them being *Notholca heptodon*, *Bipalpus vesiculosus*, *Chromogaster testudo*, *Æcistes mucicola*, and *Æ. Socialis*, *Brachionus dorcas*, and others, which were accompanied by beautifully executed drawings by Mr. Dixon-Nuttall. Mr. Western pointed out the uncertainty and variability of many of the characters relied upon for specific, and in some cases for generic, value, such as the presence or absence of setæ, antennal appendages, or even of the eyes. Mr. Michael said with regard to the eye he had frequently found the same peculiarity among the Hydrachnea or water-mites; in the same gathering would perhaps be met with specimens otherwise identical, some with and some without eyes, or the eye present on one side only. The pigment greatly varied in amount, or was entirely wanting, but without sections it was difficult to say whether that was the case with the true nervous part of the visual organ, which, from its transparency, was easily overlooked in merely surface views.

PARIS.

Academy of Sciences, May 21.—M. Lœwy in the chair.—Researches on trimethylene and propylene, and on a new class of hydrocarbons: dynamical isomerism, by M. Berthelot. Trimethylene and propylene have, respectively, − 17·1 Cal. and − 9·4 Cal. for heats of formation from their elements. The corresponding dibromides, sulphates, and alcohols have nearly the same heats of formation; just as trimethylene and propylene differ by − 7·7 Cal. in heat of formation, so the formation of bromides, sulphates, and alcohols from these substances liberates more heat in the case of trimethylene, the excess being + 9·4, + 8·8, and + 10·2 Cal. in the respective cases. The dibromides liberate heat on the further addition of bromine as follows:—

	$+Br.$	$+Br_2.$	$+2Br_2.$	$+3Br_2.$
Propylene dibromide	+0·522,	+0·872,	+1·397,	+1·661 cal.
Trimethylene dibromide	+0·592,	+1·010,	+1·567,	+2·052 ,,

The heat of formation of terebenthene is +4·2 Cal., of citrene is + 21·7 cal., and of liquid camphene is about 24 Cal. The corresponding hydrochlorides have nearly the same heats of formation. From these data it is argued that trimethylene and terebenthene belong to a new class of hydrocarbons, and are dynamical isomerides of propylene and camphene respectively.—A note by M. Lœwy accompanying the presentation of a volume of the "Annales de l'Observatoire de Bordeaux."—On the formation of urea in the liver after death, by M. Charles Richet. The formation of urea is analogous to the production of sugar. Urea continues to be formed in the liver after removal from the body and cleansing from blood, &c., by washing, probably by hydrolysis due to the action of a soluble diastase.—The insects of the carboniferous period, by M. Charles Brongniart.—On the superficial tension of saline solutions, by M. H. Sentis. If F be the superficial tension of the saline solution, f that of water at the same temperature, u the volume of 100 molecules of water, and v that of a mixture of n molecules of the salt with 100 − n molecules of water, we have

$$\Phi = F - \frac{100-n}{100} \cdot \frac{f}{\sqrt[3]{\frac{v}{u}}},$$

where Φ is the action per unit of length between the molecules of the salt and the molecules of water. With regard to Φ—(1) This action is independent of the temperature between 0° and 25°; (2) it is proportional to n up to the most concentrated solutions; (3) it is independent of the nature of the salt and approximately equal to 0·78 dyne per centimetre for each radical equivalent (*e.g.* $\frac{\Phi}{n}$ for NaBr, KCy, $MgSO_4$, $CaCl_2$, and K_2CrO_4 is respectively 1·6; 1·5; 1·6; 2·3; and 2·4).—Properties of magnetic substances at various temperatures, by M. P. Curie. Oxygen, manganese chloride, ferrous sulphate, and palladium follow the law expressed by $k = \frac{A}{T}$ where k is the specific coefficient of magnetisation, A is a constant, and T is the absolute temperature. The temperature of magnetic transformation of nickel is near 340°. Its coefficient between 373° and 806° is independent of the intensity of the field, and decreases regularly and very rapidly as the temperature rises. The temperature of magnetic transformation of magnetite is about 535°. From 550° to 850° it behaves like nickel, from 850° to 1370° it obeys the same law as oxygen. Iron exhibits very complex phenomena. Between 860° and 1280° there appears to be another modification of iron formed; before 860° and beyond 1280°, iron behaves like nickel.—On a system of new scales, by M. Alexandre de Bertha.—Apparent death produced by alternating currents. Restoration to life by means of artificial respiration, by M. A. d'Arsonval. In the cases where death has apparently been caused by direct action of the current on the nerve centres, without lesion or destruction of the tissues, it is found possible to revive the patient by the treatment adopted with apparently drowned persons.—On a method permitting the measurement of the mental intensity of vision and the longitudinal aberration of the eye, by M. Charles Henry.—Absorption spectra of hydrobromic solutions of cupric bromide, by M. Paul Sabatier. The absorption between $\lambda = 660\,\mu\mu$ and $\lambda = 440\,\mu\mu$ is far more intense than in the cases of the alcoholic solution of the anhydrous salt or the aqueous solutions of the green and blue hydrates.—On the molecular transformations of some chromic compounds, by M. A. Recoura.—On some combinations of ammonia with various silver salts, by MM. Joannis and Croizier. The compounds $AgBr.3NH_3$, $AgBr.1\frac{1}{2}NH_3$, $AgBr.NH_3$, $AgI.NH_3$, $AgI.\frac{1}{2}NH_3$, $AgCy.NH_3$, $AgNO_3.3NH_3$, $AgNO_3.2NH_3$, $AgNO_3.NH_3$ have been studied, and their temperatures of dissociation, as also their characteristic formulæ for the pressures of dissociation at any temperature, are given.—On the detection of hydrochloric acid, by MM. A. Villiers and M. Fayolle.—On geraniol from the essence of *Andropogon Schœnanthus*.—Does digestion of proteid matters without digestive ferments exist? by M. A. Béchamp.—Essay on a theory of the temporal (bone), by M. S. Jourdain.—On the increase of temperature of earth-layers with the depth in the low Algerian Sahara, by M. Georges Rolland. In many parts of the low Algerian Sahara, between 30° and 35° Lat., the temperature increases with the depth at least 1° for 20 metres, and often much more rapidly.—Agronomic map of the canton of Ferté-sous-Jouarre, by M. Gatellier.

BOOKS and PAMPHLETS RECEIVED.

BOOKS.—Studies in Forestry: Dr. J. Nisbet (Oxford, Clarendon Press).—Systematic Survey of the Organic Colouring Matters: Drs. G. Schultz and P. Julius, translated and edited by A. G. Green (Macmillan).—Discourses, Biological and Geological: T. H. Huxley (Macmillan). Geology: C. Bird (Longmans).—Primitive Civilizations, 2 Vols.: E. J. Simcox (Sonnenschein).—Lehrbuch der Zoologie: Dr. J. E. V. Boas (Jena, Fischer).—Blackie's Chemistry Demonstration Sheets; eight Sheets (Blackie).—Micro-Organisms in Water: Prof. P. Frankland and Mrs. P. Frankland (Longmans).—Climbing and Exploration in the Karakoram Himalayas: W. M. Conway (Unwin).—Étude Industrielle des Gites Metallifères: G. Moureau (Paris, Baudry).

PAMPHLETS.—The Marine Biological Laboratory 6th Annual Report, 1893 (Boston).—A Description of Two Large Spinel Rubies: Dr. V. Ball (Dublin).

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THURSDAY, JUNE 7, 1894.

HAGEN'S SYNOPSIS OF HIGHER MATHEMATICS.

Synopsis der Höheren Mathematik. Von Johann G. Hagen, S.J., Director der Sternwarte des Georgetown College, Washington, D.C. Erster Band: Arithmetische und algebraische Analyse. (Berlin: Felix L. Dames, 1891.)

THE author's object has been to give a bird's-eye view, or synopsis, of the whole range of higher mathematics; and this handsome volume of 398 pages is a first instalment. The work is not intended as a treatise, or to be merely a book of reference to which the mathematician may turn for his formulæ. It has a much more ambitious scope, and aims at presenting a general view of all branches of mathematics, methodically arranged and separated into a great number of sections, each of which contains a notice of the history of the subject to which it relates, followed by a series of numbered paragraphs giving the principal formulæ, with full references to the books and writings from which they are taken, and to which the reader must have recourse for further information.

The branches of mathematics treated of in the present volume may be classed under the four heads of Theory of Numbers, Theory of Series, Theory of Functions, and Theory of Equations. In this classification, however, an extended meaning must be given to these titles, for the functional branch includes determinants, invariants, and groups. Altogether there are twelve subject headings divided into 102 sections, each of which is further subdivided into separate articles when required. As an example of the mode of arrangement, we may take the Partition of Numbers. We first find a general sketch of the algebraical methods of Euler, Cayley, and Sylvester, with many of Euler's most interesting results; then we pass to partitions into figurate numbers and to quadratic forms, both treated in a similar manner.

It is evident that any near approach to absolute completeness could not be attained in such a comprehensive undertaking. No single person could read and digest the whole of mathematics as it exists in our day, and arrange and systematise it in a series of volumes. It might even be regarded as open to question whether so bold an enterprise could meet with any measure of success. But no one can look at this volume without admitting that the attempt has been well justified, and that, whatever its imperfections, we are indebted to the author for a most interesting and valuable work.

The critical reader naturally turns first to the subjects—or, rather, the portions of subjects—with which he is himself best acquainted, and it is not surprising if he should here find omissions; but, even in this extreme case, the sections in question can scarcely be read without advantage as well as interest. The true test of the utility of the work is afforded by an inspection of the sections relating to subjects which lie adjacent to, but not upon, the direct line of the reader's own studies; here he cannot fail to be impressed by the new matter which he will find set out before him.

The history, theorems, and references are grouped together in an attractive manner; a mathematician could not turn over the pages, even in the most casual manner, without being tempted to stop here and there and pore over some of the paragraphs. The historical introduction is always remarkably clear, and the formulæ are sufficiently explained to render them intelligible as they stand. Although the book is to some extent a cyclopædia, it is not unduly concise, nor is any attempt made to save space by the introduction of special abbreviations in the explanations or references.

As an illustration of the contents of the sections, we may take the paragraphs which relate to the number of prime numbers. We first find references to the proofs of the theorems that the number of primes is unlimited, and that every arithmetical progression, whose first term and difference have no common factor, must contain a prime. The next paragraph gives an account of Gauss's, Encke's, and Legendre's approximate formulæ for the numbers of primes between given limits, with references. Then we come to a *résumé* of Tchebicheff's memoir of 1851, with Sylvester's additions (1881), followed by a similar statement of Riemann's results (1859) and a reference to Meissel's methods of calculating the exact number of primes up to a given limit (1871). As another illustration, we may take the section relating to the harmonic series. First we find references to works or memoirs where special cases of harmonic series are treated at some length; then we come to the general summation by means of the semi-convergent series with Eulerian numbers as coefficients; and the section closes with an account of the history of Euler's constant. From this description it will be seen that the work, covering as it does all higher mathematics, is unique in its character. No other writer has attempted to deal systematically with any large field of mathematical research so fully and completely.

It seems to us that Mr. Hagen has very skilfully combined statements of results with references. It is difficult to avoid being too diffuse when formulæ have to be selected from an elaborate memoir; and it is difficult to render a mere body of references attractive. But in both these respects the author has been successful. The references are always accompanied by enough explanatory matter to render them interesting; in fact, unlike most mathematical quartos, every page of the book is "readable" in the ordinary sense of the word. The subdivision of the subjects into so many sections, though convenient for the user, must have added considerably to the labour of preparation, and increased the difficulty of arranging the references so as to avoid repetition.

A list of sixty-six treatises and twenty-one periodicals, which are referred to in the volume, is given at the end. This list, long as it is, might have been considerably extended, had more complete libraries been accessible to the author. As it is, the works consulted form a most excellent nucleus, which may be supplemented at some future time by the author or a successor. Had many more been included, we think the author's attempt must have failed, no matter what ability and perseverance he might have brought to his task. It is to be remembered that for such a compilation it is necessary to study the memoirs with some care in order to decide upon the results to be selected. No one who has not had experience of this kind of work can appreciate the labour involved; it is comparatively easy when the abstractor can confine himself to his own line of study, but when he has to get up fresh subjects for the purpose, the difficulty is enormously increased. It would be manifestly unfair to criticise a work of this kind on account of its deficiencies, or even its errors. Any competent mathematician who carries out such an undertaking is entitled to the thanks of his fellows for whatever he puts before them; and when he does his work well, as Mr. Hagen has done, he may be heartily congratulated upon a real service rendered to mathematical science.

The difficulty of dealing with the ever-increasing volume of journal literature is one which is common to all the sciences, but it is perhaps felt most acutely in mathematics, where the lines of research are so very numerous, and the workers in each are but few. The want of treatises has to some extent been supplied by the republication in a collected form of the scattered papers of many eminent mathematicians. The value of these complete editions cannot be exaggerated; but they necessarily aggravate the tendency to accumulate all discoveries upon the greatest names, and throw still further into the background the productions of the less distinguished writers. The paramount merit of classified indexes and books of an encyclopædic character is that they treat all papers with the same impartiality; and probably there are no works which do more for the advance of science than those which, like the present, have for their sole object to make available for general use the stores of more or less inaccessible knowledge which have been laboriously acquired and put on record. Perhaps, too, when Mr. Hagen has mapped out the whole territory of mathematics, there may be found some who will be willing to fill in certain regions on a larger scale than so comprehensive a plan has permitted to him.

A few words should be added with respect to the book itself. It is beautifully printed, the pages are large and handsome, and it is well indexed. The formulæ are so numerous, and the text is so conveniently divided into short and clear paragraphs, that the language will present no obstacle to anyone possessing the least acquaintance with German. It is intended that the complete work shall consist of four volumes, the second relating to geometry. If carried out in its entirety with the same care that has been bestowed upon the first volume, the whole work will form a splendid contribution to the history and progress of mathematics.

J. W. L. Glaisher.

MICRO-CHEMISTRY.

A Manual of Micro-chemical Analysis. By Prof. H. Behrens. With an introductory chapter by Prof. John W. Judd. (London: Macmillan and Co., 1894.)

THE necessity of supplementing the microscopical examination of rocks and minerals by chemical tests led Dr. Boricky in 1877 to devise his method of micro chemical analysis. He decomposed extremely minute particles of the substance to be examined on a glass slide, protected by a coating of Canada balsam, and examined the fluosilicates formed by the aid of the microscope. Since his time Prof. Streng, Dr. Haushofer, the author of the present manual, and others have devoted themselves to improving and extending micro-chemical methods. Although originally introduced for the purpose of enabling chemical tests to be applied to extremely small particles, it has been found that these methods have another and perhaps equally important claim to recognition. They often shorten the time required for a qualitative chemical examination. Thus Prof. Behrens tells us that a solution containing calcium, magnesium, zinc, manganese, cobalt, and nickel has been examined in forty minutes; and one containing silver, mercury, lead, bismuth, tin, antimony, and arsenic in an hour.

Up to the present time no general work on micro-chemical analysis has appeared in the English language, so that the manual before us fills a definite gap in our scientific literature. It is divided into three parts. The first treats of the general method and of the reactions at present employed in the identification of the different elements; the second, of the application of the method to the analytical examination of mixed compounds.

The apparatus required is of the simplest character. A microscope with magnifying powers of 50 and 200, a few microscopic slides, some capillary tubes, one or two platinum spoons, some platinum wire and foil, a burner giving a flame 5 mm. high, and a box of reagents, are almost all that is absolutely necessary. An idea of the scale on which the operations are conducted may be obtained from the fact that, in establishing the limits of the applicability of the several tests, the author worked with drops having a volume of one cubic millimeter. The conditions which determine the suitability of any particular reaction for micro-chemical work are obviously very different from those which govern ordinary qualitative analysis. It is much more important that the compounds formed should be easily recognisable, than that complete precipitation should be effected. The compounds by which elements are recognised under the microscope are therefore, as a rule, those which possess an appreciable though not very great solubility; for such compounds most readily form well characterised crystals.

It is in the selection of suitable reactions that Prof. Behrens has done so much to facilitate the application of micro-chemical methods. In describing these reactions he gives in each case the limit of sensibility in micro-milligrams, the precautions necessary to secure the result, and the circumstances under which the particular reaction is applicable. The work is illustrated with numerous figures representing the compounds relied upon for diagnostic purposes; but, as the author points out, the only way of acquiring facility in the identification of these compounds, as well as confidence in the method, is to go through the reactions and observe the results under the microscope.

The second part of the work treats of a systematic scheme of examination, and of the micro-chemical analysis of water, ores, rocks, alloys, and some combinations of rare elements. It must be admitted that it is at present quite impossible to formulate any general scheme at all comparable with those in use in ordinary analysis; and the chemist, unacquainted with what has been done by the aid of micro-chemical methods, would undoubtedly carry away a very unfavourable impression of them if he confined his attention to this part of the book. The following portions, which treat of the application of the method to ores, alloys, rocks, &c., are much more satisfactory, and contain information of great value to the metallurgist, petrologist, and others.

After all, micro-chemical analysis is only in its infancy, and, as the author points out, the present work will doubtless prove to be a mere outline compared with the manuals which will be published twenty years hence, "when the advantages of micro-chemical analysis will be understood everywhere, when its appliances will be fully developed, when difficulties have been surmounted, and obscurities have been cleared up." Meanwhile it is to be hoped that the publication of this small but extremely valuable little volume will have the effect of largely increasing the number of those who use micro-chemical methods in this country.

OUR BOOK SHELF.

Practical Botany for Beginners. By F. O. Bower. (Macmillan and Co., 1894.)

PROF. BOWER'S well-known "Practical Botany" has won for itself universal recognition as forming an indispensable adjunct to the botanical laboratory. But with its increasing popularity the size and scope of the volume also advanced, and at the present time, though it is invaluable to the student with sufficient time at his command, it is somewhat bulky for the large class of persons who, from various circumstances, require a more elementary acquaintance with the types they investigate.

It is for these that the "Practical Botany for Beginners" has been designed, and it will certainly prove of great service. Although the book is of smaller dimensions than the larger work just referred to, it is still conducted on the same lines. The text, so far as it goes, is for the most part similar, and the reduction in size is provided for by the use of smaller type, and by the omission of many subsidiary descriptions which had been introduced for purposes of comparison.

Like all good introductory books, it assumes no previous knowledge in the department to which it relates, and thus the student is enabled to begin really at the beginning. It will, however, be his own fault if he is not in possession of a very creditable amount of sound knowledge by the time he has worked through the volume. For those who are unable to go through the more extended course, a better book than the present one could not be recommended.

Simple Experiments for Science Teaching. By John A. Bower. (London: Society for Promoting Christian Knowledge, 1894.)

TEACHERS of science in elementary schools now live in halcyon days. Time was when books containing courses of experiments suitable for teaching the young idea the science of common things were hard to find, and they who desired to impart such instruction had to prepare their own sequence of lessons. But the examinations of the Science and Art Department and similar bodies have changed all that. There are now numerous primers for all branches of elementary science, some good, many indifferent, and a few bad. Teachers are no longer under the necessity of exercising the faculty of originality in devising experiments for class-demonstration, for the work is done for them, and frequently done well, by the much-maligned text-book writer. Possibly the mental atrophy thus brought about is not desirable, but there is little doubt that the teaching has been benefited. Few of the courses of elementary science in our schools and colleges were truly scientific in character, and it is chiefly the text-book that has improved the old state of things by giving law and order to the chaos of experiments.

Mr. Bower's book deserves classification with those that help on the work of science. It consists of two hundred experiments fully illustrating the elementary "Physics and Chemistry" division in the code for evening continuation schools. The experiments are well graded, they are simple, they illustrate phenomena of every-day life, and most of them can be performed with the homeliest things. The pupil who sees the experiments will learn much; he who does them will obtain an excellent foundation in physical science. The book is nicely printed and sufficiently illustrated, and would be a very acceptable present for a boy fond of finding out some of the ways of nature.

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 Teeth and Civilisation.

IN a letter to NATURE for May 17, on "The Teeth and Civilisation," the writer advances a theory to account for the great prevalence of decay of the teeth at the present day, and concludes that Dr. Wilberforce Smith's investigations show that "the ancients enjoyed a perfect set of teeth till advanced years, and modern savages enjoy the same blessing."

I have not had the opportunity of seeing Dr. Wilberforce Smith's communication, but the number of cases examined in this particular instance (ten Sioux Indians) would hardly be sufficient to draw any conclusions from; and even in these ten cases *all* the teeth were not examined. I think, however, it has been sufficiently proved by several careful investigations that caries of the teeth is not a purely modern disease, and is not entirely confined to civilised races. My father, in a communication to the Odontological Society in 1870, brought together the results of an inquiry extending over more than ten years, in which he examined over 2000 skulls, including all the available collections in Great Britain, and his conclusions as to the prevalence of dental caries differ very considerably from those of the writer of this letter.

Among thirty-six skulls of ancient Egyptians he found caries in fifteen (41·66 per cent.), in seventy-six Anglo-Saxon skulls he found twelve cases (15·78 per cent.), among 143 skulls of Romano Britons there were 41 cases of caries (28·67 per cent.), while among 44 miscellaneous skulls of ancient Britons 20·45 per cent. showed carious teeth. Several other collections gave similar results.

Again, with regard to savage races—among the Tasmanians 27·7 per cent. of caries was found, among native Australians 20·45 per cent., among East African skulls 24·24 per cent, and among those of West African natives 27·96.

Similar results were obtained on the examination of skulls of many other races, but I think I have quoted figures sufficient to prove that caries is not confined to civilised races or to modern times.

It is quite comprehensible that excessive nerve strain, especially by affecting vascular supply, may lead to imperfect nutrition during the *development* of the teeth, and we know that the diseases of early childhood have a very marked effect upon tooth structure, indicated by the ridged and defective teeth so frequently seen, and it seems quite possible that too early stimulus of the brain in childhood may have a similar effect on forming teeth. It is very difficult, however, to understand how nerve strain can have any *direct* effect upon fully formed teeth, and we should, I think, look for the explanation of the cases referred to in some vitiated condition of the fluids of the mouth, caused by the depressed condition of health so common amongst hospital nurses.

There is little doubt that an open-air life and healthy surroundings encourage the formation of sound teeth in a sound body: but I cannot but think that the principal cause of caries must be looked for in the food. It is plainly shown by many investigators, and in the paper above referred to, that caries is rare among peoples who subsist principally upon animal food; the Esquimaux showed, among sixty-nine skulls, only two cases of caries, and the largest amount of disease was found among those races who lived upon a mixed or exclusively vegetable diet. These results are, of course, easily understood under the more accurate knowledge which we now possess of the immediate causes of dental caries.

As to the relative frequency with which different teeth are affected, I think statistics plainly show that it is the first molar tooth of the *lower* jaw which is most prone to decay of any tooth in the series, and most authorities consider the second lower molar as the next in order; with these two exceptions the upper are more frequently diseased than the lower teeth. This would, however, not affect the argument, as the lower molars are of course also supplied by the fifth nerve.

Structural defects, due to inherited weakness or imperfect nutrition *during the development of the teeth*, combined with the use of soft cooked food, which is long retained in contact with them, and is of a nature eminently suitable for fermentation, give us, I think, the principal factors of decay among civilised races.

While allowing the influence of nerve strain in early childhood, and as a factor in hereditary transmission of defective structure, I fail to see how it can influence teeth already formed. J. Howard Mummery.

May 27.

Centipedes and their Young.

Referring to Mr. Urich's letter in your issue of April 5, I send the following remarks, which no doubt will interest some of your readers. During my eight years' residence in Guiana, I have frequently had brought to the museum, centipedes of from 5 8 inches in length, carrying their young clasped by means of their legs to all parts of the under-side of the body, though generally the young have been clustered in dense masses rather than scattered. In their very early stages the young are closely clustered, and seem quite unable to clasp their parent in turn, but later they become very restless, and will be seen moving about independently, and when clustered by the action of the parent they are incessantly changing their position in the cluster. When the young are thus bunched together, the body of the parent is coiled upon itself at that part; and the contrast between a centipede in this position, and a scorpion carrying her young upon her back, just as a small opossum does, is a very marked one.

I had imagined that this habit of the centipedes was widely and generally known; and indeed Packard ("Guide to the Study of Insects," p. 674) remarks that "Wood also states that the female guards her young by lying on her side, and then coiling her body passes them along by a rapid cilia-like action of her feet, thus arranging them satisfactorily to herself." This is but a very terse description of what will be observed when one disturbs a centipede and the arrangement of her young about her body.

As remarked by Dalton ("History of British Guiana," vol. ii. p. 267), the centipedes "lay their eggs in clusters like little berries on the ground, and the female chooses an obscure place for this purpose, as under flower-pots, where she can remain until the eggs are hatched." Centipedes are not seldom met with in such obscure and uniformly moist places as under flower-pots and tubs, or boards and shingles, with their eggs clustered as described.

With regard to the disappearance of the young ones from the box forwarded from Trinidad to London, the most likely explanation is that they were eaten by the parent. If the parent centipede be kept with the young ones, and left unfed for a day or two, it will be observed to feed quite leisurely and greedily at times on its young. This I have witnessed directly in three separate cases where they had been kept unfed in a long glass jar in the museum. The most desirable food for centipedes in the tropics, I may incidentally remark, is the cockroach. J. J. Quelch.

The Museum, British Guiana, May 10.

The Penetrative Power of Bullets.

I have been stimulated by the recent trials of the bullet-proof cuirass, to try a few experiments on the subject. I will only mention one experiment, which I made this morning, assisted by several members of the junior scientific club here. It occurred to me that if the energy of the bullet could be made to act at rather a large angle to its line of flight, its penetrative power would be diminished. To effect this, I arranged a number of soft iron rods ¼-inch in diameter and 5 inches long, side by side and touching a piece of deal board; on these another layer was placed, so that one of the upper rods touched two of the under ones. A sheet of thin rubber $\frac{1}{16}$-inch thick, placed on this, separated it from a similar combination attached to it at right angles; and the whole formed the target. The rifle used was a Winchester, 22 bore, carrying a long bullet. At a distance of 20 feet the bullet penetrated 5 inches of hard pine with certainty; but when the bullet fired at the same distance hit my rod target, it failed to penetrate even the first layer, but only drove the upper rods aside nearly at right angles to the line of flight. The next experiments will be made with heavier materials and larger shot. Possibly a similar arrangement, but of large steel cylinders, might make a satisfactory barrier to the shot of big guns. Frederick J. Smith.

Millard Engineering Laboratory, Oxford, June 1.

The Garhwal Landslip.

Let me point out that the paragraph on p. 109 of Nature for May 21, stating that the landslip that had occurred in the Garhwal district in the Himalaya, blocking up the Bireh Ganga river, had burst, causing the loss of many lives, is erroneous. The catastrophe reported from India had reference to a locality in Kulu, and not to Garhwal, the two being several hundred miles apart.

An accurate description of the Garhwal landslip will, I hope, be shortly published in the Royal Geographical Society's journal. The obstruction is being carefully watched, and the water has not yet topped it. There is, I think, considerable reason to anticipate that no great destruction will be caused at this place, as the landslip is of such vast dimensions as to make it almost impossible that it should be carried away in a manner to give rise to a great and sudden flood. It is upwards of a mile in length and two-thirds of a mile wide, rising about 900 feet above the original level of the valley, and being largely composed of enormous masses of rock.

June 1. R. Strachey.

Research Work.

May I be allowed to suggest that it would be a great help to many interested in science if an authorised body, such as the British Association, were occasionally to indicate paths of research work in different branches of science, especially in physics and chemistry, which would offer a reasonable prospect of leading to useful results? Many, especially among those engaged in educational work away from London, have not the advantage of continued intercourse with the leaders of scientific thought which would give them the opportunity of forming a judgment themselves, and the fear of having been forestalled by others makes them hesitate to devote the time required for a sustained course of experimental research. Within the writer's experience, men whose judgment carries great weight do not individually feel inclined to give advice which they consider ought primarily to be devoted to the advancement of their own students. The advantages of a laboratory, of leisure time, and of a desire to add their quota to the stock of knowledge are not, by the wise, thrown away, but a great deal of energy, at present more or less dissipated, might be diverted into more useful channels if the above suggestion were carried out—offering each one the opportunity of choosing that particular line of research which most nearly satisfies the conditions in which he is placed. The idea might be still further developed by associating workers together for a common end, even at the risk of not being able to eliminate the personal factor. W. G. Woollcombe.

Birmingham, May 31.

A Daylight Meteor.

The following account of a meteor, seen by me in full daylight, may be of interest to readers of Nature. It was written a few hours after the meteor appeared.

While practising at cricket to-night (May 18), in splendid light, I observed at 7.58 (railway time) a very brilliant meteor cross the sky obliquely from a point considerably north of the zenith to the south-east. Its movement was very slow, and it shone with a brilliant intense white light, which was concentrated in itself, and did not leave a train behind it like the meteor of March 18, 1893, which I had also the good fortune to see.

It got gradually smaller and smaller, and just before disappearing broke up into three or four pear-shaped portions. During its course, although the massy head was always brilliantly white, the little tail varied in hue, crimson and a rich ultramarine blue being most noticeable.

I immediately timed it, and found that it was about 13 seconds in view, which I thought a very long time indeed.

From diagrams made on the same evening, it seems that the meteor moved from a point 40° from the zenith, and some 15° west of north to a point about 30° east of south at an altitude of 30°. JAS. G. RICHMOND.

Muirkirk, Ayrshire, May 30.

P.S.—The *head* when first seen had an apparent diameter about ⅔ that of the sun, and when last seen ⅜ sun's diameter. It rolled across like a ball with a very short tail, until it broke up, when the distance from the head to the tail of the last pear-shaped portion was about 3½ sun's diameter.

Iron Crows' Nests.

REFERRING to the note by Mr. McMillan, in your issue of May 3, it may be of interest to some of your readers to know that we have in this museum a crow's nest from Rangoon entirely made of iron wire such as is used in fastening the corks of aerated water bottles. The donor, Mr. Joseph Dawson, of the Public Works Department, Rangoon, stated in his letter at the time that "wire nests are hardly a novelty in this country, as they can always be obtained from high trees in the vicinity of aerated water factories." The nest in question has a piece of hoop-iron about three or four inches long woven into it; but with that exception it is entirely composed of the small wire, and is about a foot in diameter. J. MACNAUGHT CAMPBELL.

Kelvingrove Museum, Glasgow, May 28.

THE REPORT OF THE COMMITTEE ON ARMY EXAMINATIONS.

IN the *Times* of Wednesday, 23rd ult., there was a brief account of the report lately presented to Parliament by the committee appointed in 1893 "to enquire into the entrance examinations (in non-military subjects) of candidates for commissions in the Army, and to advise whether any modification of the existing arrangements is desirable."

The syllabus of subjects and marks recommended by the committee is as follows:—

CLASS I. (*All may be taken up.*)

	Marks.
1. Mathematics ...	3000
2. Geometrical Drawing...	1000
3. French or German ...	2000
4. English...	1000
5. Freehand Drawing ...	500

CLASS II.—(*Any three subjects may be taken up, but for Woolwich one of the three must be Chemistry and Heat.*)

	Marks.
1. Pure Mathematics ...	2000
2. Applied Mathematics...	2000
3. German or French, as alternating with the same group in Class I. ...	2000
4. Latin ...	2000
5. Greek ...	2000
6. English History ...	2000
7. Chemistry (inorganic) and Heat ...	2000
8. Electricity and Magnetism and Light ...	2000
9. Geography, Political and Physical, and Geology ...	2000
10. Biology...	2000

Certain recommendations as to the fusion of the Woolwich and Sandhurst examinations, the admission to the Army of Queen's cadets, Militia candidates, and University candidates are also made.

In regard to the question of marking for physical exercises and development, which has lately been strongly advocated, it is advised that these subjects should not be marked in these competitions. It seems to be thought, however, that though the physique of our officers has been *well maintained* under the competitive system, yet a small proportion of cadets have been admitted who were not quite up to the necessary standard, and it is recommended that the medical examination should be made somewhat more stringent.

The two changes of greatest importance which have been advised by the committee are, briefly, as follows—

(1) That an elementary knowledge of chemistry and heat shall be made practically obligatory for Woolwich.

(2) That Latin shall be transferred from Class I. to Class II.

There is also a minority report on certain points, viz., on the suggestion of a complete fusion of the competitions for Woolwich and Sandhurst, and on the proposal to transfer Latin to Class II. This is signed by three of the nine members of the committee, and one of these three also signs a separate note in which he dissents from the addition of geography to No. 9 of Class II., and of biology to Class II. as a new subject, and makes certain proposals to meet the special needs of Woolwich (which he admits) that would certainly fail to effect their proposed purpose.

On May 29, this report, and especially the two recommendations relating to science for Woolwich, and to Latin, were vehemently attacked by the *Times* in an article in which the report was denounced as such an one as "might have been framed by a committee of crammers," so far as their probable effect is concerned, rather than by a committee which is unanimous in subscribing to the principle laid down in 1869–70, that the examinations should be designed "with special reference to the curriculum adapted at the most advanced of our public schools, and with the express intention of enabling the competitors to come straight from one of those establishments to the examination-hall without having occasion to resort to any intermediate place of study." And again in a later paragraph, as a mere attempt by a portion of the committee to show themselves modern and advanced at all hazards by replacing the dead languages by the new sciences—Latin by chemistry—which latter subject is pronounced to be the most easy of all to cram in face of the statistics, produced by the Civil Service Commissioners and printed with the report, which show the subject to be above the average in discriminating power—that is to say, one in which teachers have not succeeded, by cramming or in any other way, in raising the marks of the least apt to or near the level of those of the more apt.

The *Times* has not hesitated to accuse the majority of the committee of disregarding the evidence before them, but has itself committed this fault. Its case is indeed mainly founded on such disregard of the facts. By coupling together two changes which stand upon entirely different footings it creates the impression, and is itself apparently under the impression, that the committee was divided on both the above proposals. Nothing is plainer in the reports than that this was not the case.

From the same cause, a reader would gather from the *Times* that science is recommended as an obligatory subject for all Army candidates, whereas nothing of the sort has been proposed.

Then it ignores the fact that the opinions of head masters as expressed to the committee were almost entirely in favour of giving more weight to science in the case of Woolwich candidates. And finally, it seeks to give weight to the opinions of the minority of the committee by putting aside the opinion of the present Director-General of Military Education as that of a person of little present importance on this question, by ignoring the high classical acquirements of Mr. Roby, who is a distinguished scholar and the author of a standard Latin grammar, and by dismissing Sir Henry Roscoe, with his great educational experience on the Scotch University Commission and on other occasions, as though he were an ordinary Member of Parliament with no special experience or weight on a question of this kind. All these facts combine to make it important that we should place the matter fully and in a true light before our readers.

In order to form a just judgment on the recommendations of the committee, it is necessary to do just that which the *Times* has not done. Each of the proposed changes must be considered on its own merits, in relation to the other subjects, to the needs of the various branches of the Service, and to the present teaching powers of the most advanced public schools.

We must first point out that the recommendation that chemistry and heat shall be required in future from all Woolwich candidates stands upon a footing which is in many respects different, and altogether independent of that upon which the other recommendation stands.

In the first place, this recommendation is adopted by every member of the committee except one. And even he, in his dissent, admits that for Woolwich some degree of further specialising is necessary, and makes a recommendation for the purpose of effecting it. Unfortunately his proposal would pretty certainly fail of its purpose; it is quite unsound, and was, we think rightly, not adopted by the rest of the committee.

Secondly, it is not advised that science should be made a compulsory subject for the Army in the same sense as that in which Latin has of late years been compulsory. It is not proposed to require it of all candidates, but only of those who are admitted to the scientific branches.

These, we need hardly point out, form only a minority of the whole. No one need be kept out of the Army through ignorance of science, and those who are really strong in other subjects will not even be kept out of the Artillery and Engineers by this regulation if it be adopted.

Thirdly, as what follows will show, science for Woolwich was strongly supported by most of the head masters who assisted the committee with their opinions. Thus, Dr. Percival, of Rugby, included obligatory science in a scheme of examination which he offered for consideration, and said that he thought any school which is worth considering would bring its candidates up to a very fair level in science before they entered Woolwich or Sandhurst; and explained that he meant not only the larger, but almost all schools.

The Rev. J. E. C. Welldon, of Harrow, included a branch of science in a list of obligatory subjects which he considered should enter into the education of every English gentleman.

Mr. Phillpotts, of Bedford, did not advise compulsory science, but he expressed a wish that the chemistry marks should be raised to 2500, which experience has shown in effect almost make this subject an obligatory one.

The head master of St. Paul's suggested in a letter that a branch of experimental science should be raised to Class I. with 2000 marks for Woolwich candidates.

The head master of Westward Ho wrote that he believed that nothing short of the inclusion of a science among "obligatory subjects" will bring about satisfactory results.

The head master of Loretto placed science on his optional list; but said that but for geography he is not sure if some power of practical work should not be placed among the necessary subjects, and stated that he longs to see practical chemistry introduced into the regular curriculum of schools.

Only two head masters said nothing in support of science subjects for Woolwich. And finally, Prof. Jebb has lately expressed to the Secretary of State for War his opinion that the scientific study and the linguistic studies should be put on an equal footing in respect to these examinations.

With this evidence before them, with complaints alike from schools and on the part of the Professor of Experimental Science at Woolwich, of a waste of time and power there in regard to science teaching, which makes itself felt even in Class I., and which is inevitable under the present system, and with ample testimony to the increasing importance of science to the scientific branches, could any impartial body of advisers have made a more reasonable and more modest recommendation than that which the Army Examinations Committee has made to Parliament?

As regards the influence this change would have upon the curriculum of our "most advanced public schools," and the possibility that it may drive boys from the schools to the crammer, which our contemporary seems greatly to fear, what we wonder would be said by Rugby, Cheltenham, Clifton, Marlborough, St. Paul's, or by Westward Ho, Malvern, Dover, and a score of other schools, if it were suggested to them that their appliances for and power of teaching science were inferior to those of the private tutors? It is notorious that the contrary is the case, that for long past the schools have held more than their own in these respects, and that the school of moderate size that is not now able to give good elementary instruction in chemistry and heat, is so far from being amongst our most advanced schools that it must be pronounced to be one that is unmistakably behind the times.

Finally, the selection of subjects made by the committee is not only a good one, but under the circumstances seems the best that could be made. It will not discourage either chemistry or physics entirely in the schools, and there are schools which prefer each of these branches; it is within the scope of the resources of all thoroughly efficient schools, which some other selections might not have been; and, above all, since it corresponds well with the elementary courses of instruction that have been in force at Woolwich, it will best avoid the loss of time there, which has been already alluded to, and will permit the cadets at once to proceed to those sciences of which they will need a technical and advanced knowledge, such as electricity and the chemistry of explosives, and for which more time and a better state of preparedness at entrance is said to be greatly wanted.

The recommendation to place Latin in Class II., as we have said, needs separate consideration. It must be admitted that there was a considerable body of evidence against it, and a division of opinion on the subject among the members of the committee. The question is one of great difficulty. It would have been impossible to retain compulsory Latin for Sandhurst without practically compelling it for Woolwich also. All who are experienced in these examinations will admit this. But to have retained it for Woolwich would have tended very greatly to limit the range of subjects taken by these cadets. It cannot be said that Latin is professionally an essential subject for Army candidates, as a few others are; and even the *Times* admits that possibly its study may not be "an ideal whetstone of the mind," whilst it is certain that a good many youths do not appear to gain much from it after boyhood is past. Its early introduction into education, and its retention up to a certain point, are, on the other hand, widely thought to be among the best features of the public school system. There is also a feeling that it serves as an excellent introduction to the study of languages, and doubtless it does so when well taught. But these facts, though they afford a strong reason for avoiding any step which would really be likely to prevent the teaching of Latin in the lower forms of public schools, seem to be an insufficient reason for compelling those who do not get on with the subject to continue to study it up to the age of eighteen or nineteen years, when by dropping it in reasonable time they might turn to some, for them, more profitable study. It is often forgotten that when all boys learnt Latin and Greek and little else, but few of them stayed at school so late as great numbers do at present, and that therefore there is less reason for resisting a change in this direction now than there would have been in the days mentioned by General Sir G. T. Chesney, when cadets might enter Woolwich at the age of fourteen or fifteen years.

On the whole, therefore, our feeling is that the recommendation of the majority on this point goes in the right direction. The general position of Latin in the schools will surely be sufficiently protected by the action of the universities, and hence its serious discouragement need not be greatly feared. We would ask, however, whether the objections of the dissentient members of the committee could not be met by a requirement that all candidates should take for one of their subjects from Class II. a language. This would distinctly protect linguistic studies in the schools, and so act distinctly in favour of Latin, without compelling all candidates to offer Latin, or handicapping any school which may prefer not to teach it in all its divisions. It has been said that the difficulty of Latin will prevent its being much adopted as a voluntary subject. Surely this must mean that too high a standard has been adopted for the circumstances of these candidates who cannot of course reach to the level of the higher classical forms. The Civil Service Commissioners should and could prevent any such unfairness as this from occurring, and therefore could prevent the subject from being killed, which surely all would regret.

RECENT ADDITIONS TO THE ZOOLOGICAL SOCIETY'S MENAGERIE.

ALTHOUGH it becomes more difficult year by year for the Zoological Society to add new objects to their collection of living animals, yet, as is shown by the annual reports read at the anniversary meetings, examples of a certain number of species which have not been "previously exhibited" are acquired every year. In 1892, as we are told in last year's report, specimens of 11 mammals, 20 birds, 14 reptiles, and one batrachian "referable to species not included in the last (eighth) edition of the 'List of Animals,'" were added to the series. In 1893, the numbers of novelties in the respective classes were hardly less numerous.

FIG. 1.—The Ounce or Snow-Leopard.

Some of the more noticeable among the recent additions we now propose to bring before the readers of this journal by illustrations drawn from the life by Mr. J. Smit, the principal artist employed by the Zoological Society.

(1) The Ounce or Snow-Leopard (*Felis uncia*).—The Society's lion-house always contains a good representative series of the larger species of cats (*Felis*), such as lions, tigers, pumas, leopards, and cheetahs. All do well in confinement, and probably live much longer in their cages in the Regent's Park than they would do in their native wilds, subject "to the struggle for existence." The jaguar is certainly less easy to obtain, and perhaps less suited to captivity than those already mentioned, but has always a place in the series. But the ounce, or "snow-leopard," as the Indian sportsmen call *Felis uncia*, is a much more difficult subject to deal with. In the first place, the snowy interior of Central Asia, where it lives, is by no means easy of access. In the second place, the animal when captured must "pass through the fire" of an Indian sea-port on its way home, and is not unlikely to succumb to such an ordeal. It was consequently, in spite of the exertions of their many Indian friends and

Fig. —The Cunning Bassaris.

correspondents, not until 1891 that the Zoological Society acquired their first specimen of the ounce. This, however, was a mere kitten, in feeble condition, and, notwithstanding the care lavished on it, did not live many weeks. But in the spring of the present year the Society were more fortunate, having received a fine young male of this animal from the Western Himalayas. It was originally captured, when quite small, by the retainers of Thakur Debi Chand, a native chieftain of Gundla, in Lahaul, in the Western Himalayas, and was sent as a present to Mrs. Mackay, of Dunbar House, Kullu. Mrs. Mackay made a complete pet of it, and brought it up most carefully by hand. It is now nearly full-grown, measuring upwards of six feet in length, and is in splendid health and condition.

In its native state the ounce is said to live amongst the rocks at an elevation of 9000 feet and upwards, on the borders of the snows in the Himalayas and Thibet. It preys upon the wild sheep and goats, and probably also upon the rodents that inhabit these inhospitable regions. In similar situations the ounce is said to be found throughout the higher districts of Central Asia, extending northwards to the Altai and to Amoor-land, and even, it is said by Schrenck, into the Island of Saghalin. But the story of the occurrence of the ounce in Asia Minor, credited by Mr. D. G. Elliot, who has figured this species in his "Monograph of the *Felidæ*," is, as has been subsequently shown, altogether apocryphal, the animal mistaken for the ounce in this district being simply a pale variety of the leopard (*Felis pardus*).

(2) The Cunning Bassaris (*Bassaris astuta*).—The racoons and their allies form a peculiar family of carnivora restricted to the New World with one special exception, *Ælurus* of the Himalayas. One of the most singular and interesting genera of this group is *Bassaris*, of Central America, of which two species are known, *B.*

Fig. —The Grey Coly-strike.

astuta of Texas, California, and Northern Mexico, and its southern representative, *B. sumichrasti* of Southern Mexico, Guatemala, and Costa Rica. It is the former of these two species of which an example has recently been acquired by the Zoological Society after a period of forty years, during which, so far as it is known, no bassaris has reached Europe alive.

The cunning bassaris is of about the size of a small domestic cat, but more slender in form, and provided with a long cylindrical white tail, which is crossed by seven or eight distinct black rings, rendering it the most conspicuous feature of the animal. In a state of nature the bassaris lives among wooded rocks, but often takes up its abode close to houses, and proceeds to ravage the pigeons and poultry. The genus *Bassaris* was originally referred by systematists to the *Viverridæ*, but Sir William Flower's account of its anatomy, published in 1869 (*P.Z.S.* 1869, p. 31), has placed its correct systematic position among the *Procyonidæ* beyond question.

(3) The Grey Coly-strike (*Hypocolius ampelinus*).—For their living specimens of this rare and beautiful passerine bird, which will be found lodged in one of the large cages in the parrot-house, the Society are indebted to their excellent correspondent Mr. W. D. Cumming, of Fao, on the Persian Gulf. The coly-strike has obtained its name, together with its scientific appellation *Hypocolius*, from some fancied resemblance to the African colies (*Colius*), with which, however, it has really nothing to do, though the tints of its plumage exhibit some slight similarity to the above-mentioned form. But *Hypocolius* is a true passerine bird, probably belonging to the caterpillar-hunters (*Campophagidæ*), though this is by no means certain. It was first discovered by the French collector Botta, on the coast of Abyssinia, and described from his specimens by Bonaparte. The German naturalist Heuglin obtained examples of it in 1850 from Massowah,

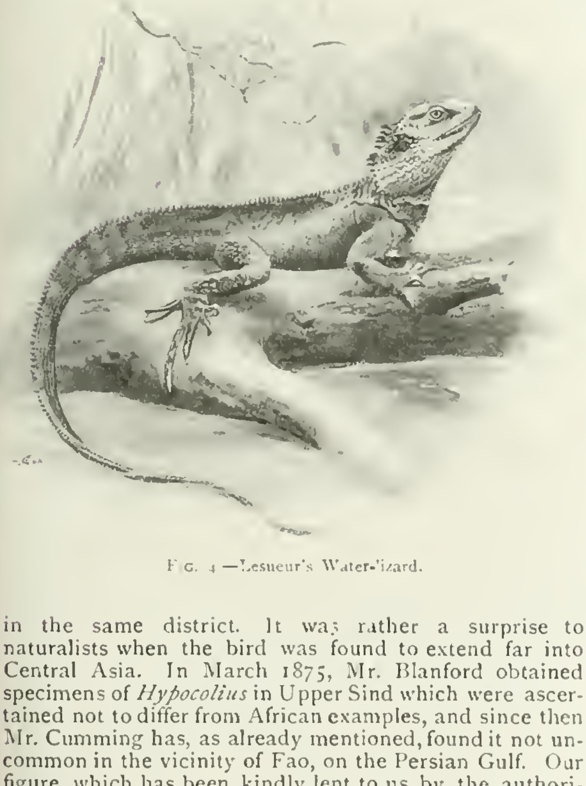

FIG. 4.—Lesueur's Water-lizard.

in the same district. It was rather a surprise to naturalists when the bird was found to extend far into Central Asia. In March 1875, Mr. Blanford obtained specimens of *Hypocolius* in Upper Sind which were ascertained not to differ from African examples, and since then Mr. Cumming has, as already mentioned, found it not uncommon in the vicinity of Fao, on the Persian Gulf. Our figure, which has been kindly lent to us by the authorities of the Zoological Society of London, represents both sexes of this bird during their attempts at nest-making in the Zoological Society's aviary.

(4) Lesueur's Water-lizard (*Physignathus lesueuri*).—Some very strange forms of Agamoid lizards are found in Australia, such as *Chlamydosaurus kingi* with its conspicuous frill, and *Moloch horridus* with its coat of spikes, pronounced by an American writer to be "one of the most repulsive creatures in nature"! The lizard which we now figure, though belonging to the same family, is, however, rather elegant in shape, and bright in colour. It is a member of the Agamoid genus *Physignathus*, of which seven species are recognised by Mr. Boulenger in his "Catalogue of Lizards." Of these four are inhabitants of Australia, whilst one comes from Timor Lant, and the remaining two are found in Cochin China and Siam. The name is taken from the bladder-like expansion of the lower angle of the jaw, which is very striking in these lizards.

In habits the *Physignathi* are said to be aquatic, inhabiting the trees on the margins of rivers, and swimming well with the aid furnished by the wide expansion of the horizontal fringes of scales on the sides of their long stout toes.

The Zoological Society's specimen of this lizard—so far as is known the first that has reached Europe alive—was received, along with other Australian reptiles, in exchange from the Australian Museum, Sydney.

NOTES.

PROF. ROBERTS AUSTEN has been awarded, by the Société d'encouragement pour l'industrie Nationale of Paris, a prize of 2000 frs. for his recent researches on alloys, and more particularly for those which relate to the behaviour of metals and alloys at high temperatures and to their mechanical properties as influenced by small quantities of added elements.

AT the last general meeting of the Zoological Society, it was announced by the Council that they had resolved to bestow the silver medal of the Society on Mr. Henry Hamilton Johnson, C.B., H.B.M. Commissioner and Consul-General for British Central Africa, in acknowledgment of the efforts he had made to increase our knowledge of the zoology of British Central Africa.

WE regret to learn that the American journal *Science* has been discontinued owing to insufficiency of support. The first number appeared on February 9, 1883, and though the circulation, after fluctuating, has steadily increased during the last two years, the paper has never paid expenses.

THE Salters' Company have recently established in connection with the medical school of St. Thomas's Hospital a Research Fellowship in Experimental Pharmacology of the annual value of £100. The Fellow elected, who may hold the office for three years, will be required to devote himself to the study of the physiological action of drugs. The Salters' Company have also endowed a similar Research Fellowship in Chemistry in connection with the research laboratory of the Pharmaceutical Society, in order to provide for investigations on the chemical side of pharmacology.

THE Prince Jablonowski Society of Leipzig has just issued the subject for the mathematical competition of 1897. It is well known that the methods of integrating partial differential equations of the second and higher orders, due to Monge, Ampère, and Darboux, can only be applied to equations which have solutions in common with other equations, which solutions are not entirely dependent upon arbitrary constants. On the other hand, it follows from Lie's investigations of infinite groups that equations admitting of an infinite group of contact transformations have in general this relation of involution to other equations. The problem proposed by the Society is that of developing the methods of integration indicated, and to illustrate them by the most instructive and completely worked-out examples. The prize offered consists of 1000 marks (about £50). Full particulars are given in the annual report of the Society, 1894.

A LARGE number of pupils, friends, and colleagues of Prof. Bertrand, the Permanent Secretary of the Paris Academy of Sciences, met at the École Polytechnique on May 27, and presented him with a medal struck in commemoration of the jubilee of his service on the staff of the school. M. Maurice Lœwy, the President of the Academy of Sciences, presided over the meeting, and among those who assembled to do honour to Prof. Bertrand were General André, MM. Faye, Darboux, and Cornu, M. Gaston Boissier (the Administrator of the Collége de France), G. Perrot (the Director of the École Normale), M. Poincaré, and M. Mercadier (the Director of Studies at the École Polytechnique). "Un pays s'honore en honorant ses grands citoyens," says the *Revue Scientifique* in its report of the ceremony. This aphorism is borne in mind in France more than anywhere else. Bertrand has now been honoured by receiving the homage of his admirers and pupils, like Pasteur and Hermite before him. It is right that this regard should be expressed in the manner it has, for the mathematical sciences do not appeal to the generality: and the only recompense a student of them can hope for is a recognition of the scientific importance of his labours by fellow-workers. The meeting at the Polytechnic School, and the speeches that were made at it, must have made Prof. Bertrand feel that the consecration of his life to the search for truth has brought a reward worth working for.

THE death is announced of Geheimrath A. Kundt, Professor of Physics in Berlin University, and of Dr. K. W. Baur, Professor of Mathematics in the Stuttgart Technische Hochschule.

THE *British Medical Journal* states that Prof. Czerny has declined the offer of the Chair of Surgery in the University of Vienna, made to him by the Austrian Government. It is believed that the reason for his refusal to accept the succession of his old master, Billroth, is the inadequacy of the laboratory and teaching equipment in the Allgemeines Krankenhaus.

WE learn from *La Nature* that a company, formed some time ago for the purpose of constructing an electric railway on the Jungfrau, have asked permission to devote a sum of one hundred thousand francs to the erection of a geophysical observatory, and five thousand francs annually for its maintenance. The observatory would have an altitude of 4200 metres, and the projected line would put it into direct communication with the valley below.

ACCORDING to the *Zoologist* for June, a committee of English sportsmen and naturalists has been formed for the purpose of devising some scheme for the protection of South African mammals, chiefly giraffe, zebra, gland, gnu, koodoo, and other antelopes, several of which, owing to indiscriminate slaughter, are on the verge of extinction. To attain this desirable end it is proposed to enclose a suitable tract of country, of about one hundred thousand acres, with a wire fencing, strengthened by a strong live fence of thorn on the outside. It is hoped that the British South African Chartered Company may allow such an enclosure to be made in the district near Fort Salisbury, which has already been reserved for game by the Company. That such a scheme is feasible is shown by the success which has attended Mr. Austin Corbin's efforts to establish in New Hampshire, U.S.A., a similar game park to that suggested, covering an area of twenty-eight thousand acres. The description of the enclosing and stocking of this park, which follows the proposals of the new preservation society in the *Zoologist*, will do much to combat adverse criticism.

The aim of the National Home-Reading Union may be summed up in a short sentence—to render study attractive. A happy experience of four successive summers has proved to the council of the society that there is no other means by which this can be accomplished so effectively as by taking the student to the locality which most abundantly illustrates his work. We all know that geology can only be learned in the field: and, in like manner, the beginnings of history acquire an objective reality as one stands within the circle at Stonehenge. Botany, also is irresistibly interesting when the teacher accompanies his pupils through a wood or over a moor. The summer assemblies of the Union, which are open to all, whether members of the Union or not, will be held this year at Buxton, in Derbyshire, during the last week in June, and at Salisbury during the first week in July. The character of the scientific side of the meetings may be gathered from the following abridged list of lecturers and subjects. At Buxton the inaugural address will be given by the Ven. Archdeacon Farrar, and lectures will be delivered by the Rev. R. Harley, F.R.S., and others. The geological excursions will be conducted by Mr. J. C. Marr, F.R.S., who will lecture on "The Building of the Pennine Chain." Conferences upon various social and educational subjects have also been organised. The object of the meeting at Salisbury will be the study of the monuments with which the district abounds, illustrative of the archæology, art, and history of Early England—"from Stonehenge to Salisbury Cathedral." Among the lecturers are Professor Jebb, General Pitt Rivers, F.R.S., and Sir Robert Ball, F.R.S. Archæology and geology will be in the charge of Dr. Humphry Blackmore, Professor T. McKenny Hughes, F.R.S., and Baron Anatole von Hugel. Mr. A. C. Seward will lecture on Botany, and accompany the excursions as botanical guide. The Marquis of Bath will preside at the Salisbury assembly, and the Right Hon. W. Woodall, M.P., at the Buxton meeting. Full programmes can be obtained from the Secretary to the Union, Surrey House, Victoria Embankment, London, W.C.

THE current number of *Himmel und Erde* contains a valuable article by Dr. J. Hann, entitled "Ebb and Flow of the Earth's Atmosphere." The paper deals entirely with the diurnal and annual range of the barometer, and Dr. Hann's laborious investigations of these phenomena have frequently been referred to in our columns. It is more than 200 years ago since the regular variation of the barometer by day-time was first observed, and the first person who investigated the regular variation during the night-time, and fixed the morning minimum at about 3h. or 4h. a.m. was the celebrated botanist Colestino Mutis, at Bogota, who commenced his observations in 1761. Blanford and F. Chambers first explained the characteristic difference between the daily range on the sea-coast and at inland stations, and showed the connection of this difference with land and sea breezes. Dr. Hann points out that while there is a large number of theories as to the cause of the double daily oscillation of the barometer, none of them satisfactorily explains the whole of the phenomena. With regard to the yearly range he shows that when the values for the northern and southern hemispheres are separately considered, it is found that the smallest quantities occur in both hemispheres in July, so that we obtain the important result that the values of the double daily oscillation depend more upon the position of the earth with respect to the sun than upon the seasons. He agrees with Lord Kelvin and others that the only means of eventually obtaining a satisfactory explanation of the subject will be by harmonic analysis, and by comparison of the variations at a large number of stations.

THE sixth annual report of the trustees of the Marine Biological Laboratory at Wood's Holl, Massachusetts, informs us that not only has the past season been very successful as far as the number of students and investigators and the quality of their work are concerned, but also that the condition of the finances is more satisfactory than at any time since the foundation of the laboratory. The fact that eighteen different colleges and universities now contribute annually to the support of tables in the laboratory is very encouraging, as showing a wide-spread interest in the laboratory as the summer working-place of both instructors and students interested in biology. It is the aid thus obtained from colleges and universities which, for the first time since its establishment, has rendered the laboratory self-supporting during the past season. The number of students and investigators occupying work-tables last summer was one hundred and eleven, this being the extreme limit of accommodation. There is every reason to believe that the number of applicants for places during the coming summer will considerably exceed the present capacity of the laboratory, and, unless the present building is enlarged, it will be impossible to accommodate them. The trustees hope that provision will be made for the increasing number of students. Further, they have to consider the question of the extension of the field of usefulness by the introduction of departments of biology not yet represented, and the development of those recently introduced into the institution. Such an extension implies an increase of working room, as well as an increase in the laboratory equipment. For the first time, the laboratory numbered last summer among its workers investigators in comparative pathology, and it is thought that, in the near future, this branch of biology should be included among the lines of investigation to be carried on in the laboratory, as are zoology, botany, and physiology at the present time.

A RECENT number of *Science* contains a short article on the employment of disease-causing microbes for the destruction of field mice and similar vermin, in which attention is called to a paper on this subject recently presented to the French Academy by M. Jean Danysz. The microbe employed in producing artificially a destructive epidemic amongst these troublesome vermin, is stated by the author to be very similar to the bacillus of duck cholera, but is not identical, for it is not pathogenic either to these birds or other fowls. Both Löffler and Lasar have discovered similar microbial enemies to field mice which have been used with marked success for the suppression of plagues of these animals, but so far in the United States they have been content to use poisoned grain or carbon bisulphide for this purpose; but Mr. Gerald M'Carthy's interesting little article will no doubt attract attention to this more novel method of dealing with such vermin. Another article in this number is on the self-purification of rivers, a subject upon which so much difference of opinion exists, that it invariably affords ample material for discussion. The aëration of the water of rivers in falling over dams and natural obstructions, has been regarded by some as exerting an important influence in purification, but according to the experiment made by Prof. Leeds upon the water above and below Niagara Falls, where natural aëration is carried on to the utmost extent possible, no chemical purification is effected during the process. The bacterial aspect of the subject is also discussed, and the writer closes his article with the observation that "a river which receives sewage should be considered unfit to serve as a public water supply." Fortunately in this country we are alive to this objection, but many of the largest cities in America invariably use sewage polluted river-water unpurified, resulting in severe epidemics of typhoid fever.

A PORT BLAIR correspondent of the Allahabad *Pioneer* announces the discovery of the remains of an elephant on South Sentinel, an islet about twenty miles from any other land. The remains were buried about nine inches below the surface, and since the yearly deposit of soil on the island must be very small, it is supposed that they are of very considerable age. It is, moreover, interesting to learn that the volcano on Barren Island is apparently entering upon a period of renewed activity.

THE Washington letter in the last number of the *Bulletin* of the American Geographical Society announces that the recent study of the observations on mountain summits in the neighbourhood of Mount St. Elias, shows that Mount Logan is the loftiest peak in North America with a height of 19,500 feet, thus being 1200 feet higher than Orizaba, and 1500 feet higher than Mount St. Elias itself.

THE June number of the *Geographical Journal* completes the third volume of the new form of the monthly publication of the Royal Geographical Society. It contains an exceptional range of geographical news, including the text of Mr. Littledale's paper on his recent journey across Central Asia, with a series of original maps and illustrations. Mr. Dolby Tyler contributes an account of his journey up the river Napo, perhaps the least known of all the tributaries of the Amazon. There is an excellent account of the primitive "Indians" of the region. Mr. Ravenstein, in a lightly written article on recent African books, incidentally calls attention to the immense flood of literature on that continent now appearing, his list including twenty-one works, all published within the last few months. Mr. H. Yule Oldham has a most readable account of the Manchester ship-canal, showing its peculiar geographical importance, and Mr. A. Montefiore gives a note on the geography of Franz-Josef Land.

THE *Scottish Geographical Magazine* for June contains the first part of an extremely valuable paper by Prof. Otto Pettersson, of Stockholm, on Swedish hydrographical work on the Baltic and North Seas. He uses *hydrographical* not in the ordinary English sense of a mere survey by soundings, but with the wider meaning of a physical and chemical examination of the water. This first part, indeed, is mainly chemical, detailing the processes employed for analysing the dissolved gases and determining the salinity and density of sea-water. The author's opinion that the use of hydrometers in marine research is nearly past, and that only determinations of density by weighing with apparatus similar to Sprengel's pyknometer can be held as sufficiently accurate, is not corroborated by the experience of most British oceanographers in whose hands the *Challenger*-type hydrometer has given most excellent results. The Edinburgh magazine sustains by this article the high reputation it has long held as the first English authority on oceanography, and it is to be congratulated on securing the first publication in any language usually read by scientific men outside Scandinavia of so original and able a treatise.

THE current number of *Wiedemann's Annalen* contains a paper on the similarity between the after-glow of a Geissler tube and the first glow of solid bodies, by Carl Kirn. Herr H. F. Weber has shown that the first light which becomes visible when a solid body is heated, is not, as was supposed by Draper, dark red but grey, which shows itself spectroscopically as a band in the yellow-green. The researches of Stenger and Ebert on the limits of the visible light have shown that the phenomenon was caused by the different sensitiveness of the eye to the different colours, this sensitiveness being a maximum for that part of the spectrum where the band of grey light is first seen. The Geissler tube employed by the author exhibited, after an electric discharge had been passed through it, all the phenomena observed by Riess and Morren; the yellowish-white after-glow of the bulbs being visible for more than half a minute in a completely dark room. The light being observed with a spectroscope, it was found that, while the discharge was actually passing, the tube gave a line spectrum, the brightest lines coinciding with those of nitrogen and carbonic oxide. The feeble spectrum of the after-glow, however, is continuous, and at first occupies the entire space covered by the previously mentioned line spectrum, but it shrinks fairly quickly on either side into a band lying between wave-lengths of 555 and 495 $\mu\mu$, and this band vanishes more slowly, diminishing in breadth as it does so. The colour of this band does not appear to the eye to be the characteristic colour of this part of the spectrum, but a pale yellowish-grey, which becomes darker as extinction approaches. The position of the final glow corresponds almost exactly with the line E of the solar spectrum, and coincides closely with the region of greatest brightness in the ordinary solar spectrum. The whole phenomenon is thus seen to be the exact reverse of what is observed to take place when solid bodies begin to glow. Opinion is still divided as to the cause of the after-glow in Geissler tubes, but the author considers that the results of various researches seem to show that the phenomenon must be considered to be the result of chemical modification of the contents of the tube.

The following excerpts from the Report for 1892 of the U.S. National Museum have lately been distributed by the Smithsonian Institution. "Japanese Wood-cutting and Wood-cut Printing," by Mr. T. Tokuno, edited and annotated by Mr. S. R. Koehler. Mr. Tokuno is the chief of the Bureau of Engraving and Printing Department at Tokio, and the information which he has given to the National Museum will be welcomed by all who are interested in the art of the wood-cutter and in the arts of Japan, more especially as his communication is believed to be the first authoritative statement on this subject made by a native of Japan thoroughly qualified for the task. "The Crump Burial Cave," discovered on the southern branch of the Warrior River, Alabama, is the subject of a paper by Mr. Frank Burns. The cave is about four hundred feet above the river, and in it were found a number of wooden coffins, indicating that the aborigines used it as a burial cave. In a note to the paper, Mr. T. Wilson, the curator of pre-historic anthropology in the Smithsonian Institution, points out that while this method of coffin burial was unusual, if not previously unknown in the United States, yet there are several instances of similar burials among the prehistoric peoples of other countries. Mr. Wilson has a paper on an extensive series of minute stone implements collected by Mr. A. C. Carlyle in the Vindhya bills or mountains in central and north-western India, and now in the National Museum. The implements are said to belong to the neolithic period, but Mr. Carlyle has also found others belonging to the palæolithic period in the same locality, and he believes that the evidence of the archæology of the district shows that there was no hiatus between the palæolithic and neolithic periods, and that the series of implements run from one period to another, their differences being accounted for by the general progress from the lower to the higher civilisation. "The Comparative Oology of North American Birds" is the subject of another excerpt. In this Dr. R. W. Schufeldt brings together a large amount of information of interest to ornithologists, and presents it in a manner which will greatly facilitate the study of the variations in the matter of form and colouration of the eggs of birds of different countries.

Messrs. Cassell and Co. have commenced a new issue, in monthly parts, of Mr. W. F. Kirby's admirable and comprehensive work on "European Butterflies and Moths."

Mr. C. F. Juritz's report on work done in the Analytical Laboratory and Mineralogical Museum at the Cape of Good Hope, during 1893, has just been issued.

It was a happy inspiration that led to the publication of the series of little books on "The Country Month by Month," by Mrs. J. A. Owen and Prof. G. S. Boulger. The June number of the series points out the beauties of nature in the same attractive style that distinguished previous volumes. Messrs. Bliss, Sands, and Foster are the publishers.

Mr. A. F. Calvert, the author of several works on Australia and its resources, has collected a number of facts and fancies with regard to "The Coolgardie Goldfield" in Western Australia, and his compilation has been published by Messrs. Simpkin, Marshall, and Co. The evidence adduced goes to show that the Coolgardie district is richly auriferous, and that the only great drawback to its development is the scarcity of water.

Following the lead of other London Polytechnic Institutes, that at Battersea has started a journal—the *Battersea Polytechnic Review*. We hope that the new journal will not become merely a medium for recording cricket matches and social gatherings. Schemes of courses of study in various branches of science, art, and technology might be profitably included in its pages; and also lists of good books to read, and notes on recent work; while brief descriptions of the Polytechnics on the continent would create a spirit of emulation that would certainly help to develop the work of the Institute in the proper direction.

Each of the papers in *Science Progress* is an important addition to scientific literature. The contributors to this monthly review of current investigations are always men in thorough touch with their subjects, and the result is that they summarise all that is worth knowing on the matters treated by them. The contents of the June number are as follows:—"Pure Yeast and its Relations to Brewing Operations," by Dr. A. K. Miller; "Electrosynthesis," by Dr. James Walker; "Glycogen," by Prof. W. D. Halliburton, F.R.S.; "Mesozoic and Kainozoic Geology in Europe," by Mr. Philip Lake; "The Localisation of Enzymes in Plants," by Prof. J. R. Green; and "Recent Additions to our Knowledge of the Ancient Sediments," by Mr. J. E. Marr, F.R.S.

The additions to the Zoological Society's Gardens during the past week include a Two-Spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Mr. Joseph Wills; a Raccoon (*Procyon lotor*) from North America, presented by Mr. H. Burgess; a Grey Parrot (*Psittacus erithacus*) from West Africa, presented by Mrs. Lemming; two Goliath Beetles (*Goliathus druryi*) from West Africa, presented by Captain A. S. Mitchell; a White-handed Gibbon (*Hylobates lar*) from the Malay Peninsula; two Gazelles (*Gazella dorcas*, ♂ ♀) from Suakin, deposited; a Beech Marten (*Mustela foina*), a Pine Marten (*Mustela martes*), European, a Silky Bower Bird (*Ptilonorhynchus violaceus*), a Garrulous Honey-eater (*Myzanthe garrula*) from Australia, four Vinaceous Turtle Doves (*Turtur vinaceus*), four Cape Doves (*Œna capensis*) from Africa, a Timneh Parrot (*Psittacus timneh*) from Sierre Leone, two Stanley Cranes (*Tetrapteryx paradisea*) from South Africa, purchased; two Hamadryads (*Ophiophagus elaps*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

Astronomical Congresses at Utrecht and Vienna.—An astronomical congress will be held at Utrecht on Friday, the 10th, Saturday, the 11th, and Monday, the 13th of August. Notices of motion and other communications should be addressed to one of the committee before August 7. Dr. H. Gyldén, of Stockholm, will preside. Herren H. Seeliger, of Munich, and R. Lehmann-Filhés, of Berlin, are acting as secretaries.

The preparations for Section 2 (Astronomy) of the meeting of German men of science and physicians, to be held this year at Vienna, from Sept. 24 to 30, are under the direction of Prof. E. Weiss, Dr. J. Palisa, and Dr. J. Holetschek. Papers and subjects for demonstration should be announced to them at once, so as to form part of the provisional programme to be issued early in July. Intending exhibitors at the scientific exhibition, to be held in connection with the meeting, should write to the "Ausstellungs Comité der Naturforscher-versammlung, Wien., Universitat."

PROPOSED ASTRONOMICAL CONGRESS IN 1896.—At the end of a paper read at the last meeting of the Royal Astronomical Society, Dr. Gill propounded the following questions, which we reprint from the *Observatory*. (1) Whether, in the opinion of astronomers generally, steps should be taken for a more complete and harmonious organisation and partition of the astronomical world from the year 1900? (2) Are astronomers prepared to enter upon a preliminary study, discussion, and experiment on the practical methods by which the art of observation may be raised to a higher level of accuracy, and its results be derived and published in a more systematic and homogeneous system? (3) If these questions are answered in the affirmative, would it be desirable to hold an international astronomical congress, say in 1896, to discuss and make the necessary preliminary arrangements, and then let the definitive programme and partition of work be made at another general congress to be held in the year 1899?

THE LAW AND GREENWICH TIME.—Is there any legal authority for the use of Greenwich Time throughout Great Britain? The editors of the *Observatory* point out that in the Statutes (Definition of Time) Act 1880, 43 and 44 Vic. cap. 9, it is enacted that whenever any expression of time occurs in any Act of Parliament, deed, or any other legal instrument, the time referred to shall, unless it is otherwise specifically stated, be held in the case of Great Britain to be Greenwich Time, and in the case of Ireland, Dublin Time. It is remarked, however, that Sir James Stephen says, in the Larceny Act, "Criminal Law Digest," p. 247, sec. 3, in referring to the expression "of the clock":—"It may be worth while to observe that the expression 'nine of the clock,' 'six of the clock,' indicates *mean* as opposed to *solar* time; but a question might arise as to whether they mean local mean time or the mean time commonly observed at any given place. London time, or, as it is called, railway time, is now very generally observed, and there is a difference of more than twenty minutes between London and Cornwall. Local mean time is the natural meaning." In the case which led our contemporary to look up the matter, a defendant arrived at a court at the local (Carlisle) time appointed by the court to sit, but found that the court had met by Greenwich Time, and had decided against him. The difference of interpretation of the time appointed led to the granting of a new trial.

THE WORK OF HERTZ.[1]

THE untimely end of a young and brilliant career cannot fail to strike a note of sadness and awaken a chord of sympathy in the hearts of his friends and fellow-workers. Of men thus cut down in the early prime of their powers there will occur to us here the names of Fresnel, of Carnot, of Clifford, and now of Hertz. His was a strenuous and favoured youth; he was surrounded from his birth with all the influences that go to make an accomplished man of science—accomplished both on the experimental and on the mathematical side. The front rank of scientific workers is weaker by his death, which occurred on January 1 of the present year, the thirty-sixth of his life. Yet did he not go till he had effected an achievement which will hand his name down to posterity as the founder of an epoch in experimental physics.

In mathematical and speculative physics others had sown the seed. It was sown by Faraday, it was sown by Thomson and by Stokes, by Weber also doubtless, and by Helmholtz, but in this particular department it was sowed by none more fruitfully and plentifully than by Clerk Maxwell. Of the seed thus sown Hertz reaped the fruits. Through his experimental discovery, Germany awoke to the truth of Clerk Maxwell's theory of light, of light and electricity combined, and the able army of workers in that country (not forgetting some in Switzerland and France and Ireland) have done most of the gleaning after Hertz.

This is the work of Hertz which is best known; the work which brought him immediate fame. It is not always that public notice is so well justified. The popular instinct is generous and trustful, and it is apt to be misled. The scientific eminence accorded to a few energetic persons by the popular estimate is more or less amusing to those working in the same lines. In the case of Hertz no such mistake has been made. His name is not over well known, and his work is immensely greater in every way than that of several who have made more noise.

His best known discovery is by no means his only one. I have here a list of eighteen papers[1] contributed to German periodicals by him, in addition to the papers incorporated in his now well-known book on electric waves. I would like to suggest that it would be an act of tribute, useful to students in this country, if the Physical Society of London saw their way to translate and publish a collection of, at any rate, some of these papers.

Portrait Slide.

The portrait which I show is not a specially pleasing one. It is from a photograph taken by Mr. Yule, one of the band of foreign students who flocked to Hertz's laboratory at Bonn. It is excellent as a photograph, though it fails to represent Hertz at his best; perhaps because it was not taken till after the pharyngeal trouble had set in, which ultimately carried him off.

In closing these introductory and personal remarks, I should like to say that the enthusiastic admiration for Hertz's spirit and character, felt and expressed by students and workers who came into contact with him, is not easily to be exaggerated. Never was a man more painfully anxious to avoid wounding the susceptibilities of others; and he was accustomed to deprecate the prominence given to him by speakers and writers in this country, lest it might seem to exalt him unduly above other and elder workers among his own sensitive countrymen.

Speaking of the other great workers in physics in Germany, it is not out of place to record the sorrow with which we have heard of the recent death of Dr. August Kundt, Professor in the University of Berlin, successor of von Helmholtz in that capacity.

When I consented to discourse on the work of Hertz, my intention was to repeat some of his actual experiments, and especially to demonstrate his less known discoveries and observations. But the fascination exerted upon me by electric oscillation experiments, when I, too, was independently working at them in the spring of 1888,[2] resumed its hold; and my lecture will accordingly consist of experimental demonstrations of the outcome of Hertz's work rather than any precise repetition of portions of that work itself.

In case a minority of my audience are in the predicament of not knowing anything about the subject, a five minutes' explanatory prelude may be permitted, though time at present is very far from being "infinitely long."

[1] A Lecture delivered at the Royal Institution on Friday, June 1, by Prof. Oliver Lodge F.R.S., ably assisted during both preparation and performance by Mr. Edward E. Robinson.

[1] *Hertz's Papers.*

1878-79. *Wied. Ann.*, 1880, vol. 10. p. 414. Experiments to establish an Upper Limit for the Kinetic Energy of Electric Flow.

1880. Inaugural Dissertation (Doctor Thesis) on Induction in Rotating Spheres.

1881. Vol. 13, *Wied. Ann.*, p. 266. On the Distribution of Electricity on the Surface of Moving Conductors.

1883, March. *Schlömilch Zeitschrift*, p. 125. On the Distribution of Pressures in an Elastic Circular Cylinder.

1881 (?) Crelle. vol. 92. p. 156. On the Contact of Solid Elastic Bodies.

1882. *Verhandlungen des Vereins des Gewerbfleisses* (Sonderabdruck). On the Contact of Solid Elastic Bodies and on Hardness

1881. Vol. 14, *Wied. Ann.*, p. 581. Upper Limits for the Kinetic Energy of Moving Electricity

1882. *Wied. Ann.*, vol. 17, p. 177. On the Evaporation of Liquids, especially of Quicksilver, in Air-Free Space, and on the Pressure of Mercury Vapour.

1883. *Wied. Ann.*, vol. 20, p. 279 On the Property of Benzine as an Insulator and as showing Elastic Reaction (Rückstandsbildner).

1882. *Verhandln. d. phys. Gesellschaft in Berlin*, p. 18. On a New Hygrometer.

1883. *Wied. Ann.*, vol. 19, p. 78. On an Appearance accompanying Electric Discharge.

1883. *Ib.*, vol. 19, p. 782. Experiments on Glow Discharge.

1883. *Zeitschrift für Instrumentenkunde.* Dynamometric Contrivance of Small Resistance and Infinitesimal Self-Induction.

1884 *Met. Zeitschrift*, November, December. Graphic Methods for the Determination of the Adiabatic Changes of Condition of Moist Air.

1884. *Wied. Ann*, vol. 22, p. 449. On the Equilibrium of Floating Elastic Plates.

1884. *Ib.*, vol. 23. On the Connection between Maxwell's Electrodynamic Fundamental Equations and those of opposition Electrodynamics.

1885. *Ib.*, vol. 24, p. 114. On the Dimension of a Magnetic Pole in different Systems of Units.

1887-1889. Papers incorporated in his book, "Ausbreitung der Elektrischen Kraft," translated under the title of "Electric Waves."

1892. *Wied Ann.*, vol. 45. p. 28. On the Passage of Cathode Rays through thin Metal Sheets.

[2] *Phil. Mag.*, xxvi. pp. 229, 230, August 1888: or "Lightning Conductors and Lightning Guards" (Whittaker), pp. 104, 105; also *Proc. Roy. Soc.* vol. l. p. 27.

The simplest way will be for me hastily to summarise our knowledge of the subject before the era of Hertz.

Just as a pebble thrown into a pond excites surface ripples, which can heave up and down floating straws under which they pass, so a struck bell or tuning-fork emits energy into the air in the form of what are called sound waves; and this radiant energy is able to set up vibrations in other suitable elastic bodies.

If the body receiving them has its natural or free vibrations violently damped, so that when left to itself it speedily returns to rest, then it can respond feebly to notes of almost any pitch. This is the case with your ears and the tones of my voice. Tones must be exceedingly shrill before they cease to excite the ear at all.

If, on the other hand, the receiving body has a persistent period of vibration, continuing in motion long after it is left to itself, like another tuning-fork or bell for instance, then far more facility of response exists, but great accuracy of tuning is necessary if it is to be fully called out; for if the receiver is not thus accurately syntonised with the source, it fails more or less completely to resound.

Conversely, if the *source* is a persistent vibrator, correct tuning is essential, or it will destroy at one moment motion which it originated the previous moment. Whereas if it is a dead beat or strongly-damped excitor, almost anything will respond equally well or equally ill to it.

What I have said of sounding bodies is true of all vibrators in a medium competent to transmit waves. Now a sending telephone or a microphone, when spoken to, emits waves into the ether, and this radiant energy is likewise able to set up vibration in suitable bodies. But we have no delicate means of directly detecting these electrical or etherial waves, and if they are to produce a perceptible effect at a distance they must be confined, as by a speaking tube, prevented from spreading, and concentrated on the distant receiver.

This is the function of the telegraph wire; it is to the ether what a speaking-tube is to air. A metal wire in air (*in function*, not in details of analogy) is like a long hollow cavity surrounded by nearly rigid but slightly elastic walls.

Sphere charged from Electrophorus.

Furthermore, any conductor electrically charged or discharged with sufficient suddenness must emit electrical waves into the ether, because the charge given to it will not settle down instantly, but will surge to and fro several times first; and these surgings or electric oscillations must, according to Maxwell, start waves in the ether, because at the end of each half swing they cause electrostatic, and at the middle of each half swing they cause electromagnetic effects, and the rapid alternation from one of these modes of energy to the other constitutes etherial waves.[1] If a wire is handy they will run along it, and may be felt a long way off. If no wire exists they will spread out like sound from a bell, or light from a spark, and their intensity will decrease according to the inverse square of the distance.

Maxwell and his followers well knew that there would be such waves; they knew the rate at which they would go, they knew that they would go slower in glass and water than in air, they knew that they would curl round sharp edges, that they would be partly absorbed but mainly reflected by conductors, that if turned back upon themselves they would produce the phenomena of stationary waves, or interference, or nodes and loops; it was known how to calculate the length of such waves, and even how to produce them of any required or predetermined wave-length from 1000 miles to a foot. Other things were known about them which would take too long to enumerate: any homogeneous insulator would transmit them, would refract or concentrate them if it were of suitable shape, would reflect none of a particular mode of vibration at a certain angle, and so on, and so on.

All this was "known," I say, known with varying degrees of confidence, but by some known with as great confidence as, perhaps even more confidence than, is legitimate before the actuality of experimental verification.

Hertz supplied the verification. He inserted suitable conductors in the path of such waves, conductors adapted for the occurrence in them of induced electric oscillations, and to the surprise of everyone, himself doubtless included, he found that the secondary electric surgings thus excited were strong enough to display themselves by minute electric sparks.

Syntonic Leyden Jars.

I shall show this in a form which requires great precision of tuning or syntony, both emitter and receiver being persistently vibrating things giving some thirty or forty swings before damping has a serious effect. I take two Leyden jars with circuits about a yard in diameter, and situated about two yards apart. I charge and discharge one jar, and observe that the surgings set up in the other can cause it to overflow if it is syntonised with the first.[1]

A closed circuit such as this is a feeble radiator and a feeble absorber, so it is not adapted for action at a distance. In fact, I doubt whether it will visibly act at a range beyond the $\frac{1}{4}\lambda$ at which true radiation of broken off energy occurs. If the coatings of the jar are separated to a greater distance, so that the dielectric is more exposed, it radiates better; because in true radiation the electrostatic and the magnetic energies are equal, whereas in a ring circuit the magnetic energy greatly predominates. By separating the coats of the jar as far as possible we get a typical Hertz oscillator, whose dielectric extends out into the room, and this radiates very powerfully.

Ordinary size Hertz Vibrator.

In consequence of its radiation of energy its vibrations are rapidly damped, and it only gives some three or four good strong swings. Hence it follows that it has a wide range of excitation, *i.e.* it can excite sparks in conductors barely at all in tune with it.

The two conditions, conspicuous energy of radiation and persistent vibration electrically produced, are at present incompatible. Whenever these two conditions coexist, considerable power or activity will of course be necessary in the source of energy. At present they only coexist in the sun and other stars, in the electric arc, and in furnaces.

Two Circular Vibrators sparking in sympathy.

The receiver Hertz used was chiefly a circular resonator, not a good absorber but a persistent vibrator, well adapted for picking up disturbances of precise and measurable wave-length. I find that the circular resonators can act as senders too; here is one exciting quite long sparks in a second one.

Electric Syntony—that was his discovery, but he did not stop there. He at once proceeded to apply his discovery to the verification of what had already been predicted about the waves, and by laborious and difficult interference experiments he ascertained that the previously calculated length of the waves was thoroughly borne out by fact. These interference experiments in free space are his greatest achievement.

He worked out every detail of the theory splendidly, separately analysing the electric and the magnetic oscillation—using language not always such as we should use now, but himself growing in theoretic insight through the medium of what would have been to most physicists a confusing maze of troublesome facts, and disentangling all their main relations most harmoniously.

Holtz Machine, A and B Sparks; Glass and Quartz Panes in Screen.

While Hertz was observing sparks such as these, the primary or exciting spark and the secondary or excited one, he observed as a bye issue that the secondary spark occurred more easily if the light from the primary fell upon its knobs. He examined this new influence of light in many ways, and showed that although spark light and electric brush light were peculiarly effective, any source of light that gave very ultra-violet rays produced the same result.[2]

Wiedemann and Ebert, and a number of experimenters, have repeated and extended this discovery, proving that it is the cathode knob on which illumination takes effect; and Hall-

[1] [illegible] in the waves themselves there is no lag or difference of phase between the electric and the magnetic vibrations, the difference exists in emitter or receiver, but not in the transmitting medium. True radiation of energy does not begin till about a quarter wave-length from the source, and within that distance the initial quarter period difference of phase is obliterated.

[1] See NATURE, vol. 41, p. 36[illegible]; or J. J. Thomson, "Recent Researches," p. [illegible]95.

[2] The experiment shown in the lecture was on the lines of those described in my book, "Lightning Conductors," pp. [illegible]14 and [illegible]; the connections being much as on p. 2[illegible]5, or as depicted in *Proc. Roy. Soc.*, vol. [illegible], p. 4.

wachs made the important observation, which Righi, Stoletow, Branly, and others have extended, that a freshly-polished zinc or other oxidisable surface, if charged negatively, is gradually discharged by ultra-violet light.

It is easy to fail in reproducing this experimental result if the right conditions are not satisfied; but if they are, it is absurdly easy, and the thing might have been observed nearly a century ago.

Zinc discharging Negative Electricity in Light; Gold Leaf Electroscope; Glass and Quartz Panes; Quartz Prism.

Take a piece of zinc, clean it with emery paper, connect it to a gold leaf electroscope, and expose it to an arc lamp. If charged positively nothing appears to happen, the action is very slow, but a negative charge leaks away in a few seconds if the light is bright. Any source of light rich in ultra-violet rays will do; the light from a spark is perhaps most powerful of all. A pane of glass cuts off all the action; so does atmospheric air in sufficient thickness (at any rate, town air), hence sunlight is not powerful. A pane of quartz transmits the action almost undiminished, but fluor-spar may be more transparent still. Condensing the arc rays with a quartz lens and analysing them with a quartz prism or reflexion grating, we find that the most effective part of the light is high up in the ultra-violet, surprisingly far beyond the limits of the visible spectrum.[1]

This is rather a digression, but I have taken some pains to show it properly because of the interest betrayed by Lord Kelvin in this matter, and the caution which he felt about accepting the results of the Continental experimenters too hastily.

It is clearly a chemical phenomenon, and I am disposed to express it as a modification of the Volta contact effect[2] with illumination.

Return now to the Hertz vibrator, or Leyden jar with its coatings well separated so that we can get into its electric as well as its magnetic field. Here is a great one, giving waves 30 metres long, radiating while it lasts with an activity of a hundred horse-power, and making ten million complete electric vibrations per second.

Large Hertz Vibrator in action; Abel's Fuse; Vacuum Tube: Strike an Arc.

Its great radiating power damps it down very rapidly, so that it does not make above two or three swings; but, nevertheless, each time it is excited, sparks can be drawn from most of the reasonably elongated conductors in this theatre.

A suitably situated gas-leak can be ignited by these induced sparks. An Abel's fuse connecting the water-pipes with the gas-pipes will blow off; vacuum tubes connected to nothing will glow (this fact has been familiar to all who have worked with Hertz waves since 1889); electric leads, if anywhere near each other, as they are in some incandescent lamp-holders, may spark across to each other, thus striking an arc and blowing their fuses.

This blowing of fuses by electric radiation frequently happened at Liverpool till the suspensions of the theatre lamps were altered.

[1] While preparing for the lecture it occurred to me to try, if possible, during the lecture itself, some new experiments on the effect of light on negatively charged bits of rock and ice, because if the effect is not limited to metals it must be important in connection with atmospheric electricity. When Mr. Branly coated an aluminium plate with an insulating varnish, he found that its charge was able to soak in and out of the varnish during illumination (*Comptes Rendus*, vol. 110, p. 898, 1890). Now, the mountain tops of a negatively charged earth are exposed to very ultra-violet rays, and the air is a dielectric in which quiet up-carrying and sudden downpour of electricity could go on in a manner not very unlike the well-known behaviour of water vapour; and this perhaps may be the reason, or one of the reasons, why it is not unusual to experience a thunderstorm after a few fine days. I have now tried these experiments on such geological fragments as were handy, and find that many of them discharge negative electricity under the action of a naked arc, especially from the side of the specimens which was somewhat dusty, but that when wet they discharge much less rapidly, and when positively charged hardly at all. Ice and garden soil discharge negative electrification too, under ultra-violet illumination, but not so quickly as limestone, mica schist, ferruginous quartz, clay, and some other specimens. Granite barely acts; it seems to insulate too well. The ice and soil were tried in their usual moist condition, but, even when thoroughly dry, soil discharges quite rapidly.

No rock tested was found to discharge as quickly as does a surface of perfectly bright metal such as iron, but many discharged much more quickly than ordinary dull iron, and rather more quickly than when the bright iron surface was thinly oiled or wetted with water.

To-day (June 5) I find that the leaves of a geranium discharge positive electrification five times as quickly as negative, under the action of an arc-light, and that glass cuts the effect off while quartz transmits it.

[2] See Brit. Assoc. Report, 1884, pp. 502, 519; or *Phil. Mag.* vol. 19, pp. 267, 352.

The striking of an arc by the little reverberating sparks between two carbon points connected with the 100 volt mains I incidentally now demonstrate.

There are some who think that lightning flashes can do none of these secondary things. They are mistaken.

Specimens and Diagrams.

On the table are specimens of various emitters and receivers such as have been used by different people. The orthodox Hertz radiator of the dumb-bell type, and the orthodox Hertz receivers—a circular ring for interference experiments, because it is but little damped; and a straight wire for receiving at a distance, because it is a much better absorber. Beside these are the spheres and ellipsoids (or elliptical plates) which I have mainly used, because they are powerful radiators and absorbers, and because their theory has been worked out by Horace Lamb and J. J. Thomson. Also dumb-bells without air-gap, and many other shapes, the most recent of mine being the inside of a hollow cylinder with sparks at ends of a diameter; this last being a feeble radiator but a very persistent vibrator,[1] and therefore well adapted for interference and diffraction experiments. But indeed spheres can be made to vibrate longer than usual by putting them into copper hats or enclosures, in which an aperture of varying size can be made to let the waves out.

Many of these senders will do for receivers too, giving off sparks to other insulated bodies or to earth; but besides the Hertz type of receiver, many other detectors of radiation have been employed. Vacuum tubes can be used, either directly, or on the trigger principle, as by Zehnder,[2] the resonator spark precipitating a discharge from some other auxiliary battery or source of energy, and so making a feeble disturbance very visible. Explosives may be used for the same purpose, either in the form of mixed water-gases or in the form of an Abel's fuse. Fitzgerald found that a tremendously sensitive galvanometer could indicate that a feeble spark had passed, by reason of the consequent disturbance of electrical equilibrium which settled down again through the galvanometer.[3] This was the method he used in this theatre two years ago. Blyth used a one-sided electrometer, and young Bjerkness has greatly developed this method, abolishing the need for a spark, and making the electrometer metrical, integrating, and satisfactory.[4] With this detector many measurements have been made at Bonn, by Bjerkness, Yule, Barton, and others, on waves concentrated and kept from space-dissipation by guiding wires.

Mr. Boys has experimented on the mechanical force exerted by electrical surgings, and Hertz also made observations of the same kind.

Going back to older methods of detecting electrical radiation, we have, most important of all, a discovery made long before man existed, by a creature that developed a sensitive cavity on its skin; a creature which never so much as had a name to be remembered by (though perhaps we now call it trilobite). Then, in recent times, we recall the photographic plate and the thermopile, with its modification the radio-micrometer; also the so-called bolometer, or otherwise known Siemens' pyrometer, applied to astronomy by Langley; applied to the detection of electric waves in wires by Rubens and Ritter and Paalzow and Arons. The thermal junction was applied to the same purpose by D. E. Jones and others.

And, before all these, the late Mr. Gregory, of Cooper's Hill, made his singularly sensitive expansion meter, whereby waves in free space could be detected by the minute rise of temperature they caused in a platinum wire: a kind of early and sensitive form of Cardew voltmeter.

Going back to the physiological method of detecting surgings, Hertz tried the frog's-leg nerve and muscle preparation, which to the steadier types of electrical stimulus is so surpassingly sensitive, and to which we owe the discovery of current electricity. But he failed to get any result. Ritter has succeeded; but, in my experience, failure is the normal and proper result. Working with my colleague Prof. Gotch, at Liverpool, I too have tried the nerve muscle preparation of the frog, and we find that an excessively violent stimulus of a rapidly alternating character, if pure and unaccompanied by secondary actions,

[1] J. J. Thomson, "Recent Researches," p. 344.
[2] *Wied. Ann.* 47, p. 77.
[3] Fitzgerald, NATURE, vol. 41, p. 295, and vol. 42, p. 172.
[4] *Wied. Ann.* 44, p. 74.

produces no effect,—no stimulating effect, that is, even though the voltage is so high that sparks are ready to jump between the needles in direct contact with the nerve.

All that such oscillations do, if continued, is to produce a temporary paralysis or fatigue of the nerve, so that it is unable to transmit the nerve impulses evoked by other stimuli, from which paralysis it recovers readily enough in course of time.

Experiment of Gotch and Lodge on the physiological effect of rapid pure electric alternations. Nerve and muscle preparation, with four needles or else non-polarisable electrodes applied to the nerve. C and D are the terminals of a rapidly alternating electric current from a conductor at zero potential, while A and B are the terminals of an ordinary very weak galvanic or induction coil stimulus only just sufficient to make the muscle twitch.

This has been expected from experiments on human beings; such experiments as Tesla's and those of d'Arsonval. But an entire animal is not at all a satisfactory instrument wherewith to attack the question; its nerves are so embedded in conducting tissues that it may easily be doubted whether the alternating type of stimulus ever reaches them at all. By dissecting out a nerve and muscle from a deceased frog, after the historic manner of physiologists, and applying the stimulus direct to the nerve, at the same time as some other well-known 1/100th of a volt stimulus is applied to another part of the same nerve further from the muscle, it can be shown that rapid electric alternations, if entirely unaccompanied by static charge or by resultant algebraic electric transmission, evoke no excitatory response until they are so violent as to give rise to secondary effects such as heat or mechanical shock. Yet, notwithstanding this inaction, they gradually and slowly exert a paralysing or obstructive action on the portion of the nerve to which they are applied, so that the nerve impulse excited by the feeble just perceptible 1/100th volt stimulus above is gradually throttled on its way down to the muscle, and remains so throttled for a time varying from a few minutes to an hour after the cessation of the violence.

I had intended to exhibit this effect, which is very marked and definite, but it is impossible to show everything in the time at my disposal.

Air Gap and Electroscope, charged by Glass Rod and discharged by moderately distant Sphere excited by Coil.

Among trigger methods of detecting electric radiation, I have spoken of the Zehnder vacuum tubes; another method is one used by Boltzmann.[1] A pile of several hundred volts is on the verge of charging an electroscope through an air-gap just too wide to break down. Very slight electric surgings precipitate the discharge across the gap, and the leaves diverge. I show this in a modified and very simple form. On the cap of an electroscope is placed a highly-polished knob or rounded end, connected to the sole, and just not touching the cap. Such an electroscope overflows suddenly and completely with any gentle rise of potential. Bring excited glass near it, the leaves diverge gradually and then suddenly collapse, because the air space snaps; remove the glass, and they rediverge with negative electricity; the knob above the cap being then charged positively, and to the verge of sparking. In this condition any electrical waves, collected if weak by a foot or so of wire projecting from the cap, will discharge the electroscope by exciting surgings in the wire, and so breaking down the air-gap. The chief interest about this experiment seems to me the extremely definite dielectric strength of so infinitesimal an air space. Moreover, it is a detector for Hertz waves that might have been used last century; it might have been used by Benjamin Franklin.

For to excite them, no coil or anything complicated is necessary; it is sufficient to flick a metal sphere or cylinder with a silk handkerchief, and then discharge it with a well-polished knob. If it is not well-polished the discharge is comparatively gradual, and the vibrations are weak; the more polished are the sides of an air-gap the more sudden is the collapse, and the more vigorous the consequent radiation, especially the radiation of high frequency, the higher harmonics of the disturbance.

For delicate experiments it is sometimes well to repolish the knobs every hour or so. For metrical experiments it is often better to let the knobs get into a less efficient but more permanent state. This is true of all senders or radiators. For the generation of the, so to speak, "infra-red" Hertz waves any knobs will do, but to generate the "ultra-violet" high polish is essential.

Microphonic Detectors.

Receivers or detectors which for the present I temporarily call microphonic are liable to respond best to the more rapid vibrations. Their sensitiveness is to me surprising, though of course it does not approach the sensitiveness of the eye; at the same time, I am by no means sure that the eye differs from them in kind. It is these detectors that I wish specially to bring to your notice.

Prof. Minchin, whose long and patient work in connection with photoelectricity is now becoming known, and who has devised an instrument more sensitive to radiation than even Boys' radio-micrometer, in that it responds to the radiation of a star while the radio-micrometer does not, found some years ago that some of his light excitable cells lost their sensitiveness capriciously on tapping; and later he found that they frequently regained it again while Mr. Gregory's Hertz wave experiments were going on in the same room.

These "impulsion-cells," as he terms them, are troublesome things for ordinary persons to make and work with—at least I have never presumed to try—but in Mr. Minchin's hands they are surprisingly sensitive to electric waves.[1]

The sensitiveness of selenium to light is known to everyone, and Mr. Shelford Bidwell has made experiments on the variations of conductivity exhibited by a mixture of sulphur and carbon.

Nearly four years ago, M. Edouard Branly found that a burnished coat of porphyrised copper spread on glass diminished its resistance enormously, from some millions to some hundreds of ohms, when it was exposed to the neighbourhood, even the distant neighbourhood, of Leyden jar or coil sparks. He likewise found that a tube of metallic filings behaved similarly, but that this recovered its original resistance on shaking. Mr. Croft exhibited this fact recently at the Physical Society. Branly also made pastes and solid rods of filings in Canada balsam and in sulphur, and found them likewise sensitive.[2]

With me the matter arose somewhat differently, as an outcome of the air-gap detector employed with an electroscope by Boltzmann. For I had observed in 1889 that two knobs sufficiently close together, far too close to stand any voltage such as an electroscope can show, could, when a spark passed between them, actually cohere; conducting an ordinary bell-ringing current if a single voltaic cell was in circuit; and, if there was no such cell, exhibiting an electromotive force of their own sufficient to disturb a low resistance galvanometer vigorously, and sometimes requiring a faintly perceptible amount of force to detach them. The experiment was described to the Institution of Electrical Engineers,[3] and Prof. Hughes said he had observed the same thing.

Coherer in open, responding to Feeble Stimuli; Small Sphere, Gas-lighter, Distant Sphere, Electrophorus.

Well this arrangement, which I call a coherer, is the most astonishingly sensitive detector of Hertz waves. It differs from the actual air-gap in that the insulating film is not really insulating; the film breaks down not only much more easily, but also in a less discontinuous and more permanent manner than an air gap. A tube of filings, being a series of bad contacts, clearly works on the same plan; and though a tube of filings is by no means so sensitive, yet it is in many respects easier to work with, and, except for very feeble stimuli, is more metrical. If the filings used are coarse, say turnings or borings, the tube approximates to a single coherer; if they are fine, it has a larger range of sensibility. In every case what these receivers feel are sudden jerks of current; smooth sinuous vibrations are ineffective. They seem to me to respond best to waves a few inches long, but doubtless that is determined chiefly by the dimensions of some conductor with which they happen to be associated.

Filings in open, responding to Sphere, to Electrophorus, to Spark from Gold-leaf Electroscope.

I picture to myself the action as follows. Suppose two fairly clean pieces of metal in light contact—say two pieces of

[1] *Wied. Ann.* 4 , p. [illegible]

[1] *Phil. Mag.* vol. 31, p. 223.

[2] E. Branly, *Comptes Rendus* vol. 111, p. 785; and vol. 112, p. 90.

[3] *Journal Inst. E. E.*, 1890, vol. 19, pp. 352-4; or "Lightning Conductors and Lightning Guards" (Whittaker), pp. 382-4.

iron—connected to a single voltaic cell; a film of what may be called oxide intervenes between the surfaces, so that only an insignificant current is allowed to pass, because a volt or two is insufficient to break down the insulating film except perhaps at one or two atoms. If the film is not permitted to conduct at all, it is not very sensitive; the most sensitive condition is attained when an infinitesimal current passes, strong enough just to show on a moderate galvanometer.

Now let the slightest surging occur, say by reason of a sphere being charged and discharged at a distance of forty yards, the film at once breaks down—perhaps not completely, that is a question of intensity—but permanently. As I imagine, more molecules get within each other's range, incipient cohesion sets in, and the momentary electric quiver acts as it were as a flux. It is a singular variety of electric welding. A stronger stimulus enables more molecules to hold on, the process is surprisingly metrical: and as far as I roughly know at present, the change of resistance is proportional to the energy of the electric radiation from a source of given frequency.

It is to be specially noted that the battery current is not needed to effect the cohesion, only to demonstrate it. The battery can be applied after the spark has occurred, and the resistance will be found changed as much as if the battery had been on all the time.

The incipient cohesion electrically caused can be mechanically destroyed. Sound vibrations, or any other feeble mechanical disturbances, such as scratches or taps, are well adapted to restore the contact to its original high-resistance sensitive condition. The more feeble the electrical disturbance the slighter is the corresponding mechanical stimulus needed for restoration. When working with the radiating sphere at a distance of forty yards out of window, I could not for this reason shout to my assistant, in order to cause him to press the key of the coil and make a spark, but I showed him a duster instead, this being a silent signal which had no disturbing effect on the coherer or tube of filings. I mention forty yards, because that was one of the first outdoor experiments; but I should think that something more like half a mile was nearer the limit of sensitiveness. However, this is a rash statement not at present verified. At forty yards the exciting spark could be distinctly heard, and it was interesting to watch the spot of light begin its long excursion and actually travel a distance of two or three inches before the sound arrived. This experiment proved definitely enough that the efficient cause travelled quicker than sound, and disposed completely of any sceptical doubts as to the sound-waves being perhaps the real cause of the phenomenon.

Invariably, when the receiver is in good condition, sound or other mechanical disturbance acts one way, viz. in the direction of increasing resistance, while electrical radiation or jerks act the other way, decreasing it. While getting the receiver into condition, or when it is getting out of order, vibrations and sometimes electric discharges act irregularly, and an occasional good shaking does the filings good.

I have taken rough measurements of the resistance, by the simple process of restoring the original galvanometer deflection by adding or removing resistance coils. A half-inch tube, eight inches long, of selected iron turnings, had a resistance of 2500 ohms in the sensitive state. A feeble stimulus, caused by a distant electrophorous spark, brought it down 400 ohms. A rather stronger one reduced it by 500 and 600, while a trace of spark given to a point of the circuit itself, ran it down 1400 ohms.

This is only to give an idea of the quantities. I have not yet done any seriously metrical experiments.

From the wall diagram which summarises the various detectors, and which was prepared a month or so ago, I see I have omitted selenium, a substance which in certain states is well known to behave to visible light as these other microphonic detectors behave to Hertz waves.

And I want to suggest that quite possibly the sensitiveness of the eye is of the same kind. As I am not a physiologist I cannot be seriously blamed for making wild and hazardous speculations in that region. I therefore wish to guess that some part of the retina is an electrical organ, say like that of some fishes, maintaining an electromotive force which is prevented from stimulating the nerves solely by an intervening layer of badly conducting material, or of conducting material with gaps in it; but that when light falls upon the retina these gaps become more or less conducting, and the nerves are stimulated.

I do not feel clear which part is taken by the rods and cones, and which part by the pigment cells; I must not try to make the hypothesis too definite at present.

If I had to make a demonstration model of the eye on these lines, I should arrange a little battery to excite a frog's nerve and muscle preparation through a circuit completed all except a layer of filings or a single bad contact. Such an arrangement would respond to Hertz waves. Or if I wanted actual light to act instead of grosser waves, I would use a layer of selenium.

But the bad contact and the Hertz waves are the most instructive, because we do not at present really know what the selenium is doing, any more than what the retina is doing.

And observe that (to my surprise I confess) the rough outline of a theory of vision thus suggested is in accordance with some of the principal views of the physiologist Hering. The sensation of light is due to the electrical stimulus; the sensation of black is due to the mechanical or tapping-back stimulus. Darkness is physiologically not the mere cessation of light. Both are positive sensations, and both stimuli are necessary; for until the filings are tapped back vision is persistent. In the eye model the period of mechanical tremor should be say $\frac{1}{10}$th second, so as to give the right amount of persistence of impression.

Eye Model with Electric Bell on Board.

No doubt in the eye the tapping back is done automatically by the tissues, so that it is always ready for a new impression, until fatigued. And by mounting an electric bell or other vibrator on the same board as a tube of filings, it is possible to arrange so that a feeble electric stimulus shall produce a feeble steady effect, a stronger stimulus a stronger effect, and so on, the tremor asserting its predominance and bringing the spot back whenever the electric stimulus ceases.

An electric bell thus close to the tube is, perhaps, not the best vibrator; clockwork might do better, because the bell contains in itself a jerky current, which produces one effect, and a mechanical vibration, which produces an opposite effect; hence the spot of light can hardly keep still. By lessening the vibration—say by detaching the bell from actual contact with the board, the electric jerks of the intermittent current drive the spot violently up the scale; mechanical tremor brings it down again.

You observe that the eye on this hypothesis is, in electrometer language, heterostatic. The energy of vision is supplied by the organism, the light only pulls a trigger. Whereas the organ of hearing is idiostatic. I might draw further analogies, about the effect of blows or disorder causing irregular conduction and stimulation, of the galvanometer in the one instrument, of the brain cells in the other.

A handy portable exciter of electric waves is one of the ordinary hand electric gas-lighters, containing a small revolving doubler—*i.e.*, an inductive or replenishing machine. A coherer can feel a gas-lighter across a lecture theatre. Minchin often used them for stimulating his impulsion cells. I find that, when held near, they act a little before the spark occurs, plainly because of the little incipient sparks at the brushes or tinfoil contacts inside. A Voss machine acts similarly, giving a small deflection while working up before it sparks.

And notice here that our model eye has a well-defined range of vision. It cannot see waves too long for it.

Holtz Sparks not exciting Tube: except by help of a polished knob.

The powerful disturbance caused by the violent flashes of a Wimshurst or Voss machine it is blind to. If the knobs of the machine are well polished, it will respond to some high harmonics, due to the vibrations in the terminal rods; and these are the vibrations to which it responds when excited by a coil. The coil should have knobs instead of points. Sparks from points or dirty knobs hardly excite the coherer at all. But hold a well-polished sphere or third knob between even the dirty knobs of a Voss machine, and the coherer responds at once to the surgings got up in it.

Electrophorous Lid and insulated Sphere.

Feeble short sparks again are often more powerful exciters than are strong long ones. I suppose because they are more sudden.

This is instructively shown with an electrophorous lid. Spark it to a knuckle, and it does very little. Spark it to a knob, and it works well. But now spark it to an insulated sphere, there is some effect. Discharge the sphere, and take a second spark, without recharging the lid. Do this several times; and at last, when the spark is inaudible, invisible, and otherwise imperceptible, the coherer some yards away responds more violently than ever, and the spot of light rushes from the scale.

If a coherer be attached by a side wire to the gas-pipes, and an electrophorous spark be given to either the gas pipes or the water-pipes, or even to the hot-water system, in another room of the building, the coherer responds.

In fact when thus connected to gas-pipes, one day when I tried it, the spot of light could hardly keep five seconds still. Whether there was a distant thunderstorm, or whether it was only picking up telegraphic jerks, I do not know. The jerk of turning on or off an extra Swan lamp can affect it when sensitive. I hope to try for long-wave radiation from the sun, filtering out the ordinary well-known waves by a black-board or other sufficiently opaque substance.

We can easily see the detector respond to a distant source of radiation now, viz. to a 6-inch sphere placed in the library between coil knobs.

Portable Detector.

Also I exhibit a small complete detector made by my assistant Mr. Davies, which is quite portable and easily set up. The essentials are all in a copper cylinder three inches by two. A bit of wire a few inches long, pegged into it, helps it to collect waves. It is just conceivable that at some distant date, say by dint of inserting gold wires or powder in the retina, we may be enabled to see waves which at present we are blind to.

Observe how simple the production and detection of Hertz waves are now. An electrophorous or a frictional machine serves to excite them: a voltaic cell, a rough galvanometer, and a bad contact, serve to detect them. Indeed they might have been observed at the beginning of the century, before galvanometers were known. A frog's leg or an iodide of starch paper would do almost as well.

A bad contact was at one time regarded as a simple nuisance, because of the singularly uncertain and capricious character of the current transmitted by it. Hughes observed its sensitiveness to sound-waves, and it became the microphone. Now it turns out to be sensitive to electric waves, if it be made of any oxidisable metal (not of carbon), and we have an instrument which might be called a micro-something, but which, as it appears to act by cohesion, I call at present a coherer. Perhaps some of the capriciousness of an anathematised bad contact was sometimes due to the fact that it was responding to stray electric radiation.

The breaking down of cohesion by mechanical tremor is an ancient process, observed on a large scale by engineers in railway axles and girders; indeed, the cutting of small girders by persistent blows of hammer and chisel reminded me the other day of the tapping back of our cohering surfaces after they have been exposed to the welding effect of the electric jerk.

Put Copper Hat over Tube. Shut up everything in Box completely.

If a coherer is shut up in a complete metal enclosure, waves cannot get at it, but if wires are led from it to an outside ordinary galvanometer, it remains nearly as sensitive as it was before (nearly, not quite), for the circuit picks up the waves, and they run along the insulated wires into the closed box. To screen it effectively it is necessary to enclose battery and galvanometer and every bit of wire connection; the only thing that may be left outside is the needle of the galvanometer. Accordingly here we have a compact arrangement of battery and coil and coherer, all shut up in a copper box. The coil is fixed against the side of the box at such height that it can act conveniently on an outside suspended compass needle. The slow action of the coil has no difficulty in getting through copper, as everyone knows; only a perfect conductor could screen off that, but the Hertz waves are effectively kept out by sheet copper.

Chink, Round Hole; Protruding Wire.

It must be said, however, that the box must be exceedingly well closed for the screening to be perfect. The very narrowest chink permits their entrance, and at one time I thought I should have to solder a lid on before they could be kept entirely out. Clamping a copper lid on to a flange in six places was not enough. But by the use of pads of tinfoil, chinks can be avoided, and the inside of the box becomes then electrically dark.

If even an inch of the circuit protrudes, it at once becomes slightly sensitive again; and if a single branch wire protrudes through the box, provided it is insulated where it passes through, the waves will utilise it as a speaking tube, and run blithely in. And this whether the wire be connected to anything inside or not, though it acts more strongly when connected.

Receiver Hat and Metal Tube for Connecting Wires.

If wires are to be taken out of the box to a coherer in some other enclosure, they must be enclosed in a metal tube, and this tube must be well connected with the metal of both enclosures, if nothing is to get in but what is wanted.

Similarly, when definite radiation is desired, it is well to put the radiator in a copper hat, open in only one direction. And in order to guard against reflected and collateral surgings running along the wires which pass outside to the coil and battery, as they are liable to do, I am accustomed to put all these things in a packing case lined with tinfoil, to the outside of which the sending hat is fixed, and to pull the key of the primary exciting circuit by a string from outside.

Sender in Hat and Box, with Lid (adjustable) clamped on.

Even then, with the lid of the hat well clamped on, something gets out, but it is not enough to cause serious disturbance of qualitative results. The sender must evidently be thought of as emitting a momentary blaze of light which escapes through every chink. Or, indeed, since the waves are some inches long, the difficulty of keeping them out of an enclosure may be likened to the difficulty of excluding sound; though the difficulty is not quite so great as that, since a reasonable thickness of metal is really opaque. I fancied once or twice I detected a trace of transparency in such metal sheets as ordinary tinplate, but unnoticed chinks elsewhere may have deceived me. It is a thing easy to make sure of as soon as I have more time.

One thing in this connection is noticeable, and that is how little radiation gets either in or out of a small round hole. A narrow long chink in the receiver box lets in a lot; a round hole the size of a shilling lets in hardly any, unless indeed a bit of insulated wire protrudes through it like a collecting ear-trumpet.

Gas-lighter with Tinfoil.

It may be asked how the waves get out of the metal tube of an electric gas-lighter. But they do not; they get out through the handle, which being of ebonite is transparent. Wrap up the handle tightly in tinfoil, and a gas-lighter is powerless.

Optical Experiments.

And now in conclusion I will show some of the ordinary optical experiments with Hertz waves, using as source either one of two devices: either a 6-inch sphere with sparks to ends of a diameter, an arrangement which emits 9-inch waves, but of so dead-beat a character that it is wise to enclose it in a copper hat to prolong them, and send them out in the desired direction; or else a 2-inch hollow cylinder with spark knobs at ends of an internal diameter. This last emits 3-inch waves of a very fairly persistent character, but with nothing like the intensity of one of the outside radiators.

As receiver there is no need to use anything sensitive, so I employ a glass tube full of coarse iron filings, put at the back of a copper hat with its mouth turned well askew to the source, which is put outside the door at a distance of some yards, so that only a little direct radiation can reach the tube. Sometimes the tube is put lengthways in the hat instead of crossways, which makes it less sensitive, and has also the advantage of doing away with the polarising or rather analysing power of a crossway tube.

Various Apertures in Lid.

The radiation from the sphere is still too strong, but it can be stopped down by a diaphragm plate with holes in it of varying size clamped on the sending hat.

Reflecting Plate, Wet Cloth, Glass Plate.

Having thus reduced the excursion of the spot of light to a foot or so, a metal plate is held as reflector, and at once the spot travels a couple of yards. A wet cloth reflects something, but a thin glass plate, if dry, reflects next to nothing, being, as is well known, too thin to give anything but "the black spot." I have fancied that it reflects something of the 3-inch waves.

Refracting Prism and Lens.

A block of paraffin about a cubic foot in volume is cast into the shape of a prism with angles 75°, 60°, and 45°. Using the large angle, the rays are refracted into the receiving hat, and produce an effect much larger than when the prism is removed.

An ordinary 9-inch glass lens is next placed near the source, and by means of the light of a taper it is focussed between source and receiver. The lens is seen to increase the effect.

Arago Disk, Grating and Zone-plate.

The lens helps us to set correctly an 18-inch circular copper disk in position for showing the bright diffraction spot. Removing the disk, the effect is much the same as when it was present. Add the lens, and the effect is greater. With a diffraction grating of copper strips two inches broad and two inches apart, I have not yet succeeded in getting good results. It is difficult to get sharp nodes and interference effects with these sensitive detectors in a room. I expect to do better when I can try out-of-doors, away from so many reflecting surfaces; indoors it is like trying delicate optical experiments in a small whitewashed chamber well supplied with looking-glasses; nor have I ever succeeded in getting clear concentration with this zone-plate having Newton rings fixed to it in tinfoil. But really there is nothing of much interest now in diffraction effects except the demonstration of the waves and the measure of their length. There was immense interest in Hertz's time, because then the wave character of the radiation had to be proved; but every possible kind of wave must give interference and diffraction effects, and their theory is, so to say, worked out. More interest attaches to polarisation, double refraction, and dispersion experiments.

Polarising and Analysing Grids.

Polarisation experiments are easy enough. Radiation from a sphere is already strongly polarised, and the tube acts as a partial analyser, responding much more vigorously when its length is parallel to the line of sparks than when they are crossed; but a convenient extra polariser is a grid of wires something like what was used by Hertz, only on a much smaller scale; say an 18-inch octagonal frame of copper strip with a harp of parallel copper wires. The spark-line of the radiator being set at 45°, a vertical grid placed over receiver reduces the deflection to about one-half, and a crossed grid over the source reduces it to nearly nothing.

Rotating either grid a little rapidly increases the effect, which becomes a maximum when they are parallel. The interposition of a third grid, with its wires at 45° between two crossed grids, restores some of the obliterated effect.

Radiation reflected from a grid is strongly polarised, in a plane normal of course to that of the radiation which gets through it. They are thus analogous in their effect to Nicols, or to a pile of plates.

The electric vibrations which get through these grids are at right angles to the wires. Vibrations parallel to the wires are reflected or absorbed.

Reflecting Prism.

To demonstrate that the so-called plane of polarisation of the transmitted radiation is at right angle to the electric vibration,[1] *i.e.* that the wires of the grid are parallel to it, I use the same paraffin prism as before, but this time I use its largest face as a reflector, and set it at something near the polarising angle. When the line of wires is parallel to the plane of incidence, in which case the electric vibrations are perpendicular to the plane of incidence, plenty of radiation is reflected by the paraffin face. Turning the grid so that the electric vibrations are in the plane of incidence, we find that the paraffin surface set at the proper angle is able to reflect hardly anything. In other words, the vibrations contemplated by Fresnel are the electric vibrations; those dealt with by McCullagh are the magnetic ones.

Thus are some of the surmises of genius verified and made obvious to the wayfaring man.

[1] *c.f.* Trouton, in NATURE, vol. 39. p. 393; and many other optical experiments by Mr. Trouton, vol. 40, p. 398.

THE REPORT OF THE ASTRONOMER ROYAL.

AT the annual visitation of the Royal Observatory, Greenwich, on Saturday last, the Astronomer Royal presented his report of the progress made from May 11, 1893, to May 10 of this year. We take from it the following information:—

It appears that the average number of transits observed was no less than 31 each day, or if Sundays are excluded, 36. As an instance of the number of observations which were made under very favourable conditions, it may be mentioned that on three consecutive days in February no fewer than 458 transits and 460 zenith distances were observed.

A new universal transit-circle or altazimuth is being constructed by Messrs. Troughton and Simms, and satisfactory progress has been made towards completion. All the heavy portions of the instrument, including the rotating and reversing gear, are made, and have been put together, the object glasses for the instrument and collimators are practically finished, as well as the eye end with its micrometers, and the circles, microscopes, &c., are in hand.

As previously noted in our astronomical column, a valuable gift has been made to the Observatory by Sir Henry Thompson, who has generously offered a sum of £5000 to provide a large photographic telescope with accessories, which would serve as the complement of the 28 inch visual telescope just completed. This munificent offer was readily accepted by the Admiralty, and after careful consideration and discussion, a photographic telescope of 26 inches aperture and 22 feet 6 inches focal length, equatorially mounted, was ordered of Sir H. Grubb on May 5, the instrument to be completed in eighteen months. This telescope will be of exactly double the dimensions (aperture and focal length) of the astrographic equatorial which has proved so successful, and it will be mounted on a very firm stand which will allow of complete circumpolar motion without the necessity for reversal on the meridian, which has been felt as a drawback in the astrographic equatorial. It will be erected on the central tower of the new Physical Observatory, under the 30 feet dome which is shortly to be placed there, and will carry the 12¾-inch Merz refractor as a guiding telescope and the Thompson 9-inch photoheliograph. It will thus be mounted under very favourable conditions for work, and will be in every respect a most effective instrument.

The new 28 inch refractor has been brought into working order after much time spent in the erection of the instrument, in the adjustment of the object glass, and in the provision of various fittings at the eye end. The adjustments were finished by October 1, when, under good atmospheric conditions, the definition was found to be very fine. Since then the object glass has been tested on various objects with very satisfactory results. A sketch of Jupiter and some measures of double stars have been made, and the colour correction of the object glass has been determined on stars by readings for focus at different parts of the spectrum.

The object glass has also been tried in the photographic position, with the crown lens reversed and the lenses separated on the plan proposed by Sir G. G. Stokes. The determination of the best distance between the lenses and the exact adjustment of the crown lens for tilt and centering relatively to the flint has necessarily taken a long time, as small modifications were required in the cells and special contrivances had to be devised for the delicate adjustment of the heavy crown cell and lens. A large number of photographs have been taken at different distances inside and outside of the focus corresponding to different positions of the crown lens, and affording interesting information which will be useful in connection with the Thompson 26-inch photographic telescope.

With the astrographic equatorial, 923 plates, with a total of 2143 exposures, were taken on 183 nights in the year ending May 10. Of these 181 were rejected, owing to photographic defects, mechanical injury, mistakes in setting, the plate being wrongly placed in the carrier, failure in clock driving, and interference by cloud. The following statement shows the progress made with the photographic mapping of the heavens in the year covered by the report:—

	No. of Photos taken.	Successful Plates.
Astrographic chart (exposure 40m.) ...	280	220
Plates for catalogue (exposures 6m., 3 m. and 20s.)	508	387
Number of fields photographed for the chart		200
Number of fields photographed for the catalogue		367
Total number of fields photographed since the commencement of the work for the chart		333
Total number of fields photographed since the commencement of the work for the catalogue		610

To test the optical photographic distortion up to considerable distances from the centre, seven plates with the Pleiades photographed in the four corners have been measured. It appears that the distortion is practically insensible up to 60′ from the centre, and is still small up to 80′, but is not quite the same in the four corners of the plate. On examination, the character of the images in the four corners was also found to vary slightly, the coma being slightly inwards in one corner and outwards in another. The perpendicularity of the plate and object glass to the optic axis were examined and found to be satisfactory.

Solar Observations.

Observations of the sun have shown that the solar activity was fully maintained throughout the whole of 1893, the mean daily spotted area for the year being considerably in excess of that for 1892. The great spot of 1892 February still remains the largest hitherto seen in the present cycle, but in 1893 August a very fine group attained dimensions but little inferior, and the groups of 1893 November and 1894 February were very large. The characteristic of the year was, however, rather the great number of groups visible at the same time than the extent of any one of them. Thus in August and December 1893 as many as 16 or 18 distinct groups of spots were seen on the disk at the same time.

Magnetic Observations.

The variations of magnetic declination, horizontal force and vertical force, and of earth currents were registered photographically, and accompanying eye observations of absolute declination, horizontal force and dip were made as in former years. The period was one of much less magnetic activity than last year, but there was a large increase occurring in 1894 February, at the time of the great sun-spot. Copies of the magnetic and earth current registers during the disturbances of February 20–March 1 and March 30–April 1, have been supplied to Mr. Preece for discussion in connection with disturbances on the telegraph lines.

Meteorological Observations.

Meteorological observations have been made as usual. The reductions show that the mean temperature of the year 1893 was 51°·1, being 1°·6 above the average for the 50 years 1841–1890.

During the twelve months ending 1894 April 30, the highest air temperature in the shade exceeded 80° on 28 days. It was 91°·0 on June 19, 93°·0 on August 16, 94°·2 on August 17, and 95°·1 on August 18. In the 53 years since 1841 higher temperatures have been recorded only twice previously (on both occasions in July). The lowest was 12°·8 on January 5, the maximum on that day being only 19°·0 and the mean daily temperature 15°·9. The mean temperature on August 18 was 79°·6, being the highest mean value recorded in August since 1841. The mean temperature of January 5 was lower than any previously recorded since 1841, with two exceptions. The mean monthly temperature was above the average in all months excepting September, November, and January 1894. In May it was 4°·6, in August 3°·9, in March 2°·7, and in April 3°·8, above the average. In November it was 1°·5 below the average.

The number of hours of bright sunshine recorded during 1893 by the Campbell-Stokes sunshine instrument was 1454, the greatest number on record since the commencement of the registration in 1877. This is 171 hours above the average of the preceding 16 years, after allowance is made for the small difference of indication of the Campbell and Campbell-Stokes instruments. The aggregate number of hours during which the sun was above the horizon was 4454, so that the mean proportion of sunshine for the year was 0·326, constant sunshine being represented by 1.

The rainfall for 1893 was 20·1 inches, being 4·4 inches below the average of the 50 years 1841–1890. From March 1 to September 30 (the period of the great drought) the rainfall amounted to only 7·77 inches, while the average for the 50 years 1841–90 for those months is 14·22 inches.

The mean amount of cloud for the year on the scale 0–10 was 5·75. The average amount as determined by Mr. Ellis (*Quarterly Journal Royal Meteorological Society*, vol. xiv.) from 70 years' observations is 6·75.

The outlook as regards instruments and accommodation for them is stated to be fairly satisfactory; but the fact that four vacancies in a staff of twelve persons have occurred during the fiscal year has necessarily caused serious disorganisation of the work, and greatly handicaps progress.

SCIENCE IN THE MAGAZINES.

THERE are few articles of scientific import in the magazines received by us. By this we do not mean to say that science is unrepresented in magazine literature for June, but that the articles, while affording an excellent pabulum for the omnivorous reader, lack originality of thought. They are, in fact, more descriptive than suggestive. "In the year 1887" (writes Mr. Edison, as an introductory note to an article by Antonia and W. K. L. Dickson in the *Century*) "the idea occurred to me that it was possible to devise an instrument which should do for the eye what the phonograph does for the ear, and that by a combination of the two all motion and sound could be recorded and reproduced simultaneously." The development of this idea, and its practical realisation, are well described by the authors of the article on Edison's kineto-phonograph—this being the comprehensive term given to the invention that is able to record and give back the impressions to the eye as well as to the ear. Muybridge, Marey, Boys, and others have shown what can be done in the way of instantaneous photography, but the plan used by Edison to obtain pictures of movable objects appears to differ from any previously used. After many trials, a highly sensitised strip of celluloid one and a-half inches wide has been adopted for the production of negatives, each strip being perforated on the outer edge. "These perforations occur at close and regular intervals, in order to enable the teeth of a locking-device to hold the film steady in the nine-tenths of the one forty-sixth part of a second, when a shutter opens rapidly and admits a beam of light, causing an image of phase in the movement of the subject. The film is then jerked forward in the remaining one-tenth of the forty-sixth part of a second, and held at rest while the shutter has again made its round, admitting another circle of light, and so on until forty-six impressions are taken a second, or 2760 a minute. This speed yields 165,600 pictures in an hour, an amount amply sufficient for an evening's entertainment, when unreeled before the eye. . . . The advantage of this system over a continuous band, and of a slotted shutter forging widely ahead of the film, would be this, that in one case only the fractional degree of light comprised in the 1720th part of a second is allowed to penetrate to the film, at a complete sacrifice of all detail, whereas in the present system of stopping and starting, each picture gets one-hundredth part of a second's exposure with a lens but slightly stopped down—time amply sufficient, as any photograper knows, for the attainment of excellent detail even in an ordinarily good light." The perforations in the film, referred to in the foregoing, are of assistance in establishing harmonious relations between the kinetoscope and phonograph, in making the action recorded by the one suit the word imprinted upon the other. Several reproductions of series of pictures obtained by the kinetograph accompany the article. In order that the subjects leaving their "passing moods" upon the kinetograph film may be brilliantly illuminated, a new kind of studio has been constructed. The building is pivoted at the centre, and is capable of being rotated so as to present any desired aspect to the sun. Another article in the *Century*, entitled "Field Notes," by Mr. John Burroughs, contains some interesting notes on the habits of a few common animals. This kind of contribution is very common in the magazines. "The Dog," by Mr. N. S. Shaler, and "American Game Fishes," by Mr. L. M. Yale, both in *Scribner*, belong to this anecdotal class.

Cassell's Family Magazine contains an article by Mr. J. Munro on "How I discovered the North Pole." The story is, of course, purely imaginary, but the idea upon which it is based might be developed for preliminary geographical exploration. A number of balloons are supposed to have been set free in high north latitudes, each provided with magazine cameras stocked with plates and having long-distance lenses of various focal lengths. Exposures were automatically made at regular intervals by means of clockwork, so that when the balloons were captured, they contained photographs of the tracks above which they had passed. Each balloon also carried a gyroscope mounted in such a manner that when its axis of rotation became vertical—that is, when the balloon containing it was exactly over the North Pole, cameras were brought into action and photographs taken of the earth below.

"The Spring of the Year," in *Longman's*, is an inspiring article written by Richard Jefferies, and found by Mrs. Jefferies among the MSS. left by him. Mr. A. Morgan retails some second-hand information on "Celestial Photography" in the same magazine. In *Good Words* Sir Robert Ball gives the second of a series of articles on "The Great Astronomers," the subject of his biographical sketch being Kepler. E. M. Caillard founds an excellent article on "Matter," and manages to impart clear and accurate notions on the universal properties of extension, inertia, unity, indestructibility and structure.

We note in *Chambers's Journal* "The Science of Colouring in Animals," "The Sargasso Sea," "Spiders and their Habits," and "The Identification of Habitual Criminals." Mr. A. Binet's "Mechanism of Thought," in the *Fortnightly*, is chiefly concerned with psychology and hypnotism. Honour is done to the late Prof. Robertson Smith by Mr. J. G. Frazer in the same magazine. Prof. Victor Horsley replies in the *Humanitarian* to the paper on vivisection contributed by Bishop Barry to the April number. The seventh of Mr. Phil Robinson's articles on "The Zoo Revisited," in the *English Illustrated*, deals with the animals in the "Small Cats' House." In the same magazine, Mr. W. B. Tegetmeier briefly describes the scope of his forthcoming book on horses, asses, and zebras. The May number of the *Nautical Magazine* contains an article in which Capt. Wilson Barker points to the study of "Natural History" (a term used to cover the ground of physiography) as a recreation for sailors.

In addition to the magazines mentioned in the foregoing, we have received the *Contemporary* and *National* reviews.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Provost of King's, Mr. A. Austen Leigh, has been re-elected Vice-Chancellor for the ensuing year.

St. John's College has carried off both the Smith's prizes this year; the winners are Mr. S. S. Hough and Mr. H. C. Pocklington, third and bracketed fourth Wranglers respectively in 1892, and first class in Part II. of the Mathematical Tripos, 1893.

Candidates for the University Lectureship in Invertebrate Morphology, vacated by Prof. Hickson, are requested to send their names to the Vice-Chancellor by June 9. The stipend is £50 a year.

Prof. Foster has been re-appointed a Manager of the Balfour Studentship Fund for the ensuing five years.

Mr. J. J. Lister, of St. John's, is to occupy the University's table at the Plymouth Biological Laboratory this summer.

The first examination for Diplomas in Agricultural Science will be held on July 2. Candidates are to send their names and fees to the Registrary by June 13.

The next examination for Diplomas in Public Health will begin on October 2. The names of candidates, with their certificates, are to be sent to the Registrary by September 18.

Sir G. G. Stokes, Dr. Sandys, and Prof. Robinson, are to represent the University at the Bi-centenary Festival of the University of Halle, to be held next August.

The following Examiners have been nominated by the Special Board for Medicine:—In Medicine, Dr. W. H. Dickinson, Dr. J. K. Fowler, Dr. L. Humphry, Dr. J. F. Payne; in Midwifery, Dr. W. S. A. Griffith, Dr. J. Phillips; in Surgery, Mr. H. H. Clutton, Mr. F. Treves, Mr. H. Marsh, Mr. W. H. Bennett.

Mr. H. Woods, of St. John's College, has been appointed an Elector to the Harkness Scholarship in Geology and Palæontology.

SCIENTIFIC SERIALS.

American Meteorological Journal, May.—The principal article is "Meteorology and Geodesy," by Prof. C. Abbe. It contains tables showing the variations in the force of gravity over the North American continent and the Atlantic ocean and their effect on the mercurial barometer. The author points out that there is a local attraction of gravitation that is less over the continents than over the oceans, and probably, on the average, less in the northern than in the southern atmosphere; these differences must be allowed for, in combination with the effects due to the density of the atmosphere and to centrifugal force. The principal resistance to the motion of the atmosphere originates in the connective processes that force stagnant air to mix with air in motion; this convective friction is quite independent of viscosity, which has been generally introduced into the formulæ for atmospheric motion, and it is much more effective. The most important subject for the meteorologist to study is these convective mixtures and the resistances or accelerations that result therefrom. The author considers it unnecessary to take up the minute irregularities treated of in this paper, until after the study above referred to has explained the larger part of the irregularities of atmospheric motions. The same journal contains some very useful suggestions by Prof. Abbe, on the various meteorological problems that might be taken up by mathematical students.

Bulletin de la Société des Naturalistes de Moscou, 1893, Nos. 2 and 3.—On the copulation organs of the males of the genera *Crosica*, *Melecta*, *Pseudomelecta*, &c., by General O. Radoczkowsky (in French, with four plates).—Contribution to the pathologic evolution of the nervous system, by Mme. O. V. Leonova, being a description of a complicated case of total anencephaly in a human embryo.—A case of seeming hermaphroditism with *Perca fluviatilis*, by N. Iwanzoff.—The Tithonian deposits of Theodosia, Crimea, by O. Retowski (in German, with six plates). This elaborate monograph contains the description of sixty-five fossil species from those little-known beds—no less than thirty-one species and one genus being new.—Palæontological data for the vertical subdivision of the Sarmathian deposits of South Russia, by A. P. Ivanoff (in Russian, summed up in French). The following five zones are distinguished:—(1) Zone of *Cerithium mitrale*, *mediterraneum*, and *rubiginosum*; (2) *C. disjunctum* and *mitrale*; (3) *C. nodosoplicatum*, *disjunctum*, and *mitrale*; (4) *C. rubiginosum*, *nodosoplicatum*, *disjunctum*, *mitrale*, var. *bicostata*, and *nympha*; (5) *C. mitrale*, var. *bijuga*; and (6) *C. disjunctum*. The beds overlying the above are characterised by the absence of *Cerithes*, and the appearance, for the first time, of *Trochus podolicus*, and a great development of *Mactra ponderosa*. The uppermost layers of the series contain no *Trochus podolicus*, while other species of *Trochus* and *Turbo* appear in great numbers. The birds of Moscow, by Th. Lorenz, continued.—Note on J. D. Chersky, with a complete list of his works, by A. Iwanowski.—On a new species, *Parus transcaspius*, by N. Zaroudnoi (in French).

Memoirs of the Kazan Society of Naturalists, vol. xxvi. Nos. 4, 5, and 6.—On the theory of the root-force in the plant, by Dr. Alexis Horvath. The manometric measurements of the author prove the existence of a rarefaction within the plant, and he therefore considers the vessel of a plant as a tube, in which we should have a succession of drops of a liquid, separated from each other by bulbs of air. The heating of the gas and its expansion acts in the tube as the piston of an aspirating pump.—On the consequences of the decapitation of the plant on some of its organs, by W. Rothert.—On the supply of water to Kazan, by Prof. Stscherbakoff.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 19.—"On Variations observed in the Spectra of Carbon Electrodes, and on the Influence of one Substance on the Spectrum of Another." By W. N. Hartley, F.R.S.

Certain "lines" in Hartley and Adeney's spectrum of carbon are attributed to cyanogen in a recent paper by Eder and Valenta.[1] These lines are not produced by cyanides such as potassium cyanide or mercuric cyanide. Graphite electrodes immersed in solutions show beautiful groups of lines which coincide with the edges of certain bands in spectra of the flame of burning cyanogen. These bands can be recognised in the groups iii. and iv. on the spectra photographed by Kayser and Runge.

The origin of these coincident portions of spectra, namely, from the combustion of cyanogen and from carbon electrodes in saline solutions, taken in conjunction with the fact that they are not rendered by cyanides, makes it doubtful whether the cyanogen spectrum is not due to elementary carbon, as first advocated by Marshall Watts. There are other facts and circumstances which somewhat support this doubt. First, variations have been observed in the spectrum of carbon which cannot be easily accounted for. Secondly, the effect of one substance on

[1] "Line Spectrum of Elementary Carbon and the Ultra-violet Spark Spectrum of Wet and Dry Wood Charcoal" (Vienna: "Akad Wiss. Denkschriften," vol. 60, 1893).

the spectrum of another, which I have recently observed, not only strengthens weak lines, but in certain cases brings a new series of lines into view. Thirdly, the spectra of mixed vapours have been shown to be different from the spectra of the substances by themselves (Liveing and Dewar, "Roy. Soc. Proc.," vol. xxxiv. p. 428); and, fourthly, the influence of the strong lines of an element on adjacent weaker lines of another substance is to strengthen the weaker lines in some cases, but almost to obliterate them in others.

Variations in the spectrum of carbon as observed in different circumstances have been carefully examined and described. In order to test the probability of the carbon and nitrogen spectra being subject to variations when the two elements are together in the spark or flame, it is necessary to consider the effect of one spectrum on another when the two are produced simultaneously from quite different materials.

In the oxyhydrogen flame the water-vapour lines are prominent, but only two groups are visible in the spectrum under normal conditions, and with an exposure of half an hour. If, however, some sulphur be burnt in the flame, the conditions being otherwise unchanged, then the spectrum, in addition to a band of continuous rays and flutings characteristic of sulphur vapour, shows the water-vapour lines wonderfully strong, with groups extending beyond those portions of the spectrum usually photographed, and not only are the lines distinct, but dense, as if their radiating power or the chemical action of their radiations was greatly increased. This does not arise from the continuous spectrum merely overlapping and apparently strengthening the water-vapour lines, since new groups of lines came into view which were too feeble to be visible on the other photographs. Sulphur is not the only substance which affects this spectrum; for instance, the banded spectrum of magnesia and the spectrum of lime also appear to intensify it.

It is probable that something similar takes place with regard to carbon; we know that the spectrum is modified by the surrounding nitrogen of the atmosphere, and the rays of carbon increase the intensity of the nitrogen rays adjacent to the carbon lines, the effect being increased in the case of the spark by a saturated solution of zinc or calcium chloride.

The facts here set forth certainly favour the view that the lines in Hartley and Adeney's spectrum of carbon are the lines of the element and not merely the edges of cyanogen bands. Finally, the carbon spectra of Eder and Valenta differs from that published in the *Journal* of the Chemical Society, vol. xli. p. 91; the graphite spectrum, No. 10, on plate ii., yields neither the group III. nor group IV. of cyanogen as depicted in spectrum No. 4 of the photogravure plate illustrating Eder and Valenta's paper.

"Experimental Determination of Poisson's Ratio." By C. E. Stromeyer.

The experiments with which this paper deals were carried out between the years 1883 and 1886 by Prof. Kennedy and the author, with an instrument which the latter had originally designed for measuring local strains in metal structures, but which proved itself to be so exceedingly sensitive that it was capable of being applied to the measuring of the cross contraction of test pieces while these were subjected to a longitudinal pull, thus providing the means for measuring Poisson's ratio direct.

The conclusions drawn from the experiments with nineteen samples are:—

(1) That Poisson's ratio is not a constant value for all materials.

(2) That mechanical treatment (cold rolling and annealing) of the metal alter it.

(3) That Poisson's ratio is sometimes a function of the stress.

(4) That Poisson's ratio, as found by direct measurement, is not the same as that found by comparing torsion and tension experiments.

May 24.—"Some Voltaic Combinations with Fused Electrolytes and Gaseous Depolariser." By. J. W. Swan.

In this paper are described several voltaic combinations in which fused electrolytes and a gaseous depolariser were used. The electrodes were the same in all the experiments, viz. lead in a fused state as the positive, and carbon as the negative. The electrolyte used in the first experiments was a fused mixture of KCl,NaCl, but this was changed for one of $PbCl_2$. The depolarising gas used in all the experiments was chlorine, and was so applied as to chemically act on the electrolytic product formed at the carbon pole. Several methods of applying the gas were employed: by forcing the gas through porous carbon, by making the carbon pole tubular and feeding the chlorine through it, and by nearly wholly surrounding the carbon pole by an atmosphere of chlorine.

The condition found to be most necessary for successful depolarisation was *to alternately expose the carbon pole to the action of the gas and electrolyte in rapid succession.* During the electrolytic action, the lead dissolves as chloride of lead, and lead is deposited on the carbon pole, but is immediately reconverted to chloride by the action of the chlorine gas. The theoretical E.M.F. corresponding to the union of Pb and Cl_2 is 1·7942 volts, the highest obtained was 1·40 volts, this lower E.M.F. was probably due to the incomplete solution of the lead at the carbon electrode.

A noticeable feature of this kind of cell is the very low internal resistance, which makes it possible to obtain a large current density with comparatively small electrodes. In one of the experiments a current of 1·0 ampère was given with an area of the carbon of 10 to 12 sq. cm. It was also observed that the internal resistance, and at the same time the polarisation, *decrease*, when the electrical output *increases*, and that the cell gave an almost constant effect. The best results were obtained with small cells, the action of the chlorine being then more effective than when larger cells were employed. Experiments were also made with oxygen as a depolariser, but a description of them is left for a future paper.

Physical Society, May 25.—Prof. A. W. Rücker, F.R.S., President, in the chair.—Prof. W. Ramsay, F.R.S., read a paper on the passage of hydrogen through a palladium septum, and the pressure which it produces. After referring to the analogy between osmotic pressure of solutions, and the behaviour of hydrogen and palladium, the author described the apparatus he had used in his experiments, and showed it in operation. A vertical platinum tube provided with a palladium cap is enclosed within a glass vessel through which hydrogen or other gases may be passed, and outside the glass vessel is a vapour jacket, by means of which a constant temperature can be maintained. The lower end of the platinum tube communicates through a graduated capillary tube, with adjustable manometer, which enables the volume of the enclosed gas to be kept constant. Great precautions were taken for ensuring purity and dryness of the gases used. After filling the palladium and platinum tube with dry nitrogen at atmospheric pressure and the desired temperature, hydrogen was passed through the glass vessel. Some of the hydrogen permeated the palladium walls, thus increasing the pressure inside. After some time (usually an hour or so) the pressure attained a steady value, and the total increase was then observed. Experiments were made with air, nitrogen, nitric oxide, nitrous oxide, carbon dioxide, carbon monoxide, and cyanogen in the palladium tube, and in some cases the hydrogen was diluted with nitrogen. In all cases the maximum pressure of the hydrogen within the tube was less than that of the hydrogen outside the tube, as will be seen from the following table, which shows the ratio of these pressures under various conditions:—

Gas originally inside tube.	Gas passed outside tube.	Temp.	Ratio $\frac{\text{Internal hydrogen pressure}}{\text{External hydrogen pressure}}$
Nitrogen	Hydrogen	280 C.	0·9053
,,	,,	335	0·8984
,,	,, 50 % (rest N)	,,	0·9362
,,	,, 25 ,, ,,	,,	0·9344
Carbon Dioxide	Hydrogen	280	0·9621
,, Monoxide	,,	,,	0·9545
Cyanogen	,,	,,	0·9693

After the palladium had been used once or twice it became coated with mercury (vapourised from the manometer), and lost its permeable properties. It was found necessary to heat the tube to remove the mercury, and then dissolve off the oxide of palladium thus produced, after each experiment. The permeable nature of palladium was found to depend greatly on the temperature, for at 232° C. the passage of hydrogen was so slow that the internal pressure was still rising after ten days; at 330 the passage was very rapid. An attempt to use the apparatus for giving a continuous indication of the amount of hydrogen in coal gas failed because the palladium did not retain its activity sufficiently long. Other experiments showed that nickel is impervious to carbon monoxide. In the latter portion of the paper the author discusses the various "so-called" explanations which have been given of the phenomena, but finds none satisfactory. Experiments on the absorption of gases by platinum and other metals are in progress with a view to the further elucidation of the subject. Mr. Mond thought the fact that rise of temperature accelerates diffusion, tended to confirm Graham's view that the gases pass through openings in the solid, for increase of temperature would widen any pores which might exist in the metal. The President inquired whether the author's argument against the possibility of palladium hydride condensing in the pores of the metal, because of its being unstable at the temperatures employed, would be affected by the fact of water being capable of existing in contact with glass at temperatures much above boiling point. In reply Prof. Ramsay said the President's suggestion might be true, but if so another condition must be fulfilled, viz. that the hydrogen molecules must be split up into the atomic or *nascent* state.—A paper on the relations of pressure, volume, and temperature of rarefied gases, by Prof. W. Ramsay, F.R.S., and Mr. E. C. C. Baly, was read by the latter. In the first part of the paper a historical summary of previous researches on the subject is given, and the chief sources of error pointed out. The method employed by the authors was to have two McLeod gauges connected with a pump, and arranged so that both could be trapped under exactly the same pressure. One of the gauges was surrounded by a vapour jacket at about 130 C., whilst the other was cold at about 13° C. After both were trapped, the hot gauge was allowed to cool and the readings of both taken. From these observations the coefficient of expansion of the gas used could be calculated. The experiments also served as tests of the reliability of the McLeod gauge under different conditions. For air and carbon dioxide the gauges proved quite unreliable, whilst for hydrogen they were very satisfactory. With carbon dioxide the surface condensation was so large as to make the observations worthless, but hydrogen suffered no condensation between pressures of 650 mm. and 0·000076 mm. Great difficulty was experienced in filling the gauges with pure hydrogen, but when accomplished the expansion was found to be normal ($\frac{1}{273}$) down to 0·4 mm. pressure, and diminished to $\frac{1}{300}$ at 0·07 mm. Oxygen, however, gave a coefficient of $\frac{1}{261}$ at 5 mm. pressure, $\frac{1}{250}$ at 2·5 mm., and $\frac{1}{233}$ at 1·4 mm. At 0·7 mm. its behaviour was most erratic, there being as much as fifteen times the amount of gas trapped in the gauge at one time as at another. This confirms C. Bohr's observations on the anomalous behaviour of oxygen about this pressure. For nitrogen the values of the coefficients found were $\frac{1}{300}$ at 5 mm., $\frac{1}{304}$ at 1·1 mm., and $\frac{1}{342}$ at 0·6 mm. At small pressures the elasticities of hydrogen, nitrogen, carbon dioxide and air increase with decrease of pressure, but in oxygen the reverse holds. Examining the consequences of this increase of elasticity in the light of the kinetic theory of gases the authors point out that it means an increase of internal energy, and suggest that this may be the the cause of phosphorescence in high vacua. The President announced that the discussion on the last paper would be taken at the next meeting, after proofs had been distributed to members.

Chemical Society, May 3.—Dr. Armstrong, President, in the chair.—The following papers were read.—The structure and chemistry of the cyanogen flame, by A. Smithells and F. Dent. The flame of cyanogen burning in air consists of an inner cone of a peach-blossom tint surrounded by a blue-grey mantle. With a small air-supply the only products of combustion in the intercenal gases are carbon monoxide and nitrogen with small proportions of nitrogen oxides and carbonic anhydride; the quantity of the latter constituent increases as the air-supply increases. On igniting dry cyanogen—the flame being fed with dry air—and separating the two cones in the usual way, the outer cone becomes extinguished; this agrees with Dixon's observation that a mixture of dry carbon monoxide and air is not explosive.—The results of measurements of the freezing points of dilute solutions, by H. C. Jones. The author defends his work from Pickering's recent criticisms, and attacks Pickering's method of plotting the results of freezing point determinations.—The conditions in which carbon exists in steel, by J. O. Arnold and A. A. Read. The authors confirm the existence in steel of a carbide having the composition Fe_3C; it is isolated as a greyish-black powder from normal steel, and as bright silvery plates from well-annealed steel. A highly manganiferous steel contained a double carbide of the composition Fe-Mn C_3.—The "cis" and "trans" modifications of tetramethylenedicarboxylic acid (1 : 2) and pentamethylenedicarboxylic acid (1 : 2), by W. H. Perkin, junr.—Hexamethylenedibromide, $BrCH_2 . CH_2 . CH_2 . CH_2 . CH_2 . CH_2 Br$, by E. Haworth and W. H. Perkin, junr. The authors have prepared chloromethoxypropane, $Cl (CH_2)_3 OMe$; this, when treated with potassium in benzene solution, yields a substance of the composition $MeO (CH_2)_6 OMe$, which is converted into hexamethylenedibromide on heating with hydrobromic acid.—α-Hydrindone and its derivatives, by F. S. Kipping.

Linnean Society, May 24.—Anniversary meeting.—Prof. Stewart, President, in the chair.—The Treasurer presented his annual report duly audited, and the Secretary having announced the elections and deaths during the past twelve months, the usual ballot took place for new members of Council, when the following were elected in the place of those retiring:—Dr. John Anderson, F.R.S., C. B. Clarke, F.R.S., Prof. J. Reynolds Green, Arthur Lister, and Albert D. Michael. On a ballot taking place for the elections of President and officers, Mr. Charles Baron Clarke, F.R.S., was elected President, and the officers were re-elected. The Librarian's report having been read, and certain formal business disposed of, the retiring President delivered his annual address, taking for his subject "The Locomotion of Animals, with special reference to the Crustacea." On the motion of Dr. D. H. Scott, seconded by Mr. Howard Saunders, a unanimous vote of thanks was accorded to the President for his able address, with a request that he would allow it to be printed.—The Society's gold medal was then formally awarded to Prof. Ernst Haeckel, of Jena, and was received on his behalf by Mr. W. Percy Sladen, who read a long and excellent letter of acknowledgment and thanks, which was prefaced by an expression of the writer's regret at his inability to come to England to receive the medal in person.

CAMBRIDGE.

Philosophical Society, May 14.—The Master of Downing College, Vice-President, in the chair.—Mr. S. J. Hickson exhibited a specimen of *Chelifer* from Celebes, showing a remarkable sense-organ on the coxæ of the last legs.—Mr. A. E. Shipley read a note on *Filaria immitis*.—On variations in the larva of *Asterina gibbosa*, by Mr. E. W. MacBride. The larva of *Asterina gibbosa* when fully developed possesses five cœlomic cavities, a median anterior and two pairs of posterior cavities, which suggest a comparison with the similarly arranged spaces in the *Balanoglossus* larva, a suggestion which derives further support from the fact that in both cases the anterior cavity opens to the exterior by a pore situated on the left side, called the madreporic pore, in the *Asterina* larva. Two cases of a similar pore on the right side were recorded, but the variations described chiefly concern the more anteriorly situated of the paired cavities. The left of these forms the water vascular system of the adult. In one instance a pore was observed leading from it directly to the exterior, recalling the collar pore of *Balanoglossus*. The right usually remains rudimentary, but several instances are described of its presenting in greater or less degree the features normally exhibited by its fellow on the left. These variations are to be interpreted, taking into consideration the bilateral symmetry of Echinoderm larvæ, as atavisms.—On a new method of preparing culture media, by Dr. Lorrain Smith. The author described a method for preparing media suitable for the cultivation of bacteria. The principle of the method consists in the addition of a small percentage of alkali to fluids which contain proteid such as egg-white and serum of blood. The fluid is then heated to the boiling-point or over it in the autoclave. By this means it is converted into a clear transparent jelly. It is then a medium suitable for the growth of a large variety of germs.

PARIS.

Academy of Sciences, May 28.—M. Lœwy in the chair.—Observations of Brooks' comet, 1893, 6 (October 16, 1893), and of Wolf's planet (AX, 1894), made with the great equatorial of Bordeaux Observatory, by MM. G. Rayet, L. Picart, and F. Courty. Note by M. G. Rayet.—On solar faculæ, by Prof. George E. Hale. A rejoinder to some remarks by M. Deslandres on a paper published by the author in *Knowledge*.—Observations of the sun made at Lyons Observatory during the first quarter of 1894, by M. J. Guillaume. From the observations quoted, March shows a decided minimum of spot surface more marked than the minimum of November 1893; the maximum for spots was in August 1893, and for faculæ in May of the same year.—On four related solutions of the problem of the transformation relative to the elliptic function of the second order, by M. F. de Salvert.—On the limitation of degree for the algebraical integrals of the differential equation of the first order, by M. Autonne.—On the properties of groups of substitutions of which the order is equal to a given number, by M. E. Maillet.—On the integration of partial equations of the second order with two independent variables, by M. J. Beudon.—On uniform integrals of partial differential equations of the first order and *genre zéro*, by M. Petrovitch.—Variation of the surface tension with the temperature, by M. H. Pellatt. A mathematical paper leading to the conclusion that the surface tension is a linear function of the absolute temperature.—On the capacity of the capillary electrometer, and on the initial capacity of mercury, by M. E. Bouty.—Method for the direct measurement of electromotive forces in absolute value, by M. C. Limb. The method depends on the direct comparison of the unknown electromotive force with an induced electromotive force in a case where the latter may be calculated.—*Résumé* of meteorological observations made at Joal (Senegal) by the mission sent by the Bureau des Longitudes to observe the total eclipse of the sun on April 16, 1893. A note by M. G. Bigourdan.—On the detection of hydrochloric acid, by MM. A. Villiers and M. Fayolle.—A comparative study of the nitrobenzoic acids, by M. Oechsner de Coninck. The reactions of these acids with aqua regia, dilute chromic acid, dilute hydrochloric acid, dilute nitric acid, dilute alcohol, and acetone have been further studied. Just as was found for their physical properties, two of these acids yield similar reactions, and differ from the third.—On the constitution of licareol, by MM. Ph. Barbier and L. Bouveault. The formula adopted now for licareol is the following:—

$$CH_3 . C(CH_3) : CH . CH_2 . CH(CH_2OH) . C(CH_3) : CH_2.$$

Athough licareol has given nearly the same products of oxidation as geraniol, the corresponding aldehydes appear to be different, as they give compounds with para-amidophenol having different melting points. Licareol is active, geraniol is inactive, and may possibly be a racemic form of the alcohol.—On the melting points of some phenols and their benzoates, by MM. A. Béhal and E. Choay. A tabular statement.—On the rectification of alcohol, by M. E. Sorel.—On the latex of the lacquer-tree, by M. G. Bertrand. The mechanism of the production of lacquer from the exudation from trees of the *Rhus* genus is demonstrated. It is shown that the oxidation of the substance *laccol* only produces the characteristic black insoluble lacquer in the presence of a diastase termed by the author *laccase*.—On parthenogenesis in the Sarcoptidæ. A note by M. E. Trouessart.—On the development of excretory organs in *Amphiuma*, by M. Herbert Haviland Field.—Utilisation of vintage *marcs*, by M. A. Muntz. The wine retained by the *marc* is displaced mechanically by water in special cylindrical vessels, and yields a good quality wine practically undiluted. The residual *marc* after treatment is utilised as cattle food.

AMSTERDAM.

Royal Academy of Sciences, April 21.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Schoute made a communication on the regular sections and projections of the hekatonkosædroid (Z^{120}) and the hexakosiœdroid (Z^{600}). The chief results can be gathered from the following table:—

Projections of							Sections of
Z^{120}	v	42	52	56	44	f	Z^{120}
	e	120	130	150	120	e	
	f	80	80	96	78	v	
Z^{600}	v	158	180	160	80		
	e	240	282	250	120	e	Z^{600}
	f	84	104	92	42	v	

The four columns of the above represent at the same time the number of vertices, edges and faces of the projections of Z^{600} and Z^{120}, and the number of faces, edges and vertices of the sections of Z^{120} and Z^{600}.—Prof. Kamerlingh Onnes communicated the results of measurements made by Dr. Zeeman in the Leyden laboratory, of the reflection of polarised light on the pole of a magnetised nickel mirror. The so-called null rotation changes its sign at the incidence of 26°, in accordance with Goldhammer's theory. Drude's theory gives a value of 60°.

BOOKS AND SERIALS RECEIVED.

BOOKS.—The Frog: Prof. A. Milnes Marshall, 5th edition (Manchester, Cornish).—Walks in Belgium—the Old Flemish Towns and the Ardennes: edited by P. Lindley (30 Fleet Street).—A Handbook to the Marsupialia and Monotremata: R. Lydekker (W. H. Allen).—A Handbook to the Birds of Great Britain: Dr. R. B. Sharpe, vol. 1 (W. H. Allen).—Flore de France: A. Acloque (Paris, Baillière).—The Camel, its Uses and Management: Major A. G. Leonard (Longmans).—The Country Month by Month: J. A. Owen and Prof. Boulger, June (Bliss).—Elementi di Fiscia: Prof. A. Roiti, vol. 2 (Firenze, Monnier).—An Introduction to the Study of Metallurgy: Prof. W. C. Roberts-Austen, 3rd edition (Griffin).—Électricité Appliquée a la Marine: P. Minel (Paris, Gauthier-Villars).—Étude Expérimentale Dynamique d'une Machine a Vapeur: V. Dwelshauvers-Dery (Paris, Gauthier-Villars).

SERIALS.—English Illustrated Magazine, June (London).—Zeitschrift für Physikalische Chemie, xiv. Band, 1 Heft (Leipzig, Engelmann).—Brain, Part 65 (Macmillan).—Natural History of Plants: Kerner and Oliver, Part 2 (Blackie).—Natural Science, June (Macmillan).—Longman's Magazine, June (Longmans).—Chambers's Journal, June (Chambers).—Good Words, June (Isbister).—Sunday Magazine, June (Isbister).—Beiträge zur Methodik der Erdkunde, Heft 1 (Halle a S.).—Humanitarian, June (Soonenschein).—Century Magazine, June (Unwin).—Cassell's Magazine, June (Cassell).—Report of the Marlborough College Natural History Society, No. 42 (Marlborough).—Transactions of the Linnean Society of London, 2nd series, Zoology, Vol. vi. Part 2: The Subterranean Crustacea of New Zealand: Dr. C. Chilton (Taylor and Francis).—National Review, June (Allen).—Contemporary Review, June (Isbister).—European Butterflies and Moths: W. F. Kirby, Part 1 (Cassell).—Geographical Journal, June (Stanford).—Bulletin de l'Academie Royale des Sciences de Belgique, No. 4, tome 27 (Bruxelles).—Journal of Botany, June (West).—Fortnightly Review, June (Chapman).—Geological Magazine, June (K. Paul).—Encyklopædie der Naturwissenschaften, Erste Abthg., 68 Liefg.; Zweite Abthg., 77 to 82 Liefg.; Dritte Abthg., 16 to 21 Liefg. (Breslau, Trewendt).—Science Progress, June (Scientific Press, Ltd.).—Michigan State Agricultural College, Experiment Station, Bulletins 107-110 (Michigan).—Bulletin of the New York Mathematical Society, Vol. 3, No. 8 (New York, Macmillan).

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MINING BOOKS.

Economic Geology of the United States, with briefer mention of Foreign Mineral Products. By Ralph S. Tarr, B.S., F.G.S.A., Assistant Professor of Geology at Cornell University. (London: Macmillan and Co., 1894.)

The Ore Deposits of the United States. By James F. Kemp, A.B., E.M., Professor of Geology in the School of Mines, Columbia College. (New York: Scientific Publishing Company, 1893.)

Mining; an Elementary Treatise on the Getting of Minerals. By Arnold Lupton, M.I.C.E., F.G.S., &c. (London: Longmans, 1893.)

The Miner's Handbook. Compiled by John Milne, F.R.S., Professor of Mining in the Imperial University of Japan. (London: Lockwood, 1893.)

THE mining student of to-day has no reason to complain that his interests are being neglected, for text-books relating to his art are being showered upon him. Prof. Tarr states in his preface that there is no recent text-book on economic geology of any value. Surely the well-known library of his University must possess the big treatise of Fuchs and De Launay, published last year. The first part of Prof. Tarr's work, which deals with the mineralogical aspect of the question, might well have been omitted, for the student gains nothing in the end by being taught mineralogy in a loose and vague fashion. Objection must be taken to the word "mineralizer," which is used throughout the book to denote a non-metallic element, such as sulphur or chlorine, combined with a metal. In mining and metallurgy the author perpetrates a series of blunders, for which even junior students would be upbraided by an examiner. In speaking of the extraction of metals, he says there are three methods of treating ores: "Amalgamation, smelting (the dry way), and metallurgy (the wet way)." A treatise upon metallurgy would be strangely imperfect if Prof. Tarr's definition of the term were adopted. On the next page is the remarkable statement: "Before smelting some ores it is necessary to either calcine them—that is, to allow them to decompose in the air at ordinary temperatures—or to roast them." A moment's reflection upon the derivation of the word "calcine" would have prevented the mistake. It is evident that the author has not even turned over the pages of "De re Metallicâ," for otherwise we should not have the curious piece of historical information: "During the reign of Agricola, Portugal produced stream tin." Though sadly marred by careless writing of this description, the book contains much useful information compiled from various sources; but it is singularly deficient in figures.

Prof. Kemp in his introduction gives a valuable *résumé* of various schemes for classifying ore-deposits, a subject upon which there is much difference of opinion, for mining geologists are not yet agreed whether the basis of the classification should be form or origin. The author casts his vote in favour of the latter, and brings forward an elaborate scheme of his own, which will be of service to teachers and to students in reminding them of the very various causes which may have contributed to the production of ore-deposits. But is it not a mistake for a Professor to limit his classification to deposits worked for metals? Surely it is better to make the student take a wider view of the subject, and adopt some scheme which includes all kinds of mineral deposits. In the second part of the work will be found concise and useful descriptions of the modes of occurrence of the various metallic ores, with references to numerous original memoirs. The illustrations are far too few to do justice to the importance of the subject, and many of them are valueless. Reproductions of photographs of mining buildings and mining camps serve no useful purpose in a work of this description. There is a strange lack of geological feeling in the section of the Eureka Mine; judging by the illustration, the surrounding strata are horizontal, whilst Mr. Curtis' original plates show that they are highly inclined. Several of the woodcuts are rendered useless from the absence of any explanatory legend.

Prof. Lupton has brought into comparatively small compass the results of a long experience among mines; but it is not good taste in an author to blow his own trumpet so loudly in his preface. The arrangement of the book is not all that one would desire, for it shows a decided want of method. Like many of his predecessors, the author devotes one of the early chapters to "sinking," with the result of confusing the student, who is introduced suddenly to processes of excavation, supporting, winding, pumping and ventilation, all of which are described at length in other parts of the book. The gases found in mines are dealt with in the chapter upon ventilation; it would have been more logical to have discussed the nature of the polluting agents before describing the means of getting rid of them. Due importance is very rightly given to the dangers arising from coal dust; but why separate this chapter by 200 pages from the part of the book treating of accidents generally? The student will be grateful to the author for the lavish manner in which he inserts woodcuts, though some are far from satisfactory, and a few utterly useless. Reduction by photography may be carried too far, and the figure of the Rio Tinto drill is practically incomprehensible.

In the remarks about coal-cutters the author is not up to date, for he says "electrical coal-cutters have made but small progress," and supposes that no Winstanley machines are in use at the present time.

Mistakes are more frequent than they should be in the case of an author who has travelled much at home and abroad. It might almost be supposed that he had never looked inside a smith's shop at a mine, when one reads that the edge of a drill cannot be sharpened sufficiently by hammering. It will be news to most miners that lead ore is jigged upon a bed of *felspar*, and that gold quartz, after a preliminary crushing, is passed through rolls before going to the stamps. The description of the concentration of gold ores by endless belts is strangely confused. The author is weak in physics, for he seems to consider the density and the specific gravity of a gas to be two different things. The passage of gases through porous diaphragms is spoken of as "Eudiometry," and the repetition of the word in the index proves that it is not a mere slip of the pen.

The same inexactness pervades his mineralogy and geology; he looks upon tungsten ore and wolfram as two different minerals, and he puts down cadmium and phosphorus in his list as if they occurred native. If he had taken the trouble to consult the details of the official statistics, which he quotes, he would have been spared the erroneous statements that all the British tin comes from Cornwall, and that only small quantities of zinc ore are obtained in Great Britain.

When dealing with coal-mining Prof. Lupton is standing upon firmer ground, and he has brought together much general information and many useful details, which will render the book acceptable to students. Considering the amount of matter and the number of illustrations, the treatise is remarkably cheap.

During his long stay in Japan, Prof. Milne seems to have acquired the deftness of a native in packing, for it is difficult to conceive how more information could have been crammed into a book no bigger than a cigar-case, and weighing only six and a half ounces. It is a veritable miniature compendium of mining, which is likely to find a place not only on the shelves, but also in the luggage of most mining engineers.

A NEW STANDARD DICTIONARY.

A Standard Dictionary of the English Language. Vol. i. (New York: Funk and Wagnall's Company, 1893).

IT has been said that "a dictionary of language should contain all the words which may be reasonably looked for in it, so arranged as to be readily and surely found, and so explained as to make their meaning, and if possible their use, clear to those who have a competent knowledge of the language or languages in which the explanations are given." In other words, a dictionary should be an "inventory of language," and this being so, it constitutes an index to the state of knowledge at any epoch. Not so very many years ago it was held that words belonging to sciences and the arts should be omitted from dictionaries. The French Academy at first went so far as to reject all technical terms from their dictionary, though they afterwards decided to admit them, and, when the Philological Society projected their dictionary in 1856, they resolved to accept all English words except "such as are devoted to purely scientific subjects, as treatises on electricity, mathematics, &c." But time has changed all that. No man is now considered well-informed if he is not familiar with common scientific words, and therefore no work in which such a sin of omission is committed deserves the name of a dictionary.

In the dictionary before us, special attention has been paid to science, and words have in all cases been submitted to specialists. As a guarantee of the trustworthy character of the definitions, it is sufficient to mention the names of some of the eminent scientific men upon the editorial staff. Among those responsible for words pertaining to astronomy, physics, and mathematics, are Prof. Simon Newcomb, Prof. Frank H. Bigelow, Dr. A. E. Bostwick, and Prof. A. J. Kimball. Meteorological definitions have been edited by Prof. Mark W. Harrington, and zoological ones have been controlled by Prof. T. N. Gill, Mr. L. O. Howard, and Mr. Ernest Ingersoll. Special biological terms have been referred to Prof. F. Starr and C. S. Dolley. The editors of botanical definitions are Prof. Frank H. Knowlton, with Mr. E. F. Smith (mycology), Mr. David White and Mr. W. T. Swingle (Palæozoic flora), and Mr. A. A. Crozier (pomological terms). Anatomy was under the editorship of Prof. Frank Baker; bacteriology, of Dr. T. M. Prudden; medicine, of Dr. F. P. Foster; chemistry, of Prof. R. O. Doremus and Dr. M. Benjamin. Dr. W. Hallock and Mr. R. Gordon are responsible for the formulæ of colours; Prof. N. S. Shaler and W. R. Dwight for geological words; Dr. G. H. Williams and Dr. W. G. Brown for mineralogy and crystallography; and Mr. G. F. Kunz for gems and precious stones. Dr. G. P. Merrill has been the referee for words relating to building-stones; Mr. R. W. Pope for words used in electricity; Prof. W. H. Pettee for those belonging to metallurgy; Prof. Huxley has had evolution under his care; Dr. P. T. Mason, anthropology, and Mr. E. Muybridge, animal locomotion. These are only a few of the names of men of science who have helped in the production of the dictionary. One has only to read through the complete list to come to the conclusion that the projectors of the dictionary have done everything possible to render the work authoritative and uniformly accurate.

It is for us to point out the special features of the dictionary as regards science. Beginning with chemistry, we find that the rules adopted for the spelling and pronunciation of chemical terms are those recommended in a resolution passed by the Chemical Section of the American Association for the Advancement of Science, at the Rochester meeting, in 1892. The following changes have, therefore, been introduced. In the case of terminations in *ide* the final *e* has been dropped, thus giving chlorid, iodid, hydrid, oxid, hydroxid, sulfid, amid, &c. In names of chemical elements and compounds terminating in *ine* (except doubly unsaturated hydrocarbons) the final *e* is also dropped, and the syllable pronounced *in*, as, for instance, chlorin, bromin, &c.; amin, anilin, morphin, quinin, vanillin, emulsin, caffein, and cocain. The termination *ine* is retained, however, in the case of the hydrocarbons referred to. Preference is given to the use of *f* in the place of *ph* in sulphur and all of its derivatives, as sulfate, sulfite, sulfuric, &c. But though this system of spelling has been accepted by most American chemists, there is little possibility of its being generally adopted in our own chemical literature.

Handicraft terms are given with great completeness and grouped under the different trades. By a new system of grouping applied to the names of fruits, flowers, coins, weights, measures, stars, &c., the facts concerning this class of words are very fully given. Thus, in *constellation* Prof. Newcomb gives the names of all the constellations; under *apple* are found the names of 368 varieties, under *dog* the names and characteristics of all the different kinds of dogs, under *coin* a complete list of coins, under *element* a list of chemical elements, with their atomic weight, specific gravity, melting points, valency, date of discovery, name of discoverer, and condition of occurrence in nature.

The volume under review is full of illustrations, and the fine plates in it are marvellous specimens of colour-printing. Among the full-page coloured plates is one of gems and precious stones, and another of birds. A third plate of special interest is a splendid monochrome in which a number of ancient coins are grouped. When the work is completed it will contain nearly five thousand illustrations, all especially drawn for it. Each picture has been drawn so as to help to define a word, and the object of the plates is to facilitate comparison.

Whether the dictionary will, in course of time, "be accepted as the standard by all who use the English language," may be doubted. Many years will pass before we spell honour without the *u*, and sulphur has evolved into sulfur. But, putting these differences of spelling aside, we have no hesitation in saying that, in point of accuracy, the dictionary will compare favourably with any similar compilation extant, while for comprehensiveness combined with handiness, it is as good a work as could be desired. Everything has been done to facilitate the finding of words and to make the definitions trustworthy when found. It passes the wit of man to suggest anything which ought to have been done that has not been done to make the dictionary a success.

OUR BOOK SHELF.

An Introduction to the Study of Metallurgy. By Prof. W. C. Roberts-Austen, C.B., F.R.S. Third edition. (London: Charles Griffin and Co., 1894.)

THE part metallurgy has played in the industrial progress and material prosperity of our country is so great, that we hail with pleasure the appearance of this enlarged edition of Prof. Roberts-Austen's book, in which all that is important for a sound knowledge of the principles on which metallurgy is based is set forth with remarkable lucidity and ability.

The issue of this edition marks, in fact, an epoch in metallurgical teaching.

Its especial value lies, not in mere descriptions of the processes and appliances of metallurgy, but in the admirable systematic course of study laid down for the student in the fundamental scientific principles on which the appliances used in metallurgy are constructed, its processes based, and the character of their products determined. Without a clear understanding of these principles, it is needless to say, no knowledge of mere practical details, however extensive, can be of any value in enabling the metallurgist to cope successfully with the difficult problems which often confront him both in furnace and laboratory operations.

The elaborate researches of the author in the "thermal treatment of metals" and "thermal measurements" is a sufficient guarantee that these subjects will be treated in a manner worthy of their importance. (Chaps. iv. and v.)

Chapter ix., a special feature of this edition of the book, is a masterly compendium of the facts, principles, theories and laws of thermo-chemistry, and the importance of a correct application of these to the practical work of metallurgy is wisely insisted on. In other text-books and treatises the laws of stoichiometry have been chiefly relied on for the guidance of the metallurgist in interpreting and controlling the reactions which take place under the complex conditions which present themselves in furnace operations, and it has long been felt that the results of many of these operations could only be imperfectly explained or predicted by these laws. In this chapter metallurgists are clearly shown that they "have no longer merely to deal with atoms and molecules, but with the influence of mass," and that if they are to advance their industrial practice "they must think in calorics, and not merely employ the ordinary atomic tools of thought." They will then be able to suggest what reactions can take place under given conditions, to indicate those which will be completed, and to avoid those which are impracticable.

Thus far we have mainly considered those chapters of the book which deal with the fundamental principles of scientific metallurgy, but the whole work is of the greatest interest, and deserves the careful and earnest study of all who are interested in the scientific advances which have been made in metallurgy during recent times. It is, in fact, indispensable not only to students, but to all metallurgists. W. GOWLAND.

Structural Botany (Flowering Plants). By Dukinfield Henry Scott, M.A., Ph.D., F.L.S., F.G.S. With 113 Figures. (London: A. and C. Black, 1894.)

AN introduction to the study of structural botany has long been a desideratum in this country, where we have hitherto been compelled to refer the beginner either to works in foreign languages, or to such help as he may glean from lecture courses. Dr. Scott's little book supplies this need in a most admirable manner, and he has thoroughly earned the gratitude both of teacher and student alike for the freshness and clearness with which he has presented his subject. We notice with satisfaction that, amongst many other good points, there is an intelligible account given of the transition of the structure of the root to that of the stem, a matter concerning which there exists a great deal of needless ignorance and misapprehension in the minds of many students. Another excellent character of the work lies in the large number of new figures which it contains, an example which might with advantage be followed by other writers, for it is really not easy to see why the older illustrations should be regarded with such superstitious (or is it indolent ?) veneration, especially when this practice leads to the exclusion of new figures, as is not unfrequently the case.

We can only hope that Dr. Scott will speedily fulfil the promise hinted at in his preface, and provide, before long, a second volume dealing with the cryptogams.

The Lowell Lectures on the Ascent of Man. By Henry Drummond. (London: Hodder and Stoughton, 1894.)

MR. DRUMMOND is well known as a brilliant and enthusiastic writer, and his latest book will be welcomed by a wide circle of admirers. He approaches the study of nature and evolution with the sympathetic eye of a moral teacher who is possessed by a praiseworthy desire to find wholesome and ennobling lessons therein. In this he is successful. He has, however, a further purpose, that of setting biologists right in matters of biology. In this he is scarcely so successful. "Evolution," he tells us in his preface, "was given to the modern world out of focus, was first seen by it out of focus, and has remained out of focus to the present hour." The focus is adjusted in "The Ascent of Man." We must, however, leave those of our readers who can spare an hour or two for the perusal of the well-printed volume, to see how far Mr. Drummond aids them in acquiring a more definite and accurate conception of evolution. They will, we feel sure, be impressed with his eloquence and earnestness.

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.*]

Tribute to Hertz.

[We have received the following two communications. In accordance with the wish expressed in the first letter, the writer's name is not given.—Ed.]:—

On page 133 of this week's number of NATURE, Prof. Oliver J. Lodge suggests "an act of tribute" to the memory of Hertz, "useful to students in this country," to which I desire to contribute *anonymously*; and I enclose my cheque for £200.

To this distinguished man the world is more indebted than has, as yet, been made known. His broad mind enabled him to conform to what Herbert Spencer has said to be the first condition of success in scientific research, viz. "an honest receptivity, and willingness to abandon all preconceived notions, however cherished, if they be found to contradict the truth."

When invited, in 1889, to witness demonstrations, declared by men of science to "demonstrate the discovery of a force previously unknown to them," he did not excuse himself on the ground of his own occupations, nor yet because he believed the man to be a charlatan. He gave over five hours to the examination of photographs of the discoverer's researching instruments; at the end of which he said that were he to go to America to witness the production of the energy, he could render no assistance; that the man must work out his system alone; and that, in order to work it out, he should not attempt to apply it to mechanics until he had obtained full knowledge of the laws of nature governing its operation.

This advice, within a period of four years, followed faithfully as it was after nearly twenty years of work on engines), has now led to the completion of a system of vibrating physics, with entire mechanical success (it is for the assistance thus rendered that I give my tribute of gratitude); and will, in the not distant future, give to the world "the crowning achievement of an age of scientific progress," opening "the unseen highways of the air" to ships of thousands of tons burden, by the neutralising of gravity.

June 9.

Since writing my letter Prof. Dewar has been here, and some remarks made by him have caused me to think I can better serve the end that I have in view by another appropriation of the £200 which I offered to you for the publication of Hertz's works, although he made no suggestions, nor does he know that I have sent it.

Will you kindly hold the cheque until I gain further information, or return it to me, as you may think best?

June 10.

[The cheque has been returned to the writer.—Ed.]

Bullet-Proof Shields.

I am induced by the sight of the letter from Mr. Frederick J. Smith, in NATURE for June 7, to suggest an idea for armour-plating which occurred to me a few weeks ago, and which seems to me to offer certain advantages over Mr. Smith's proposal.

If a space were filled closely with balls of approximately the same size as the expected missile, would not the resistance be greater than that offered by either a solid plate or by Mr. Smith's cylinders, while there would be a considerable diminution of weight as compared with either?

Each ball, except those at the surface of the receptacle, would be surrounded by twelve balls, to the three of which furthest from the missile the force of the impact would pass, radiating from the ball struck at an angle of 180°. The direction thus deflected would be passed on, again at an angle of 180°, to 3 × 3 balls, each of which would again forward it to its three hindermost balls.

These balls, of which there should perhaps be six layers, should be of the hardest metal available; perhaps of aluminium steel or aluminium bronze. Possibly they should be set in some soft and elastic medium that would prevent their leaking out at the hole made by the missile in the rigid covering; and, if this be not done, then a sheet of india-rubber of sufficient thickness to close after the entry of a bullet should be placed outside the frame holding the balls.

This method seems to me to have 50 per cent. more deflecting power than that of Mr. Smith, as the cylinders would only divide the direction of the missile into two, while the spheres would divide it into three.

Whether the missile would behave like Achilles when he so unwarrantably passed the tortoise, or whether its initial line would be curled round hexagonally in every direction, as it theoretically should be, might, I think, be very simply proved by experiment.

Emma Hubbard.

Kew, June 10.

The Teeth and Civilisation.

In reply to Mr. Arthur Ebbels, I can state some facts about several thousand people in the north isles of Scotland. We find here side by side old people with strong teeth free from decay, though possibly worn down like those of an old horse, and several later generations among whom dental caries is quite general, and including many girls in their teens who are almost edentulous.

No increased wear and tear of the nervous system, nor overstrain of the fifth nerve, nor increased privation can explain this extraordinary contrast. Work is if anything less arduous, clothing and other comforts more.

The habits of the older and younger generations form an equally striking contrast. The former, even as children, were thinly dressed, and did well on three meals daily. Both men and women gathered seaweed for kelp in all weathers, and worked until the tough bere bannock in their pockets became a tempting meal. It was then torn and masticated with incisors and molars doing their proper work. A drink of milk at the nearest farm completed the repast. Oatcake or oatmeal as brose or porridge served for breakfast and dinner, and home-brewed ale was a frequent beverage. Four distinctive facts can be pointed out. (1) They did not eat till they were hungry and at long intervals; (2) plenty of exercise for teeth and jaws; (3) no hot drinks; (4) they could eat without drinking. In all these points the younger generation differs. White bread is preferred, washed down with tea at 150 to 160° F. (tested with thermometer). The eat-and-swill method of eating is universal, the bolus being swept into the œsophagus without even the pretence of mastication. It is considered that not even a child can eat without a hot drink ready to its hand, and children of eighteen months may be seen drinking strong concoctions of theine and tannic acid, and refusing other food. And this usually for every meal. As school children they exist but do not thrive on this diet, but at twenty commences a divergence in the habits of the sexes. The woman, unless engaged in outdoor work, eats and swills more; the hungry ploughboy eats and masticates more, and swills less. As regards the teeth, two results are observed.

Either decay and disintegration takes place, or else the alveoli shorten until the teeth hang loose by their exposed fangs and drop out. This pseudo-senile change may happen before thirty. The incisors hardly ever suffer so much from inertia; biting is essential, but on the other hand the first impact of the semi-boiling tea is borne by them, and they often share the general ruin. Neuralgias of the fifth nerve and stomachic catarrh are exceedingly common. Oatmeal is of course almost banished from the diet of the people.

The only fallacy seems to be this: May not the old people in question be the exceptionally hardy survivors of a race equally prone to dental decay? Others must judge; but the old folk say, "I never heard much of toothache when I was young."

Sanday, May 26. Ed. Jas. Wenyon.

It may be mentioned, in reply to a letter on the "Teeth and Civilisation," that this agent probably affects the health of the human teeth by the injurious nature of the food and diet she introduces in her wake. The worn-down crowns of the molar teeth of the native will correspond with the use of *grain food* and vegetable diet, mostly cold, when the silex in their constituents triturates the teeth down by degrees. But the use of *meat diets* by the civilised peoples will not affect the crown of the teeth, but tend to induce rheumatic or gouty disorders and affections of their periosteum. The most likely medium of *teeth caries*, however, being induced is the use of hot drinks, soups, tea and coffee, which primarily may cause a fissure in the enamel by unequal contraction and expansion of the structures of the teeth. Into this fissure, on it cooling down, will be kneaded by mastication articles of irritating food and drink, which will lead to caries round it. The progress of this may *erode* a segment of the tooth, or at last penetrate into the cavity and the pulp, and lead to inflammation and abscess; and none is a more virulent agent in doing this than hot tea. The simmering kettle may be seen on the hobs of the kitchen fires in the houses of the working classes in Yorkshire and Lancashire, who are much subject to caries of the teeth and dyspepsia, in consequence of the frequent imbibition of its hot contents all day. W. G. BLACK.

Edinburgh, May 17.

The Lowell Observatory, Arizona.

I LEARN—although I have not myself yet seen the note—that NATURE has been unwittingly led into the error of stating that Lowell Observatory, at Flagstaff, Arizona, is a branch of Harvard College Observatory. This impression had its origin in a press dispatch, and I am, with the approval of Mr. Lowell, correcting these wrong impressions when possible.

Mr. Percival Lowell—whose father is trustee of the Lowell Fund from which the cost of the Lowell Institute Lectures is defrayed—is himself an author ("Japanese Art and Customs") and a man of scientific training. He has himself worked out the plan for his observatory work, and will personally supervise and direct the investigations. His institution is one of magnitude, having 18 in. and 12 in. telescopes, and he is justly entitled to the credit. The misunderstanding seems to have arisen from the fact that he has employed two of the Harvard College Observatory assistants for the season, they having been granted leave of absence. I enclose Mr. Lowell's own statement, published yesterday, being his paper before the Boston Scientific Society, and really the first public official statement.

May 26. JOHN RITCHIE, JUN.

[The following description is from the enclosure referred to by Mr. Ritchie. We are glad to render Mr. Lowell the credit due to him.—ED.]

The Lowell Observatory, the construction of which is now almost completed, is situated in the territory of Arizona, near the town of Flagstaff, in longitude 112° west, latitude 35° north, at an elevation of 7300 feet above the sea. Its site is thus the highest of any large observatory in the northern hemisphere, the next in point of elevation being the observatory at Denver, 5400 feet. In latitude it is furthermore the most southerly of those north of the equator. But the chief advantage hoped for from its position is in the way of atmospheric conditions, the singularly dry and clear climate of Arizona commending itself to astronomical purposes.

The observatory buildings stand upon the eastern end of a spur of high land, which rises just to the west of the town and is connected at the back some fifteen miles away with the San Francisco Mountains that reach to a height of 12,500 feet. The buildings are thus protected from the north. To the east and south they overlook the town and the plain beyond, being about 300 feet above Flagstaff and a mile away from it in an air line. The hill and the surrounding country are covered in part by a sparse growth of timber. Trees about an observatory are usually considered an advantage, as such vegetation reduces the radiation from the ground and tends to equalise the daily extremes of temperature, thus giving steadier seeing. The land for the site has very generously been given by the town, and a road to the observatory is being built by the town at its own expense.

The buildings consist of the equatorial building and of the study, placed at a short distance away from it to leeward of the prevailing winds. This disposition of the buildings is in order to minimise the risk from fire, a serious matter in so isolated a situation.

The dome of the equatorial building is constructed on a system of parallel arches, after a design by Prof. W. H. Pickering, who has made a study of domes here and abroad. It is built of a framework upon which rests a cage of wire-netting, and over this is stretched a covering of canvas. One of the chief features of the dome is its lightness. Although it is thirty-four feet in diameter, the whole revolving hemisphere weighs but two tons. Some idea of its lightness and of the ease of moving it in consequence may be got by comparing it with the dome of the large equatorial at Harvard, which, though four feet smaller, weighs fourteen tons, or seven times as much. The whole revolves on the wheels of a live-ring. The dome was built here and, together with the pier, shipped out in pieces to Arizona. The study building will contain a general or reception room, two sleeping rooms, a photographic room and a tool-room.

The telescopic equipment consists of three telescopes of 18 inches, 12 inches and 6 inches aperture, respectively. The 18-inch glass is by Brashear, and is the largest objective Mr. Brashear has yet finished. Its focal length is 26 feet 4 inches. This is an unusually long focus, and length of focus is an advantage in an objective. It and the 12-inch one of Clark's are mounted in twin. The 18-inch will be used for usual and spectroscopic purposes, while the 12-inch will be chiefly employed photographically. The third glass, the 6-inch, is also by Clark, and is a fine objective. It has already done good work at Flagstaff by being the first of those in the northern hemisphere to catch the Gale comet the other day. Incidentally, it is a far travelled telescope, having been safely half round the world and back again before ever it started for Arizona. It is of the same size and quality as the one with which Burnham made himself the first of double-star observers. By the ingenuity of Mr. Clark it is mounted portably in equatorial, being thus rendered the largest of small telescopes, or the smallest of large ones, at pleasure.

The 18-inch has been carefully fitted by Mr. Brashear with various ingenious contrivances by Prof. Pickering for photometric and spectroscopic work. For micrometrical purposes, in addition to the micrometer proper, he has also had prepared plates minutely ruled, dotted and designed and then diminished by photography, to be introduced beside the image in the telescope, for direct comparison with the canals and lakes of Mars and other similar purposes, thus furnishing a second method for micrometrical measurement of such detail.

The Berthollet-Proust Controversy and the Law of Definite Proportions.

IN his able address at the annual meeting of the Chemical Society, the President spoke of chemical text-books somewhat scornfully. While I confess that I am not prepared to regard these books as "soul-destroying," one and all, I have long felt at least that the dogmatic exposition of the elementary laws of chemistry to which they have accustomed us is most unsatisfactory, and that a critical re-statement of first principles is much needed. To deal with the subject fully, would carry me far beyond the limits of a letter to NATURE; but it is proposed in the following communication to draw attention to certain serious misconceptions which have crept into modern text-books with regard to the Berthollet-Proust controversy and the Law of Definite Proportions, and to attempt to re-define somewhat more accurately the points which were at issue.

Berthollet, it is said in the text-books, held that the composition of a compound was not rigidly constant, while Proust showed that "the same chemical compound always consists of the same elements combined in the same proportions by weight," (a statement to be referred to later, as statement A); and this statement is regarded as an enunciation of the Law of Definite Proportions, against the acceptance of which Berthollet strove so hard. As a matter of fact it seems unlikely that Berthollet would have felt in the least inclined to contradict the statement quoted. He did not suppose for a moment that it *was* possible for two substances to exist which should be sufficiently alike in properties for them to be called the same chemical compound, and yet for these to differ sensibly in their quantitative chemical composition; yet this is what a denial of statement A amounts to. On the contrary, Berthollet, like Proust, held the opposite view, namely, that the physical properties of substances are necessarily correlated with their chemical composition, and therefore that two substances differing in their chemical composition have in general different properties and are not called by the same name. We find Berthollet making use of this view, for instance, in the course of an argument given in the "Essai de Statique Chimique," vol. i. p. 346. For he says in effect that if in certain cases we only find compounds of which the constituents are united in ratios, such as $x : y$ or $x : y_1$, among the infinite number of compounds of these constituents capable of existing, it is just because these combination-ratios correspond precisely to some physical property (*e.g.* insolubility) which renders the resulting substance easy of isolation, and takes it (to use the terminology of the time) beyond the reach of the chemical forces which caused its formation.

We see then that statement A in no wise discriminates between the views of Proust and Berthollet, and cannot be regarded as an enunciation of the Law of Definite Proportions. That such misrepresentation should have arisen, shows how hard it is to find in Proust's writings any sufficiently clear account of his views. I think the following may perhaps be accepted as a correct statement of his position:—

"If two substances unite chemically, they will do so either in a single ratio or in a series of ratios which are separated by intervals of finite magnitude." Berthollet thought, on the contrary, that in most cases two substances could combine chemically in an infinite number of ratios varying continuously between certain limits.

As Berthollet himself pointed out, the whole question turns on our definition of the term *chemical union*, and of *compound*, which latter we may regard as a substance formed by the chemical union of its constituents.

The joint efforts—or rather the divided efforts—of Berthollet and Proust made clear what neither chemist was willing to recognise frankly, namely, that there exist two distinct classes of homogeneous chemical substances which might fairly have been called compounds:—

Class I.—The substances belonging to this class are formed by the union of their constituents either in a single ratio or in a series of ratios separated by a definite interval. By the addition of a small quantity of any one of its constituents to a portion of a substance of this class we shall in general obtain a heterogeneous body.

Class II.—The substances belonging to this class are formed by the union of their constituents in an infinite number of ratios which vary continuously between certain limits. By the addition of a small quantity of any one of its constituents to a portion of a substance belonging to this class, we shall in general be able to obtain a new homogeneous substance.

Berthollet, on the one hand, regarded the substances belonging to Class I. as exceptions to the normal rule; Proust, on the other, wished to restrict the name of compound entirely to these. But for such a restriction Proust had certainly no sufficient reason to give. His point, however, as is well known, was carried by the weight of Dalton's discoveries of the Law of Equivalents and the Law of Multiple Proportions, which only applied to Class I. and therefore drew special attention to it, and by the weight of Dalton's atomic hypothesis, which allowed a sharp theoretical distinction to be drawn between the constitution of substances belonging to Class I. and that of substances belonging to Class II.[1]

To enter into a more complete discussion of this distinction as understood by Dalton, and of the modifications of the theory necessitated by our modern ideas on dissociation, would be beyond the scope of the present letter; but it should be pointed out that the controversy at present raging on the theory of solutions is, after a long interval, the continuation and development of the controversy between Berthollet and Proust.

With the facts clearly set before us, we may now inquire into the origin of the error of the text-books, an error which seems to me to be not a merely verbal one, but one due to a misunderstanding of the real points at issue.

I have not found this error in any book before Davy's "Elements of Chemical Philosophy," first published in 1812,[2] and it appeared but in comparatively few text-books until attention had been re-directed to the Law of Definite Proportions by Marignac and Stas in the "sixties."[3] It has since that time been reproduced in most of the books under one form or another. It is often stated, for instance, that Stas showed that "however we prepare ammonium chloride, it always has the same composition." The real problem attacked by that great chemist was this:—"Is what we have called 'chloride of ammonium' a single chloride of ammonium or a series of chlorides of ammonium resembling one another closely, and of which the combination ratios only vary between certain narrow limits?" Or, to state the matter more generally, "Ought the substances which we have supposed to be members of Class I. (*supra*) to be really considered as members of Class II., with the reservation that the limits of the combination-ratios are in these cases close together?"

Stas's own language is, it must be admitted, not perfectly unambiguous on this point.

If Davy's treatise be possibly the historical source of the error, to trace its intellectual origin, or at any rate to offer some plausible explanation of this origin, we must go back further, and consider a time when a nomenclature founded on the exact chemical composition of substances, and the accurate measurement of their properties, was not so much impossible as uncontemplated.

In those days a common name was given to specimens of homogeneous substances, which might (excluding the case of the elements) prove to be either

(1) As in the case of liver of sulphur, a *series* of substances belonging to Class II.; or

(2) As in the case of water, a *single* substance belonging to Class I.; or

(3) As in the case of, say, some *particular* gun-metal, a *single* substance belonging to Class II.

I have chosen the order of these alternatives in this somewhat arbitrary manner in order to bring out more clearly the point where I believe misconception to have arisen. For I think that what the writers have done is to have considered only alternatives (1) and (2), and to have neglected (3).

After the rise of modern chemistry a closer examination of specimens of "liver of sulphur" and of "water" enabled chemists to say:

(B) The specimens labelled "liver of sulphur" do not always contain the same elements united in the same proportion. (C) The specimens labelled "water" do always contain the same elements united in the same proportion.

And these statements were contracted very naturally into the following:—

(D) "Liver of sulphur" does not always contain the same elements united in the same proportion; (E) "water" does always contain the same elements united in the same proportion.

Now the contracted statement (D) has misled the writers into forgetting that "liver of sulphur" is a collective noun, and that the contrast of the two statements is not a contrast between *a* mixture[1] and *a* compound, to which it is of course inapplicable; but a contrast between a *series* of mixtures and a *single* compound.[2]

They then proceed to substitute for "liver of sulphur" the general term, *a mixture*, and for water the general term, *a compound*, and so we obtain statement (F): *A mixture* does not always contain the same elements united in the same proportion; which is absurd; and our old friend (A): A *compound* does always contain the same elements united in the same proportion; which bears a very different meaning to that which its authors intend to convey by it, and which will be further considered immediately.

With statements F and A before them it appeared quite natural to the writers to suggest that "ammonium chloride" prepared in different ways might vary in composition, without their realising that they had returned to the careless days when "liver of sulphur" appeared an eminently satisfactory term.[3]

Perhaps from their error it may be possible to extract some good after all. For would it not be well to state more clearly in our books the postulate to which enunciation A reduces itself when interpreted rationally, viz. "Two portions of matter in other respects alike possess the same quantitative composition."[3] This postulate has been tacitly accepted by chemists, and it is made use of every day in the laboratory.

In conclusion I may be allowed to reply to a criticism which I foresee, namely, that no serious misunderstanding has followed from the errors to which I have drawn attention. That may be so, but accuracy of expression has a value of its own, and my object will have been attained, at any rate partially, if I have succeeded in removing (what should have been) a serious stumbling-block from the path of the student.

PHILIP J. HARTOG.

Owens College, Manchester, June 4.

[1] Kopp in his contribution to the much transformed Lehrbuch of Graham-Otto, and Mendeléef in his treatise, depart very wisely from usual custom in calling both these classes of homogeneous bodies compounds.

[2] See "Davy's Collected Works," vol. iv., p. 479 (1840). This reference I owe to my friend Dr. Harden.

[3] It must be noted that the Law of Multiple Proportions includes the Law of Definite Proportions, and the latter has on that account often been omitted entirely from text-books.

[1] I use the word "mixture" for "homogeneous mixture," or "solution" in the sense of Van't Hoff.

[2] They have neglected alternative (3), which would have reminded them that E applies quite as well to any *single* homogeneous mixture as to any single compound.

[3] The accurate statement of the problem dealt with by Stas has been given previously.

[4] This interpretation may seem to some of my readers to need a fuller explanation, for which I have not space here.

THE OXFORD MEETING OF THE BRITISH ASSOCIATION.

THERE are already signs that the meeting of the British Association, to be held this year at Oxford, will be a success. It is unfortunate, perhaps, that the city of Oxford is this year destitute of municipal buildings, the old buildings having been pulled down, while the new have scarcely their walls raised to the level of the first floor. But this deficiency is amply compensated by the numerous University and College buildings which have been placed at the disposal of the Local Executive Committee. The reception room will be in the entrance hall of the new Examination Schools in High Street, and the rooms for the meetings of Council, of the General Committee, and of Sections E and F will be held in the same building, the large south and east writing schools lending themselves particularly well for the departments of Geography and Economics and Statistics. The meeting rooms of the remaining sections will be distributed among the University Museum and among Colleges which are on the direct road between the Schools and the Museum. Section A (Mathematical and Physical Science) will meet in the Lecture Theatre of the Clarendon Laboratory, and the allied Section G (Mechanical Science) will meet in close contiguity in Keble College Hall. Section B (Chemistry) will meet in the Chemical Theatre, and for larger meetings will have the use of the large Lecture Theatre in the Museum. Section C (Geology) will meet in Hertford College Hall; Section D (Biology) in the Anatomical Theatre. Section H (Anthropology) will be accommodated in Prof. Arthur Thomson's new Hall of Anatomy, and will have the advantage of being in close proximity to the Pitt-Rivers Museum. The new Section I (Physiology) will perhaps be better off than any, as the whole of the new Physiological Laboratories will be at its disposal.

The proceedings will begin on the evening of Wednesday, August 8, when Prof. Burdon Sanderson will resign the presidency, and the new President, the Most Hon. the Marquis of Salisbury, K.G., Chancellor of the University, will deliver the opening address. On the Thursday evening there will be a conversazione in the University Museum. On the Friday evening Mr. W. H. White, C.B., will give an evening lecture in the Sheldonian Theatre, on "Steam Navigation at High Speeds." The Saturday evening lecture to working men will be given by Prof. Sollas. On Monday evening Prof. J. Shields Nicholson will lecture in the Sheldonian Theatre, on "Historical Progress and Ideal Socialism," and the Tuesday evening will be occupied by a conversazione, which will probably be given in the new Examination Schools. Invitations to foreign investigators have been issued by the Local Executive Committee, and nearly eighty have already signified their intention to attend the meeting, amongst them being Prof. Quincke, Prof. Oskar Schlömilch, Prof. Moritz Cantor, Prof. Kohlrausch, Prof. Strasburger, Prince Roland Bonaparte, Prof. Anoutchine, M. Cartailhac, Dr. Mojsisovics von Mojsvar, Prof. Maxime Kovalevskij, Prof. Victor Carus, Prof. E. van Beneden, Prof. Dames, Prof. F. von Sandberger, Prof. F. Schmidt, Prof. Taussig, Prof. Ostwald, Prof. Beilstein, and many other notabilities in every branch of science. Nearly every prominent English man of science has already expressed his intention of being present, and there can be little doubt that the Oxford meeting of 1894 will equal in interest the last Oxford meeting of 1860, which was made celebrated by Prof. Huxley's spirited defence of the then novel doctrine of Darwinism.

The Local Secretaries for the Oxford meeting are Messrs. G. C. Bourne, G. Claridge Druce, and D. H. Nagel, and any communications respecting the meeting should be addressed to them at the University Museum, Oxford.

EXHIBITIONS OF PHYSICAL APPARATUS.

IN the days when *a priori* reasoning reigned supreme, when all observations which were not found in the works of early writers were regarded with suspicion, and all facts had to stand or fall according to their relation to metaphysics, there was no demand for scientific instruments and apparatus. A cause or a principle was then stated like a proposition in mathematics, and the effects which follow upon it were deduced; nowadays the scientific method is to observe the effects, and afterwards formulate a law which embraces them. To carry out this method of experiment and induction, apparatus is needed, and hence the state of physical science at any epoch can be estimated by the character of the instruments at the disposal of investigators. Judged by this criterion, physics and astronomy must have attained a marvellous degree of accuracy. The intricate nature of some physical instruments, and the complicated accessories with which all large astronomical telescopes are now equipped, not only testify to the skill of the instrument-maker, but also represent engines of research whereby new fields are explored. These instruments thus afford tangible evidence of advance, and it is for this reason that their exhibition is to be commended. Such an exhibition of physical instruments was lately held at Paris by the Société Française de Physique, and it is well worthy of imitation on this side of the Channel.

The apparatus of physics falls naturally into two classes—that used for lectures, and that belonging more especially to the laboratory. The apparatus employed in teaching elementary science cannot be too simple and the experiments performed with it should be so clearly shown that the facts they exemplify become evident to the most obtuse student. In many cases this tenet of experimental philosophy is disregarded, the lecturer aiming at producing brilliant effects—stage fireworks, as they have been appropriately called—rather than the illustration of a physical law. In fact, there is a tendency to push lecture-room experimentation too far, to use the lecture-assistant's skill as a make-up for lack of eloquence. The popular mind looks in awe upon the abundance of instruments arranged for this end, but it may be doubted whether, under such circumstances, the points of the discourse are not often obscured.

As to laboratory experiments for students, each should constitute a little investigation in itself. An experiment consists in changing the conditions and arrangements of natural bodies in order to examine their behaviour. The student should, therefore, be given the apparatus required to demonstrate a principle, and should be told what to do with it, but the inference to be drawn from his observations should be left entirely to him. If it is necessary to tell him what the experiment proves, then the object of his work has not been attained. By following this method, and properly grading the experiments, the student not only derives considerable educational benefit in learning to think for himself, but the instinct for research is also stimulated. In many colleges and institutions where the aim is to rush the student through as much experimental work as possible in a short time, the apparatus is all arranged for the student, who merely presses a knob and sees a galvanometer needle wriggle, or something of the kind. There can be no independent thinking in such cases, and, except for examinational purposes, the experiments might just as well be left undone. Most physicists agree with these opinions, and, by arranging an exhibition of apparatus, the Physical Society would help to impress their importance upon teachers. Sets of apparatus suitable for lectures and for practical work in various branches of physics might be arranged for exhibition by a committee, and these, with the instruments of precision, would make an extremely interesting, as well as useful, collection.

The exhibition of physical apparatus at Paris comprised numerous ingenious instruments, but there was no attempt at arranging educational sets. Lord Kelvin's voltmeters and ammeters were shown, and various instruments for measuring electric energy and resistance. A binocular photometer attracted some attention, and also a new kind of ophthalometer and a monochromatoscope. M. V. Chabaud showed a form of electrometer devised by M. Lippmann, several pieces of apparatus made from dielectrine, tolueine thermometers for the measurement of low temperatures, Villard manometers, Varenne's apparatus for fractional distillation, and Bichat's hygrometers. M. J. Carpentier's exhibit included mica condensors, and an instrument invented by General Sebert for determining the rapidity of photographic plates. M. J. Richard showed a meteorograph constructed for the observatory on Mont Blanc, an electric anemometer, Favé sounding-line, and numerous recording voltmeters and ammeters. His exhibit also comprised, among other things, several of Bonetti's electrical machines, Berlemont's mercury pump, and various sterilisers. The photographs of interference fringes obtained by M. Meslin call for special mention, and also a pendulum devised by Captain Colson for measuring short exposures in photography, and a theodolite adapted to photographic work by M. Echassoux. The French Photographic Society exhibited sets of photographic apparatus, and M. G. Raymond some fine cloud photographs. The apparatus used by M. Marey for photographing objects in motion, naturally found a place in the exhibition. Photographs in colours, obtained by the Lippmann method, were seen by projection, and were greatly admired. Many other results of scientific research were shown, together with the instruments by means of which they were obtained, but no useful purpose would be served by enumerating them. It is proposed to hold a similar exhibition next year, and if instrument-makers co-operate with investigators as they did in the one just closed, there can be no doubt as to its value to workers in all branches of physics.

There should be little difficulty in arranging an annual exhibition of a similar kind in London. Scientific instrument-makers would compete with one another in showing work of a high quality; and if the exhibits were organised by a competent committee, the venture would be successful from every point of view. R. A. G.

AUGUST KUNDT.

PHYSICAL science, which within the lapse of six years has witnessed the death of Kirchhoff, Clausius, and Hertz, has suffered another severe loss; on May 21, August Kundt, who was but fifty-four years of age, suddenly died at his country place near Lübeck.

Kundt was born at Schwerin, on November 18, 1839, and began his studies at Leipzig in 1860, under Hankel, Neumann, Bruhns, and others. Thence he went to Berlin, where Encke, Forster, Dove, and Kummer were his principal teachers. He began by giving special attention to astronomy, and indeed intended to devote himself to that branch of science. While yet undecided, however, he entered the private physical laboratory that Gustav Magnus had fitted out in the Prussian capital, and in which students with a decided taste for experimental investigation were allowed to work. From the beginning he displayed extraordinary experimental ability, combined with rare energy in the pursuit of the work he had once taken in hand, qualities which were characteristic of him during his whole scientific career. He also attended the physical "colloquia" which Magnus had introduced, and under the influence of the latter was definitely enrolled in the lists of experimental physicists.

He graduated at Berlin in April 1864, with an investigation on the depolarisation of light. The first and last of the theses appended to his dissertation (dedicated to Magnus) are characteristic of the state of his mind at that time. They run as follows:—

(1) Vires animæ non minus metiri possumus, quam vires physicas. . . .

(4) Theoriam a Cl. Fresnel de torsione planitiei polarisationis promulgatam si adoptamus, omnia ea corpora quæ planitiem polarisationis torquent, sub aptis conditionibus birefractionem demonstratura esse, negare non possumus.

He never himself followed up the psychological lines of research hinted at in the first thesis; the last proposition is known to be entirely borne out by modern research on circular double refraction.

In 1867 he became "Privatdocent" in the University of Berlin, but was appointed to a professorship in the Swiss federal polytechnic school at Zurich, in the following year. There he remained but two years, removing to Würzburg in 1870, where his stay was of no longer duration, the then newly organised University of Strasburg having called him to represent his science on a brilliant staff of young and enterprising men, who within a few years brought their "alma mater" to a high level of excellence. In this work of organisation Kundt was one of the most actively engaged, holding the office of rector in the year 1877, when but 38 years of age. Quite apart from his purely scientific reputation, this alone is sufficient to mark his name with golden letters in the annals of Strasburg University, for which he also erected an imperishable monument, the Physical Institute, well known throughout the scientific world as one of the best laboratories existing.

In 1888, when Prof. von Helmholtz became president of the "Reichsanstalt," Kundt succeeded him as professor of experimental physics, and director of the Berlin Physical Institute. A prolonged period of scientific activity from a man of but fifty years of age with a world-wide reputation might still have been expected; but these hopes have proved vain. A few years ago the symptoms of a disease began to appear, which could not be subdued. Kundt fought for life to the last; and notwithstanding the slow but unceasing strides his ailment made, which would have entirely prostrated most other men, he continued his lectures and other pressing duties during the whole of last winter, thus setting an example of sacrifice to the cause of science even in the face of death. When, at the urgent instance of his medical advisers and friends, he stopped work and left Berlin, it proved of no avail; in fact, he may be said to have died as he had lived, in the midst of scientific work.

As an investigator Kundt was many-sided; his discoveries are so generally known, that it is hardly necessary to describe them in detail. He first turned his attention to acoustics; his start in scientific life being the invention of the well-known "Kundt's sound tubes," or "Kundt's dust figures," which he himself and others turned to account in many different ways. The application of that purely acoustic method led to the determination of the ratio of specific heats of mercury vapour. In collaboration with Warburg (1884), Kundt found this to be 5/3, as predicted by the kinetic theory for a monatomic gas. He also conducted researches on thermal conductivity and inter-diffusion of gases or vapours and on the influence of pressure on the surface tension of liquids; and developed his well-known red and yellow dust-spray method for investigating the pyro-electric and piezo-electric properties of crystals.

But in glancing over his life-work as it now lies before us, it appears as if the palm ought to be assigned to his optical and magneto-optic discoveries. He began with a brilliant series of papers on anomalous dispersion, which placed this important subject on a sound footing. He described the doubly refractive properties of vibrating solids, of metallic films obtained by disintegration of cathodes and of certain liquids in motion, and investigated the optical properties of electrified quartz. With Röntgen he was able to show a slight magneto-optic rotation in several vapours and compressed gases, which even Faraday had not been able to detect, and, on the other hand, its enormous value in iron, cobalt, and nickel. The latter will be known to coming generations as "Kundt's phenomenon." Last, but not least, he succeeded in determining the refractive indices of metals, which he was able to obtain in the shape of extremely thin prisms.

His experimental work, of which the above gives but an incomplete summary, is throughout characterised by the greatest ingenuity in the selection of means to attain definite ends, by the rare quality of ever-watchful self-criticism, which prevented his running away with himself. He possessed that instinctive and immediate power of discriminating the broad way of progress into the unknown from the stray paths leading into tangled wilderness, a faculty which he used to call the pioneering scent of the experimenter.

Space forbids an adequate account of what Kundt personally was to his family, his friends, and his pupils. The latter, a great number of whom are scattered throughout the civilised world, were attached to him by the strongest ties of a scientific and private character, and lost no chance of showing the high esteem they felt for him. They owe a life-long debt of gratitude to the great experimenter, who to most of them was not only a teacher but also a personal friend, ever ready to render help and advice based on his varied experience of scientific life.

H. du Bois.

NOTES.

The annual meeting for the election of Fellows into the Royal Society was held on Thursday last, when the following gentlemen were elected:—Mr. William Bateson, Mr. G. A. Boulenger, Dr. J. R. Bradford, Prof. H. L. Callendar, Prof. W. W. Cheyne, Mr. R. E. Froude, Prof. M. J. M. Hill, Prof. J. V. Jones, Mr. E. H. Love, Mr. Richard Lydekker, Mr. F. C. Penrose, Mr. D. H. Scott, Rev. F. J. Smith, Mr. J. W. Swan, Mr. V. H. Veley.

Prof. Percy Frankland, F.R.S., has been elected to the chair of chemistry and metallurgy in Mason's College, Birmingham, rendered vacant by the resignation of Dr. Tilden.

We regret to announce the death, at the age of sixty-seven, of Prof. W. D. Whitney, well known for his philological researches.

We are requested to state that a British Committee, of which Sir Douglas Galton, K.C.B., F.R.S., is the chairman, and Prof. W. H. Corfield is the treasurer, has been formed to further the interests in this country of the Eighth International Congress of Hygiene and Demography, which is to be held in Budapest, from September 1 to 8 of this year. Any information may be obtained about the Congress from the Hon. Secretary, Dr. Paul F. Moline, 42 Walton Street, Chelsea, S.W.

The University of Halle will celebrate its second centenary on August 2nd, 3rd, and 4th of this year.

Sir Spencer Wells has been elected a Fellow of the Hungarian Academy of Sciences.

M. d'Arsonval has been elected a member of the Section de Médecine et Chirurgie of the Paris Academy of Sciences, in succession to the late Dr. Brown-Sequard.

The death is announced of Dr. E. Sperk, Director of the Imperial Institute of Experimental Medicine, St. Petersburg, and of Prof. Fischer, Chief of the Royal Prussian Geodetic Institute.

Dr. H. Molisch has been appointed Director of the Institute of Vegetable Physiology at Prague, in the place of the late Prof. G. A. Weiss.

M. P. Sinteins has just started on a journey of botanical exploration in Eastern Armenia.

Dr. C. V. Riley has resigned the post of entomologist to the U.S. Department of Agriculture, on account of failing health.

It is reported by the Eastern Extension, Australasia and China Telegraph Company, that a plague has broken out at Hong Kong. No particulars as to the epidemic have been received, but its serious nature may be gathered from the report that fifteen hundred deaths have already occurred, and that this list is increased by nearly one hundred every day. It is said that half the native population, numbering about one hundred thousand, have left the colony, and thousands are following them daily.

A violent hailstorm visited Vienna on Thursday last, shortly before seven o'clock in the morning. The hail was preceded by a heavy fall of rain, and accompanied by slight displays of sheet lightning. In the course of a few minutes the streets were covered with a thickness of several inches of hailstones. It is said that upwards of one hundred thousand windows were smashed by the hail; numerous trees were entirely stripped of their foliage, and most outdoor plants within the area of fall were destroyed. The hailstones were, on the average, about the size of hazel-nuts. During the storm the temperature dropped to 10° Réaumur (54° Fahr.), but shortly afterwards the thermometer rose a few degrees. Similar storms are reported from various districts in Hungary and Croatia.

The New York members of the London Society of Chemical Industry have drawn up a petition requesting permission from the Council to form a local section. This is a step towards the realisation of the scheme suggested by Dr. Armstrong in his recent address to the Chemical Society.

The Iron and Steel Institute has issued its provisional programme for the Brussels meeting, which is to be held August 20 to 24. There will be a reception by the Local Committee on the 20th, reading and discussion of papers on the mornings of 21st and 22nd, a visit to the Antwerp International Exhibition on the afternoon of 21st, a visit to the Mariemont Collieries and Couillet Steel-works at Charleroi on the 23rd, and a visit to the works of the Cockerill Company, at Seraing, and the Angleur Steel-works, at Liége, on the 24th.

In connection with the recent foundation of a Research Fellowship in Chemical Pharmacology by the Court of the Salters' Company, the Research Committee of the Pharmaceutical Society announces that the selection of the Salters' Company's Research Fellow will take place on July 3 next. Written applications for the Fellowship must be received by the Director of the Research Laboratory, 17, Bloomsbury Square, before June 30.

At the meeting of the American Academy, on May 8, the following officers were elected to serve during the coming year: President, Prof. Josiah P. Cooke; Vice-President, Mr. Augustus Lowell; Corresponding Secretary, Prof. Charles L. Jackson; Recording Secretary, Mr. William Watson; Treasurer, Mr. Eliot C. Clarke; Librarian, Mr. Henry W. Haynes; Councillors, Messrs. William R. Livermore, Benjamin O. Peirce, Benjamin A. Gould, Henry P. Walcott, Benjamin L. Robinson, Henry W. Williams, J. R. Thayer, T. W. Higginson, and Andrew M. Davis.

The preliminary programme of the forty-third meeting of the American Association for the Advancement of Science, to be held in Brooklyn, from August 15 to 24, under the presidency of Dr. D. G. Brinton, has been issued. The officers of the various sections are as follows:—Section A (Mathematics and Astronomy): Vice-President, Prof. George C. Comstock; Secretary, Prof. Wooster C. Beman. Section B (Physics): Vice-President, Mr. William A. Rogers; Secretary, Mr. Benj. W. Snow. Section C (Chemistry): Vice-President, Mr. Thomas H. Norton; Secretary, Prof. S. M. Babcock. Section D (Mechanical Science and Engineering): Vice-President, Mr. Mansfield Merriam; Secretary, Mr. John H. Kinelay. Section E (Geology and Geography) Vice-President, Mr. Samuel Calvin; Secretary (vacancy to be filled). Section F (Zoology): Vice-President (vacancy to be filled); Secretary, Prof. William Libbey. Section G (Botany): Vice-President, Mr. Lucien M. Underwood; Secretary, Prof. Charles R. Barnes. Section H (Anthropology): Vice-President, Mr. Franz Boaz; Secretary, Mr. Alex. F. Chamberlain. Section I (Economic Science and Statistics): Vice-President, Mr. Henry Farquhar; Secretary, Mr. Manly Miles. The following subjects of addresses by the Vice-Presidents are announced:—Physics: "Obscure Heat as an Agent in producing Expansion and Contraction in Metals." Anthropology: "Human Faculty as determined by Race." Geology and Geography: "Some Points in Geological History illustrated in North-Eastern Iowa." Economic Science and Statistics: "A Stable Monetary Standard." Mathematics and Astronomy: "Binary Stars." Botany: "The Evolution of the Hepaticæ." Chemistry: "The Battle with Fire." Mechanical Science and Engineering: "Paradoxes in the Resistance of Materials."

The affiliated societies holding meetings during the meeting of the Association are:—The Geological Society of America (President, Prof. T. C. Chamberlain; Secretary, Prof. H. L. Fairchild); Society for Promotion of Agricultural Science (President, Mr. L. O. Howard; Secretary, Mr. William Frear); Association of Economic Entomologists (President, Mr. L. O. Howard; Secretary, Mr. C. P. Gillette); Association of State Weather Service (Secretary, Mr. Robert E. Kerkham); Society for Promoting Engineering Education (President, Prof. De Volson Wood; Secretary, Prof. J. B. Johnson); American Microscopical Society (President, Dr. Lester Curtis; Secretary, Dr. W. H. Seaman); American Chemical Society (President, Prof. H. W. Wiley; Secretary, Prof. Albert C. Hale); American Forestry Association (President, Prof. B. E. Fernow; Secretary, Mr. J. D. W. French); the Botanical Club (President, Prof. William P. Wilson; Secretary, Mr. Thomas H. McBride); the Entomological Club (President, Mr. C. J. S. Bethune; Secretary, Mr. C. L. Marlett). Geological, mineralogical, botanical, zoological, and engineering excursions have been organised, and arrangements are being made by the American Forestry Association to enable members to proceed from Brooklyn at the close of the session to the White Mountains to attend a Forestry Congress. Special invitations have been extended to distinguished European men of science, and it is announced that properly-accredited members of all National Associations for the Advancement of Science attending a meeting of the American Association are entitled to register without fee as members for the coming meeting. There is every prospect that the meeting will be a very successful one. Information relating to membership and papers can be obtained from Mr. F. W. Putnam, Permanent Secretary, Salem, Mass. All matters relating to local arrangements are managed by Prof. George W. Plympton, Local Secretary, 502 Fulton Street, Brooklyn, N.Y.

The revival of exploration by Frenchmen has led to the establishment of a series of lectures on scientific subjects to intending travellers at the Natural History Museum in Paris, of which the most recent, a discourse on comparative anatomy, by M. H. Beauregard, appears in the current number of the *Revue Scientifique*. This lecture was originally undertaken by Prof. Georges Pouchet, whose untimely death deprives the French scientific world of one of their most laborious and successful travelling naturalists. The lecturer attributed the lack of attention to comparative anatomy on the part of most travellers to the fact that in making collections they aimed rather to supply museums with attractive specimens than to provide specialists with the material for study and research.

A plan of Timbuktu, sent by an officer of the French expedition, was presented to a recent meeting of the Paris Geographical Society, and is reproduced in the last number of the *Comptes Rendus* of that Society. The town has about 12,000 inhabitants, but its commercial prosperity has been destroyed by recent Tuareg raids, many of the buildings being in ruins, although from a distance its large pyramidal mosques give it an imposing appearance. The town is surrounded outside the walls by mounds of dried filth and putrefying animal remains. The desert lies all round, but on the west side there is an extensive pond gradually undergoing desiccation, and several small pools whence the water-supply is obtained.

The Ethnological Museum at Berlin has just published the second part of Mr. Hrolf Vaughan Stevens' great study of the people of the Malay Peninsula, under the title "Materialen zur Kenntniss der wilden Stämme auf der Halbinsel Malaka," edited by Albert Grünwedel. This part contains a short account of the Negritoes of the Malay peninsula, and a full discussion of the mythology and religion of the Orang Panggang, illustrated by numerous drawings of ceremonial accessories, and particularly the curiously inscribed bamboo-rods called *penitah*, which are buried with the dead to serve as passports in the other world. A long glossary of the Orang-hutan dialects is given in conclusion, being compiled from the records of all travellers who have studied the Malay languages. The value of this glossary is enhanced by the actual renderings of the various authorities being preserved in the different European languages in which they wrote.

The Weather Bureau of the United States has published its first volume of results of meteorological observations for the years 1891 and 1892, continuing the series formerly published by the Signal Service, together with other climatological tables and special reports of general interest. The work contains 528 large quarto pages, with illustrations and plates, and includes hourly means for 28 stations, with comprehensive and plainly printed monthly and annual summaries at about 170 stations. Prof. C. F. Marvin gives a very full description of the various instruments in use, and Prof. C. Abbe contributes a paper on instrumental corrections and methods of reduction. Both these reports supply much valuable information which will be found very useful to the general public. The work will be widely distributed, as we see that no less than 9000 copies have been printed.

We believe it is generally known that the Central Observatory of Moncalieri has for many years published a *Bollettino Mensuale*, which is the recognised organ of the Italian Meteorological Society. The bulletin contains the monthly results of a large number of meteorological stations in the Alps, the Appennines, and other parts of Italy, summaries of the proceedings of the Italian and other meteorological societies, and bibliographical notices. In addition to the above, there are articles by members of the Italian Meteorological Society and others on various subjects of scientific interest. The number for May contains a note by Prof. G. Buti on Dr. von Bezold's thermodynamics of the atmosphere, and attention is drawn to two phenomena which up to the present time have been but little studied, viz. the supersaturation and the over-cooling of the air in relation to the formation of thunderstorms and variations of barometric pressure; also a note, by Prof. L. Descroix, on the diurnal oscillations of the barometer at Paris, based on twenty years' observations. Prof. Descroix is of opinion that the differences in the variations of the maxima and minima from day to night, in passing from the warm to the cold season, are explained by the changes of conditions of dryness in the lower strata of the atmosphere, in so far as it is due to their expansion and contraction.

THOUGH the destruction of books by insects is not so great here as in India, it is sufficient to give general interest in the result of an inquiry into the means of preservation adopted in Indian museums (*Indian Museum Notes*, vol. iii. No. 3). In the library of the Revenue and Agricultural Department of the Government of India the books are disinfected by pouring a few teaspoonfuls of refined mineral naphtha, or what is known as benzine collas, into the crevices of the binding, and then shutting up the volume for a few days in a close-fitting box to prevent the escape of the fumes. Books so treated have to be afterwards sponged over lightly with a very little of the finest kerosine oil, which should be rubbed off with a cloth before it has time to penetrate into the binding. Dr. George King reports very favourably upon a system adopted for preserving books in the Royal Botanical Gardens, Sibpore. It consists in brushing the books over with a saturated solution of corrosive sublimate made by constantly keeping a few lumps of the poison at the bottom of a jar of alcohol, so that the maximum amount may be absorbed. In the Indian Museum Library the books are kept in close-fitting glass cases with a few ounces of naphthaline upon each shelf, with the result that little or no damage is caused by insects. It appears that the paste used in binding the Indian Museum books is poisoned by adding about half an ounce of sulphate of copper to each pound of paste, while books already infested are disinfected by shutting them up for four or five days in a close-fitting box of loose naphthaline with as much of this substance as possible between the leaves.

ANOTHER new method for determining the pitches of high tuning-forks is described by Herr F. Melde in the current number of *Wiedemann's Annalen*. It is, like the vibroscopic method previously described, independent of the ear, and is based upon the resonance of a rod clamped at one end and vibrating transversely. The laws of vibration of such clamped rods have already been so carefully studied that calculations of pitch, based upon their dimensions and the properties of the material of which they are made, are very reliable. The rods used consisted of hard brass, cast steel, or iron. They were 32 cm. long, 1 cm. broad, and 1·5 or 2 mm. thick. They were firmly clamped in an iron clamp let into a piece of sandstone, care being taken that the jaws of the clamp were strictly in the same plane at right angles to the length of the rod. The tuning-fork tested was mounted in a wooden block, and placed with one prong lightly touching the end of the rod, so that a vibration of the tuning-fork when bowed produced a transverse vibration of the rod. Fine sand was dusted on to the rod. If on bowing the tuning-fork the sand did not arrange itself in straight lines at right angles to the length of the rod, the clamp was shifted until it did. The mode of vibration, and consequently the pitch, was then calculated from the number of such nodal lines produced. An interesting application of the method was the testing of Appunn's tuning-fork apparatus for the determination of the upper limit of audibility. One fork marked 16,384, as determined by the method of beats, gave really only 11,717 vibrations per second. On the other hand, a standard fork by Dr. König, of Paris, of pitch 16,383, was found to give 16,480 by the new method—a good testimony to the accuracy of both determinations. In each case, the results were confirmed by the vibroscopic method.

THE current number of *L'Elettricista* (Rome) contains an interesting description, by Signor Riccardo Arnò, of a new experiment he has performed. As is well known, Prof. Crookes has shown that when an electric discharge is passed through an exhausted tube, and a small windmill is suitably placed in the path of the discharge, a continuous rotation is obtained. This phenomenon suggested to the author to try if he could obtain a similar rotation by placing an exhausted bulb containing a small windmill in a rotating electrostatic field. The rotating electrostatic field was obtained by connecting four upright brass plates to fixed points in the secondary of a large Ruhmkorff coil, through the primary of which an alternating current was passed. In order to try the experiment it was impossible to use an ordinary radiometer with mica vanes, since the author in a previous series of experiments had shown that when a dialectric is placed in a rotating electrostatic field it experiences a force tending to rotate it, in the same sense as the direction of rotation of the field. Hence the author had a special radiometer constructed with thin brass vanes, since it was only by using a windmill made entirely of a metal that he could be sure he had entirely eliminated the direct action of the rotating field on the vanes, and be sure the effect observed was due to the gas remaining in the tube. When the electrostatic field was sufficiently strong, and the surface of the glass vessel containing the vanes well dried, a rotation was obtained in the same direction as that of the field. In order to show that the rotation is not due to direct action on the vanes, the author suspended a similar set of brass vanes, by means of a long silk fibre, in air at the ordinary pressure in the same rotating field, and found that no rotation was produced. When the radiometer is under the influence of the rotating electrostatic field the bulb is uniformly lighted up, so that the number of turns of the vanes could be counted in the dark. The author considers the effect must be due to some action of the rotating field on the molecules of the gas, which tends to increase their velocity in the direction of rotation of the field, and thus in the case when the gas is much rarefied, so that the free path of the molecules is relatively long, the impact of the molecules on the metallic vanes cause the latter to rotate in the same sense as the field.

THE current number of the *Annali dell Istituto d'Igiene di Roma* contains a paper by Dr. Palermo, on the action of sunshine on the virulence of the cholera bacillus suspended in broth and water respectively. The pathogenic property of all the infected solutions was in each case determined by inoculation into guinea-pigs, so that the difference in the toxic character of the contents of the insolated and darkened tubes could be compared with that possessed by the cholera-infected broth or water solutions treated in the ordinary manner. In order to ascertain what was the effect of sunshine on the *number* of cholera bacilli present, agar dish cultures were made of the insolated and darkened tubes respectively; in no single instance, however, could any numerical difference be detected in either set of experiments. That the sunshine had modified the biological character of the bacilli, was shown very strikingly in drop-cultures, for when examined from insolated broth tubes they were found to have been deprived of all power of motility, whilst the characteristic activity was still apparent in such cultures prepared from the darkened tubes. As regards the degree of virulence possessed by the broth cultures, those exposed to sunshine for *less* than three hours invariably killed the animals, whilst when insolation was prolonged for three and a half, four, and four and a half hours respectively, not a single guinea-pig succumbed. The interesting discovery was, moreover, made that those animals which had survived inoculation with the insolated cholera cultures were protected from cholera, for when eight days later they were inoculated with virulent cholera cultures they did not succumb to this disease. The pathogenic properties of the cholera bacillus were removed more quickly by insolation when immersed in water than in broth. It will be remembered that Arloing stated, as far back as 1885, that he had succeeded in reducing virulent anthrax cultures to the condition of vaccine by insolation; but so far as we are aware, Dr Palermo is the only other investigator who has been able to render animals immune to a disease by the inoculation of insolated pathogenic cultures.

A PAMPHLET on "Dry Methods of Sanitation," by Mr. G. V. Poore, the author of "Essays on Rural Hygiene," has been published by Mr. Edward Stanford.

IN connection with an exhibition of beautiful and curious British and foreign species of butterflies and moths, at his Piccadilly establishment, Mr. William Watkins has issued a descriptive guide to the specimens on view.

THE address on "The Rise of the Mammalia in North America," delivered by Prof. H. F. Osborn at the last meeting of the American Association for the Advancement of Science, and partly reprinted in these columns (vol. xlix. pp. 235, 257, 1893), has been published separately, and can be obtained from Messrs. W. Wesley and Son.

A PRELIMINARY list of the vertebrate animals of Kentucky is contributed by Mr. H. Garman to the *Bulletin* of the Essex Institute, Massachusetts (vol. xxvi. Nos. 1–3). The list is based upon collections and observations made in various parts of Kentucky from points near the eastern limits of the State to Hickman on the Mississippi River.

A VOLUME by Prof. Dwelshauvers-Dery, entitled "Étude Expérimentale Dynamique d'une Machine a Vapeur," has lately been added to the Aide-Mémoire series published at Paris by Gauthier-Villars and by Masson. Two other volumes recently received are "Électricité Appliquée a la Marine," by M. P. Minel, and "La Rectification de L'Alcool," by M. Ernest Sorel.

THE Agent-General for New South Wales has sent us the report of the Department of Public Works for the year 1892. A considerable amount of work was carried out during the year in connection with harbours and rivers and water supply, water conservation and irrigation, roads and bridges and sewerage. The report contains twenty-seven plates illustrating the state of the work in hand and the machinery employed.

THE difficult genera *Rosa* and *Rubus* are the subject of careful study by French botanists. A Rhodological Society has been founded for the purpose of publishing a herbarium of the Roses of France, named by the Belgian rhodologist M. Crépin. Those intending to subscribe are invited to correspond with Dr. Pons, Ille-sur-Tet, Pyrénées Orientales. A publication is also announced with the title *Rubi praesertim Gallici exsiccati*, under the editorship of Prof. Bourlay, Rue de Toul, Lille, and M. Bouly de Lesdain, 16, Rue Emmery, Dunkerque. We note also the publication of the first fascicle of Messrs. E. F. and W. R. Linton's "Set of British Willows."

FOUR new volumes of the series of reprints published by Engelmann, of Leipzig, viz. Ostwald's "Klassiker der Exakten Wissenschaften," have just appeared. Nos. 46 and 47 deal with the calculus of variation, and contain papers by Joh Bernoulli (1696), Jac Bernoulli (1697), Euler (1744), Lagrange (1762, 1770), Legendre (1786), and Jacobi (1837). Electricians will be interested in No. 52, which contains Galvani's observations on the action of electricity on the muscles of frogs. The twenty-one quaint figures in the text give this volume additional value. Gauss' researches on the intensity of terrestrial magnetism, communicated to the Gottingen Gesellschaft der Wissenschaften in 1832, are reprinted in No. 53 of this very useful series.

AMONG numerous papers recently distributed by the Smithsonian Institution are Prof. S. P. Langley's memoir on "The Internal Work of the Wind" (see NATURE, vol. xlix. p. 273, 1893), and several contributions by Prof. H. F. Osborn to the *Bulletin* of the American Museum of Natural History. One of these is concerned with the fossil mammals of the Upper Cretaceous beds of America, and the conclusions arrived at from a discussion of the upper and lower dentition are the reverse of those expressed by Prof. Marsh on the same fauna. Other recently-issued excerpts from the *Bulletin* referred to are "Artionyx, a new Genus of Ancylopoda," by Prof. Osborn and Dr. J. L. Wortman; "On the Divisions of the White River or Lower Miocene of Dakota," by Dr. Wortman; and "Ancestors of the Tapir from the Lower Miocene of Dakota," by Dr. Wortman and Mr. C. Earle.

MM. J. B. BAILLIÈRE ET FILS, Paris, have published a "Flore de France," by M. A. Acloque, containing the description of all the indigenous species, and illustrated by 2165 small figures representing the characteristic types of genera and sub-genera. The book has been designed to assist in the identification of plants. It appeals, therefore, to those who, when they see a plant, want to know its place in the flora of France. By means of it, local botanists will be able to determine easily the species of plants in their districts, and thus a large amount of useful material with regard to geographical distribution may be got together. Another flora lately published is that of "Nordwestdeutchen Tiefebene" (Engelmann, Leipzig), by Prof. F. Buchenau. This, however, is not so much a work to assist amateur botanists as a work of reference in which all the plants in the region covered are systematically arranged and described.

THREE iodo-sulphides of phosphorus have been prepared by M. Ouvrard, and are described in the June issue of the *Annales de Chimie et de Physique*. The iodide of phosphorus P_2I_4 is not attacked by sulphuretted hydrogen at the ordinary temperature, but at a temperature slightly higher than the melting point of the iodide, about 115°, hydriodic acid is slowly produced, and after a couple of days' heating at this temperature the reaction is usually complete. The product is readily soluble in carbon bisulphide, and the solution deposits crystals of an iodo-sulphide of the composition $P_4S_3I_2$. The reaction proceeds in accordance with the equation, $2P_2I_4 + 3H_2S = P_4S_3I_2 + 6HI$. This new substance forms very well-developed yellow crystals of high refractive power. They are permanent in dry air, but slowly attacked by moisture with elimination of sulphuretted hydrogen. They melt about 106° to a viscous liquid, and about 300° they inflame with evolution of iodine vapour and white fumes of phosphoric anhydride. Cold water only slowly attacks them, but they are rapidly decomposed by hot water. Fuming nitric acid at once induces an explosion accompanied by incandescence. The compound may more easily be prepared by dissolving the constituents in the correct proportions in carbon bisulphide, evaporating and heating to 120° in a current of inert gas, and again dissolving in carbon bisulphide; the solution deposits crystals of the new substance upon evaporation. It may also be at once obtained by dissolving iodine in a solution of sesquisulphide of phosphorus in carbon bisulphide and evaporating. The second iodo-sulphide of phosphorus has the composition PSI or $P_2S_2I_2$, and was obtained by the action of sulphuretted hydrogen upon the tri-iodide of phosphorus, PI_3. A lower temperature than that required for the formation of the compound just described is advisable at first; it should not be much higher than 55°, the melting point of the tri-iodide; before the conclusion of the reaction, however, it may safely be raised to 120°. The solution of the product in carbon bisulphide deposits red crystals of the new compound PSI. These crystals are much more rapidly attacked by moist air than those of the first iodo-sulphide, and the reaction is accompanied by the liberation of fumes of hydriodic acid. They take fire upon warming in the air, disseminating the odour of sulphur dioxide and the violet vapour of iodine. Water dissolves them rapidly, producing trisulphide of phosphorus and hydriodic and phosphorous acids, and sulphuretted hydrogen is subsequently evolved owing to the decomposition of the trisulsphide. The third iodo-sulphide was obtained by reacting with excess of tri-iodide of phosphorus upon the trisulphide. It is deposited from carbon bisulphide in deep red crystals, very rapidly decomposed by moist air, and its composition is P_2SI_4. It thus appears that iodine is capable of replacing more or less of the sulphur contained in the sulphides of phosphorus, although it does not succeed in totally eliminating sulphur from its combination with phosphorus. M. Ouvrard has also obtained several new halogen derivatives of the sulphides of arsenic and antimony. English readers of the original paper cannot but be sorry, however, that M. Ouvrard employs the old notation, which renders it difficult at first sight to follow the equations representing the reactions. The formulæ above given are translated into the modern notation now universally employed in this country and Germany.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, a White-throated Capuchin (*Cebus hypoleucus*) from Central America, presented by Mr. F. Erskine Paton; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Miss Florence Marryat; two Common Peafowl (*Pavo cristatus*, ♂ ♀) from India, presented by Mr. A. Tannenbaum; a Puff Adder (*Vipera arietans*) from South Africa, presented by Mr. J. E. Matcham; four Common Snakes (*Tropidonotus natrix*), a Common Viper (*Vipera berus*), British, presented by Mr. Harold Attewell; a Smooth Snake (*Coronella lævis*) British, presented by Mr. Harry Furniss; a Natterjack Toad (*Bufo calamita*), British, presented by Mr. F. Wallace; a Raven (*Corvus corax*), British, presented by Mr. Robert O. Callaghan; two Cape Crowned Cranes (*Balearica chrysopelargus*) from South Africa, four Yellow-bellied Liothrix (*Liothrix luteus*), two Hamadryads (*Ophiophagus elaps*) from India, deposited; an Ashy-black Macaque (*Macacus ocreatus*, ♂) from the East Indies, a Beech Marten (*Mustela foina*) from Russia, a Red and Yellow Macaw (*Ara chloroptera*) from South America, a Yellow-headed Vulture (*Cathartes urubitinga*) from Brazil, a Turkey Vulture (*Cathartes aura*) from America, a Guianan Crested Eagle (*Morphnus guianensis*) from the Amazons, purchased; an English Wild Cow (*Bos taurus*, var.), three Varied Rats (*Isomys variegatus*), a Bennetts Wallaby (*Halmaturus bennetti*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

REPORT OF THE ASTRONOMER-ROYAL FOR SCOTLAND.—The fourth annual report of Prof. Copeland on the Royal Observatory, Edinburgh, informs us that great progress has been made in the construction of the new Observatory. The masonry of all the buildings is complete, and some parts are ready for the internal fittings.

A comparison of the earlier Edinburgh star places with the catalogue of the *Astronomische Gesellschaft* has shown the necessity of a complete new reduction of the observations, in order to bring them into line with modern practice in this kind of work. For this purpose considerable progress has been made in an investigation of the errors of the transit instrument.

At the request of M. d'Abbadie, of the Paris Academy of Sciences, a bifilar pendulum was temporarily erected on the rock at Calton Hill on March 24. This extremely sensitive instrument, constructed by Mr. Horace Darwin on a principle suggested by Lord Kelvin, indicates the minutest change of level in the foundation to which it is attached. Prof. Copeland hopes shortly to commence a series of systematic observations in conjunction with allied observations made by M. d'Abbadie nearly on the same meridian in the south of France. These investigations will probably show if any considerable tilt takes place at the same time at both stations. It is thought that the bifilar pendulum may serve to detect the occurrence of sudden displacements in the foundations of observatories.

AWARD OF THE WATSON MEDAL.—At Washington a few weeks ago Mr. S. C. Chandler was awarded the Watson medal by the National Academy of Sciences. A description of the founding of the award and the work of previous recipients, given by Mr. John Ritchie, jun., in the *Boston Commonwealth*, recalls a few facts of interest. Prof. J. C. Watson, the founder of the award, was for many years professor of astronomy and physics in the Universities of Michigan and Wisconsin, and for some time previous to his decease was director of the Washburn Observatory at Madison. His treatise on theoretical astronomy is known to every computing astronomer. During the later years of his life he devoted his attention to the minor planets, of which he discovered twelve. It is common knowledge that, at the eclipse of July 29, 1878, he and Dr. Swift reported observations of an intra-mercurial planet, and he believed in the existence of such a body up to his death in 1880. At his death he left his estate, some family legacies excepted, in trust to the National Academy of Sciences, the fund having since been designated the Watson Fund. The amount of money realised was in all some twenty or thirty thousand dollars. The income of this is to be expended for the promotion of astronomical science, specific provision being made for the presentation of a gold medal and a gratuity of one hundred dollars in gold coin, from time to time, to an astronomer who shall have accomplished work of high merit. He nominated as trustees of his fund his friends Hilgard, Coffin and Newcomb, with provision for the appointment of their successors. The high quality of the trust has been continued by the selection of Dr. B. A. Gould and Prof. Asaph Hall as successors to Hilgard and Coffin, who passed away some three years ago. Four medals only have been given: the first to Dr. B. A. Gould in 1887; the second to Prof. Edward Schönfeld, Director of the University of Bonn, in 1888; the third to Dr. Arthur Auwers, of Berlin, in 1891; and the fourth to Mr. Chandler. It need hardly be said that the award was chiefly given to Mr. Chandler for his brilliant investigations on the variations of latitude.

TWO NEW CATALOGUES.—*Astronomische Nachrichten* No. 3232 contains a long list of stars with remarkable spectra, observed by the Rev. T. E. Espin. The catalogue comprises 167 stars, most of which have not had their spectra previously recorded, 206 stars found to have spectra belonging to Type III., and a list of 136 stars, of which it is doubtful whether they belong to Type II. or III. Nos. 3233–34 of the same publication contain a catalogue of 187 new double stars discovered with the 18½ inch refractor of the Deerhorn Observatory, U.S.A., and measures of 152 double stars, by Prof. G. W. Hough.

THE DENSITY OF NITROGEN GAS.[1]

IN a former communication[2] I have described how nitrogen, prepared by Lupton's method, proved to be lighter by about 1/1000 part than that derived from air in the usual manner.

[1] "On an Anomaly encountered in Determinations of the Density of Nitrogen Gas." A paper read before the Royal Society on April 19, by Lord Rayleigh, Sec. R.S.

[2] "On the Densities of the Principal Gases," *Roy. Soc. Proc.* vol. liii. p. 146, 1893.

In both cases a red hot tube containing copper is employed, but with this difference. In the latter method the atmospheric oxygen is removed by oxidation of the copper itself, while in Lupton's method it combines with the hydrogen of ammonia, through which the air is caused to pass on its way to the furnace, the copper remaining unaltered. In order to exaggerate the effect, the air was subsequently replaced by oxygen. Under these conditions the whole, instead of only about one-seventh part of the nitrogen is derived from ammonia, and the discrepancy was found to be exalted to about one half per cent.

Upon the assumption that similar gas should be obtained by both methods, we may explain the discrepancy by supposing either that the atmospheric nitrogen was too heavy on account of imperfect removal of oxygen, or that the ammonia nitrogen was too light on account of contamination with gases lighter than pure nitrogen. Independently of the fact that the action of the copper in the first case was pushed to great lengths, there are two arguments which appeared to exclude the supposition that oxygen was still present in the prepared gas. One of these depends upon the large quantity of oxygen that would be required in view of the small difference between the weights of the two gases. As much as 1/30th part of oxygen would be necessary to raise the density by 1/200, or about one-sixth of all the oxygen originally present. This seemed to be out of the question. But even if so high a degree of imperfection in the action of the copper could be admitted, the large alteration caused by the substitution of oxygen for air in Lupton's process would remain unexplained. Moreover, as has been described in the former paper, the introduction of hydrogen into the gas made no difference, such hydrogen being removed by the hot oxide of copper subsequently traversed. It is surely impossible that the supposed residual oxygen could have survived such treatment.

Another argument may be founded upon more recent results, presently to be given, from which it appears that almost exactly the same density is found when the oxygen of air is removed by hot iron reduced with hydrogen, instead of by copper, or in the cold by ferrous hydrate.

But the difficulties in the way of accepting the second alternative are hardly less formidable. For the question at once arises, of what gas, lighter than nitrogen, does the contamination consist? In order that the reader may the better judge, it may be well to specify more fully what were the arrangements adopted. The gas, whether air or oxygen, after passing through potash was charged with ammonia as it traversed a small wash-bottle, and thence proceeded to the furnace. The first passage through the furnace was in a tube packed with metallic copper, in the form of fine wire. Then followed a wash-bottle of sulphuric acid by which the greater part of the excess of ammonia would be arrested, and a second passage through the furnace in a tube containing copper oxide. The gas then traversed a long length of pumice charged with sulphuric acid, and a small wash-bottle containing Nessler solution. On the other side of the regulating tap the arrangements were always as formerly described, and included tubes of finely divided potash and of phosphoric anhydride. The rate of passage was usually about half a litre per hour.

Of the possible impurities, lighter than nitrogen, those most demanding consideration are hydrogen, ammonia, and water vapour. The last may be dismissed at once, and the absence of ammonia is almost equally certain. The question of hydrogen appears the most important. But this gas, and hydrocarbons, such as CH_4, could they be present, should be burnt by the copper oxide; and the experiments already referred to, in which hydrogen was purposely introduced into atmospheric nitrogen, seem to prove conclusively that the burning would really take place. Some further experiments of the same kind will presently be given.

The gas from ammonia and oxygen was sometimes odourless, but at other times smelt strongly of nitrous fumes, and, after mixture with moist air, reddened litmus paper. On one occasion the oxidation of the nitrogen went so far that the gas showed colour in the blow-off tube of the Toppler, although the thickness of the layer was only about half an inch. But the presence of nitric oxide is, of course, no explanation of the abnormal lightness. The conditions under which the oxidation takes place proved to be difficult of control, and it was thought desirable to examine nitrogen derived by *reduction* from nitric and nitrous oxides.

The former source was the first experimented upon. The gas was evolved from copper and diluted nitric acid in the usual way, and, after passing through potash, was reduced by *iron*, copper not being sufficiently active, at least without a very high temperature. The iron was prepared from blacksmith's scale. In order to get quit of carbon, it was first treated with a current of oxygen at a red heat, and afterwards reduced by hydrogen, the reduction being repeated after each employment. The greater part of the work of reducing the gas was performed outside the furnace in a tube heated locally with a Bunsen flame. In the passage through the furnace in a tube containing similar iron, the work would be completed, if necessary. Next followed washing with sulphuric acid (as required in the ammonia process), a second passage through the furnace over copper oxide, and further washing with sulphuric acid. In order to obtain an indication of any unreduced nitric oxide, a wash-bottle containing ferrous sulphate was introduced, after which followed the Nessler test and drying tubes, as already described. As thus arranged, the apparatus could be employed without alteration, whether the nitrogen to be collected was derived from air, from ammonia, from nitric oxide, from nitrous oxide, or from ammonium nitrite.

The numbers which follow are the weights of the gas contained by the globe at zero, at the pressure defined by the manometer when the temperature is 15°. They are corrected for the errors in the weights, but not for the shrinkage of the globe when exhausted, and thus correspond to the number 2·31026, as formerly given for nitrogen.

Nitrogen from NO by Hot Iron.

November 29, 1893	2·30143	Mean, 2·30008
December 2, 1893	2·29890	
December 5, 1893	2·29816	
December 6, 1893	2·30182	

Nitrogen from N_2O by Hot Iron.[1]

December 26, 1893	2·29869	Mean, 2·29904
December 28, 1893	2·29940	

Nitrogen from Ammonium Nitrite passed over Hot Iron.

January 9, 1894	2·29849	Mean, 2·29869
January 13, 1894	2·29889	

With these are to be compared the weights of nitrogen derived from the atmosphere.

Nitrogen from Air by Hot Iron.

December 12, 1893	2·31017	Mean, 2·31003
December 14, 1893	2·30986 (H)	
December 19, 1893	2·31003 (H)	
December 22, 1893	2·31007	

Nitrogen from Air by Ferrous Hydrate.

January 27, 1894	2·31024	Mean, 2·31020
January 30, 1894	2·31010	
February 1, 1894	2·31028	

In the last case a large volume of air was confined for several hours in a glass reservoir with a mixture of slaked lime and ferrous sulphate. The gas was displaced by deoxygenated water, and further purified by passage through a tube packed with a similar mixture. The hot tubes were not used.

If we bring together the means for atmospheric nitrogen obtained by various methods, the agreement is seen to be good, and may be regarded as inconsistent with the supposition of residual oxygen in quantity sufficient to influence the weights.

Atmospheric Nitrogen.

By hot copper, 1892	2·31026
By hot iron, 1893	2·31003
By ferrous hydrate, 1894	2·31020

Two of the results relating to hot iron, those of December 14 and December 19, were obtained from nitrogen, into which hydrogen had been purposely introduced. An electrolytic generator was inserted between the two tubes containing hot iron, as formerly described. The generator worked under its own electromotive force, and the current was measured by a tangent galvanometer. Thus, on December 19, the deflection throughout the time of filling was 3°, representing about 1/15

[1] The N_2O was prepared from zinc and very dilute nitric acid.

ampère. In two hours and a half the hydrogen introduced into the gas would be about 70 c.c., sufficient, if retained, to reduce the weight by about 4 per cent. The fact that there was no sensible reduction proves that the hydrogen was effectively removed by the copper oxide.

The nitrogen, obtained altogether in four ways from chemical compounds, is materially lighter than the above, the difference amounting to about 11 mg., or about 1/200 part of the whole. It is also to be observed that the agreement of individual results is less close in the case of chemical nitrogen than of atmospheric nitrogen.

I have made some experiments to try whether the densities were influenced by exposing the gas to the silent electric discharge. A Siemens tube, as used for generating ozone, was inserted in the path of the gas after desiccation with phosphoric anhydride. The following were the results:—

Nitrogen from Air by Hot Iron, Electrified.

January 1, 1894 ...	... 2·31163	Mean, 2·31059
January 4, 1894 ...	... 2·30956	

Nitrogen from N_2O by Hot Iron, Electrified.

January 2, 1894 ...	... 2·30074	Mean, 2·30064
January 5, 1894 ...	... 2·30054	

The somewhat anomalous result of January 1 is partly explained by the failure to obtain a subsequent weighing of the globe empty, and there is no indication that any effect was produced by the electrification.

One more observation I will bring forward in conclusion. Nitrogen prepared from oxygen and ammonia, and about one-half per cent. lighter than ordinary atmospheric nitrogen, was stored in the globe for eight months. The globe was then connected to the apparatus, and the pressure was readjusted in the usual manner to the standard conditions. On reweighing no change was observed, so that the abnormally light nitrogen did not become dense by keeping.

DR. ARMSTRONG ON THE PUBLICATION OF SCIENTIFIC LITERATURE.

THE presidential address delivered by Dr. Armstrong at the last annual meeting of the Chemical Society, and published in the May number of the Society's *Journal*, contains numerous suggestive remarks on questions affecting all branches of science. A subject that has lately been attracting some attention is the publication of the proceedings of societies. On this Dr. Armstrong has much to say, and as he has had abundant opportunity of proving the value of the system followed by the Chemical Society, and comparing it with those of other societies, his opinions carry weight. Our space will not permit us to reprint the address, but the following extracts will suffice to show its character.

"Chemical literature is fast becoming unmanageable and uncontrollable from its very vastness. Not only is the number of papers increasing from year to year, but new journals are constantly being established. Something must be done in order to assist chemists to remain in touch with their subject and to retain their hold on the literature generally. This object would be best attained if chemists could agree to publish everything in one journal; but for many reasons, and until the world has recognised one language, such an idea must remain but a dream. This being the case, we must endeavour to have as few journals as possible, which is desirable even from the point of view of our pockets and of the dimensions of our book-shelves and houses, none of which are infinitely elastic. It is clear that in the British Isles but one journal is necessary; a large majority of the papers by workers in British laboratories, containing matter new to chemical science, are at present communicated to us, and I see no reason why all should not be. I do not mean that all should be read before the Chemical Society, because the mere reading is frequently but a formal proceeding, or, in some cases, may take place with advantage elsewhere. The Society of Chemical Industry has set us a good example in this respect by publishing in one journal the papers read at various places in the country; it matters little that the papers are read before affiliated sections of the Society, as these sections are practically independent organisations. . . .

"It seems to me, that eventually one of two courses must be adopted in this country—either the societies engaged in doing similar work must become affiliated, or our Society must return to the practice of early days and publish lengthy abstracts of papers communicated to societies such as the Royal Societies of London and Edinburgh, in order to bring these papers properly under the notice of chemists generally. The former course would involve an agreement amongst us to print in some uniform manner, less expensive, magnificent and stately than that adopted by the Royal Societies; a somewhat larger octavo than that of our present journal would probably suffice, such as is adopted for the *Annals of Botany*. If such an agreement were arrived at, a paper read and discussed before the Royal Society of London or Edinburgh, for example, might be printed off, and the necessary number of copies supplied to the society; while, if the paper interested chemists, we might at the same time take an appropriate number, and issue the paper as part of our Transactions. . . .

"The policy thus advocated with reference to English chemical papers is already being elsewhere adopted. The *Monatshefte für Chemie*, for example, is advisedly a collection of the papers of Austrian chemists, although, unfortunately, this does not yet include the whole of the work done in Austria-Hungary. The *Gazzetta chimica italiana* appears to contain very nearly all the Italian work. All that is done in Holland is brought together in the *Recueil des travaux chimique des Pays-Bas*. France and Germany, however, each have a variety of journals. In France the prestige of the Academy is such that for some time to come it will probably be difficult to consolidate the interests of French chemists. In Germany, however, the *Deutsche chemische Gesellschaft* is no longer hampered by the words *zu Berlin*, which it has boldly dropped, while we still remain the Chemical Society *of London* in name; it is to be hoped that in the interests of the scientific world it will ere long acquire and quash the private interests by which other journals are supported. I see no good reason even why journals devoted to special branches of our subject should exist, and I regard the appearance, for example, of a special journal of inorganic chemistry as an unmitigated evil. Political colouring and a tendency to adopt methods akin to those of the newspaper editor, of which we have had evidence in one of these journals, are most undesirable features in science. Moreover, we cannot afford to buy everything; and no effort should be spared to prevent our being split up into factions and becoming narrow-minded specialists: the more the student of chemistry—and every original worker must be and remain a student throughout his life—is brought directly into contact with the work which is being done in the several departments of his science, the better it will be for him; he cannot and need not read everything, but do not let us deprive him of the opportunity of easily indulging in a mixed diet, and of exercising his mental faculties generally, while devoting himself specially to some one section of the vast subject which it is the privilege of the chemist to command.

"To complete my scheme—which I trust is not altogether visionary, for so great is the toleration and sympathy between all true-minded scientific workers that if union be possible in any field of human activity it is possible in the field of science—it will be necessary that the Scandinavian and Danish chemists, say, should unite; and also that the Russian chemists should give us a 'recueil des travaux chimiques' in *French*, so that the world may no longer be deprived of the knowledge of their labours, which we know, from experience, are of high value. As to America, it would be a great achievement if the political separation of our two nations could be disregarded and we were to unite with our cousins in establishing one journal for the publication of the work of chemists speaking English. There would be no real difficulty in doing this in these days of type-written manuscript, the proof of which need but be revised by the printers' reader. But if motives of expediency render such union impracticable, then it is to be hoped that steps may be taken to make the title *American Chemical Journal* truly and completely significant. I hope that we shall be successful in arranging to co-operate with all chemists in our own colonies and India. . . .

"There has been much discussion during the past few months, especially in the columns of NATURE, on the question of the publication of physical papers, which, strange to say, is in a very inchoate condition. I feel sure that the problem will soon be successfully solved by the Physical Society boldly coming forward and undertaking to do for physics what we have proved can be done for chemistry; there is no other solution possible, and the needs of physics are so great that no time should be lost. We, in this Society, can never be too grateful to Professor Williamson for having led the storming party to victory which established our system of abstracts; he foresaw that when such a scheme was successfully launched it was bound to become self-supporting, and such has long since proved to be the case. Let us hope that the physicists have at their disposal some one equally bold and far-sighted, who will overcome the fears of the timid, and initiate a thoroughly comprehensive scheme. Chemists are directly interested in the work, as we are bound to take notice of the progress of physics, and the want of an English record is much felt by us. We had no society with cognate aims to help us, so that the physicists are in a far stronger position than we were, as the Institution of Electrical Engineers should be prepared to forward such a cause. I believe it will be found to be of the utmost importance to them to do so. Indeed, the electrical engineer of the present day, I fear, is fast becoming a specialist of the deepest dye: having had experience of several hundreds, I know that when a student he is most difficult to deal with, as he will only pay attention, even in physics, to what he believes to be of immediate importance to him; as to chemistry, he will scarce notice it, forgetting, or not realising, that the whole field of electro-chemistry is yet untilled. It is, therefore, very necessary that no effort should be spared to make the electrical engineer better informed regarding physics generally. . . .

"The Royal Society of London has recently issued to the scientific world a circular having reference to the preparation of complete catalogues of science by *international co-operation*, which raises questions of such importance that I do not hesitate to reproduce it.

"'Sir,—The Royal Society of London, as you are probably aware, has published nine quarto volumes of *The Catalogue of Scientific Papers*, the first volume of the decade—1874-83—having been issued last year.

"'This catalogue is limited to *periodical* scientific literature, *i.e.* to papers published in the transactions, &c., of societies, and in journals; it takes no account whatever of monographs and independent books, however important. The titles, moreover, are arranged solely according to author's names; and though the Society has long had under consideration the preparation of—and is hoped may eventually issue as—a key to the volumes already published, a list in which the titles are arranged according to subject-matter, the catalogue is still being prepared according to author's names. Further, though the Society has endeavoured to include the titles of all the scientific papers published in periodicals of acknowledged standing, the catalogue is—even as regards periodical literature—confessedly incomplete, owing to the omission of the titles of papers published in periodicals of little importance or not easy of access.

"'Owing to the great development of scientific literature the task of the Society in continuing the catalogue, even in its present form, is rapidly increasing in difficulty. At the same time it is clear that the progress of science would be greatly helped by—indeed, almost demands—the compilation of a catalogue which should aim at completeness, and should contain the titles of scientific publications, whether appearing in periodicals or independently. In such a catalogue the title should be arranged not only according to authors' names, but also according to subject-matter, the text of each paper and not the title only being consulted for the latter purpose. And the value of the catalogue would be greatly enhanced by a rapid periodical issue, and by publication in such a form that the portion which pertains to any particular branch of science might be obtained separately.

"'It is needless to say that the preparation and publication of such a complete catalogue is far beyond the power and means of any single society.

"'Led by the above considerations, the President and Council of the Royal Society have appointed a committee to inquire into and report upon *the feasibility of such a catalogue being compiled through international co-operation.*

"'The Committee are not as yet in a position to formulate any distinct plan by which such international co-operation might be brought about; but it may be useful, even at the outset, to make the following preliminary suggestions:—

"'The catalogue should commence with papers published on or after January 1, 1900.

"'A central office, or bureau, should be established in some place, to be hereafter chosen, and should be maintained by international contributions—either directly, that is, by annual or other subsidies—or indirectly, that is, by the guarantee to purchase a certain number of copies of the catalogue.

"'This office should be regularly supplied with all the information necessary for the construction of the catalogue. This might be done either by all periodicals, monographs, &c., being sent direct to the office to be catalogued there, or by various institutions undertaking to send in portions of the catalogue already prepared, or by both methods combined.

"'At such an office, arrangements might be made by which, in addition to preparing the catalogue, scientific data might be tabulated as they came to hand in the papers supplied.

"'The first step, however, is to ascertain whether any scheme of international co-operation is feasible and desirable. The Committee, accordingly, is desirous of learning the views upon this subject of scientific bodies and of scientific men.

"'We, therefore, venture to express the hope that you will be so good as, at some early opportunity, to make known to us, for the use of the Committee, your own views on the matter.

"'Should the decision you report be in any way favourable to the scheme, may we further ask you to communicate to us, for the use of the Committee, any suggestions which you may think it desirable to make, as to the best methods of inaugurating such a scheme, as to the constitution and means of maintenance of the Central Office, as to the exact character of the work to be carried on there, as to the language or languages in which the catalogue should be published, and the like?

"'We are,

"'Your obedient servants,

"'M. Foster, *Secretary R.S.*

"'Rayleigh, *Secretary R.S.*

"'J. Lister, *Foreign Sec. R.S.*'

"If any such scheme as is here foreshadowed could be carried out, it would obviously be of the greatest value to the world and productive of much saving, both of time and treasure. But the subject is full of difficulty, owing to the very numerous interests concerned. I trust, however, that when the time comes to deal with the chemical section—and, indeed, in the case of any future catalogue of chemical work, that we shall not be satisfied with a mere alphabetical arrangement, but that we shall classify the subject-matter alphabetically in sections, so as to lighten the labour of ascertaining the state of knowledge in any particular group. Already we do not know very many of the names recorded in our indexes, and, in the future, we shall be ignorant of a still larger proportion, unless our system of nomenclature be made so significant that each name will explain itself; and in the case of an alphabetical arrangement, substances belonging to the same group, having names with different initial letters, occur interspersed throughout the index: so that it is a matter of the greatest difficulty, if not impossible, by consulting such an index, to ascertain the references to all the members of the group. An alphabetical index also affords no indication of the extent to which knowledge of any particular group has increased during the interval covered by it; and, in fact, it only becomes of real use when provided with a key, such as Beilstein affords, in which the names of the known members of any particular group may be first looked up before consulting the alphabetical index. Also, in using a lengthy alphabetical index it is very easy to miss entries, and it is necessary to pay far more attention when consulting it than is the case when one of limited extent is used.

"I do not believe that there would be any real difficulty in arriving at a system of classification which, at all events, would limit a reference to comparatively few pages. We are told that by the Bertillon system, dealing with the card records of 90,000 convicts, it is possible—when the necessary measurements have been taken—to ascertain whether a prisoner has been before convicted, as it may be said, with considerable, if not absolute, confidence, that, in that case, his card will be found in a drawer containing only about 400. Surely, we ought to be able to devise a system which would equally limit our search."

THE WORK OF HERTZ.

Additions and Corrections to the Lecture reported last week, by Dr. Oliver Lodge.

On page 135, middle of first column, the word "clearly" ought to have been *probably*; for I am by no means clear that the gradual discharge of negative electrification from the clean surface of metals under the action of light is really a chemical phenomenon. It had been asserted by some experimenters that the most oxidisable metals acted most powerfully, but my own experience renders this doubtful; I now find that gold platinum and carbon discharge with very fair rapidity, and that nearly all substances have some discharging power. A few materials, cobalt among metals, discharge positive electrification more rapidly than negative. The whole matter is therefore now under investigation.

In the foot-note to same column, end of first paragraph, the word "even" should be deleted. The assertion intended is that dried soil discharges rapidly, while damp soil discharges only slowly.

Same page, middle of second column, "two years ago" should be *four years ago*; since Fitzgerald's Royal Institution Lecture was delivered in March 1890, and reported in NATURE of June 19 the same year.

Lower down, the name Kolaček, preceding that of D. E. Jones, has been omitted.

Page 138, second column, with reference to the reflecting power of different substances it may be interesting to give the following numbers, showing the motion of the spot of light when 8-inch waves were reflected into the copper hat, the angle of incidence being about 45°, by the following mirrors:—

Sheet of window glass	0, or at most 1, division.
Human body	7 divisions.
Drawing board	12 ,,
Towel soaked with tap-water ...	12 ,,
Tea-paper (lead?)...	40 ,,
Dutch metal paper	70 ,,
Tinfoil	80 ,,
Sheet copper	100 and up against stops.

Page 139. It would have been clearer if the penultimate paragraph, beginning "To demonstrate," had run thus:—

To demonstrate that the so-called plane of polarisation of the radiation transmitted by a grid is at right angles to the electric vibration, *i.e.* that when light is reflected from the boundary of a transparent substance at the polarising angle the electric vibrations of the reflected beam are perpendicular to the plane of reflection, I use, &c.

The following is a copy of one of the wall-diagrams; it is interesting as showing how numerous the now-known detectors of radiation are:—

DETECTORS OF RADIATION.

Physiological	Chemical	Thermal	Electrical	Mechanical	Microphonic
					Selenium (?)
Eye	Photographic Plate	Thermopile	Spark (Hertz)	Electrometer (Blyth and Bjerknes)	Impulsion Cell (Minchin)
× Frog's leg (Hertz and Ritter)	Explosive Gases	Bolometer (Rubens and Ritter)	Telephone, Air-gap and Arc (Lodge)	Suspended Wires (Hertz and Boys)	Filings (Branly)
	Photo-electric cell	Expanding Wire (Gregory)	Vacuum Tube (Dragoumis)		Coherer (Hughes and Lodge)
		Thermal Junction (Klemencic)	Galvanometer (Fitzgerald)		
			Air-gap and Electroscope (Boltzmann)		
			Trigger Tube (Warburg and Zehnder)		

× The cross against the frog's leg indicates that it does not appear really to respond to radiation, unless stimulated in some secondary manner. The names against the other things are unimportant, but suggest the persons who applied the detector to electric radiation. The query against Selenium is placed there because of uncertainty as to its most appropriate column.

STUDY OF FLUID MOTION BY MEANS OF COLOURED BANDS.[1]

IN his charming story of "The Purloined Letter," Edgar Allan Poe tells how all the efforts and artifices of the Paris police to obtain possession of a certain letter, known to be in a particular room, were completely baffled for months by the simple plan of leaving the letter in an unsealed envelope in a letter-rack, and so destroying all *curiosity* as to its contents; and how the letter was at last found there by a young man who was not a professional member of the force. Closely analogous to this is the story I have to set before you to-night—how certain mysteries of fluid motion, which have resisted all attempts to penetrate them, are at last explained by the simplest means and in the most obvious manner.

This indeed is no new story in science. The method adopted by the minister, *D.*, to secrete his letter appears to be the favourite of nature in keeping her secrets, and the history of science teems with instances in which keys, after being long sought amongst the grander phenomena, have been found at last not hidden with care, but scattered about, almost openly, in the most commonplace incidents of everyday life which have excited no curiosity.

[1] A lecture delivered at the Royal Institution of Great Britain by Prof. Osborne Reynolds, F.R.S.

This was the case in physical astronomy—to which I shall return after having reminded you that the motion of matter in the universe naturally divides itself into three classes.

(1) The motion of bodies as a whole—as a grand illustration of which we have the heavenly bodies, or more humble, but not less effective, the motion of a pendulum, or a falling body.

(2) The relative motion of the different parts of the same fluid or elastic body—for the illustration of which we may go to the grand phenomena presented by the tide, the whirlwind, or the transmission of sound, but which is equally well illustrated by the oscillatory motion of the wave, as shown by the motion of its surface and by the motion of this jelly, which, although the most homely illustration, affords by far the best illustration of the properties of an elastic solid.

(3) The inter-motions of a number of bodies amongst each other —to which class belong the motions of the molecules of matter resulting from heat, as the motions of the molecules of a gas, in illustration of which I may mention the motions of individuals in a crowd, and illustrate by the motion of the grains in this bottle when it is shaken, during which the white grains at the top gradually mingle with the black ones at the bottom—which inter-diffusion takes an important part in the method of coloured bands.

Now of these three classes of motion that of the individual body is incomparably the simplest. Yet, as presented in the phenomena of the heavens, which have ever excited the greatest curiosity of mankind, it defied the attempts of all philosophers for thousands of years, until Galileo discovered the laws of motion of mundane matter. It was not until he had done this and applied these laws to the heavenly bodies that their motions received a rational explanation. Then Newton, taking up Galileo's parable and completing it, found that its strict application to the heavenly bodies revealed the law of gravitation, and developed the theory of dynamics.

Next to the motions of the heavenly bodies, the wave, the whirlwinds, and the motions of clouds, had excited the philosophical curiosity of mankind from the earliest time. Both Galileo and Newton, as well as their followers, attempted to explain these by the laws of motion, but, although the results so obtained have been of the utmost importance in the development of the theory of dynamics, it was not till this century that any considerable advance was made in the application of this theory to the explanation of fluid phenomena; and although during the last fifty years splendid work has been done, work which, in respect of the mental effort involved, or the scientific importance of the results, goes beyond that which resulted in the discovery of Neptune, yet the circumstances of fluid motion are so obscure and complex that the theory has yet been interpreted only in the simplest cases.

To illustrate the difference between the interpretation of the theory of heavenly bodies and that of fluid motion, I would call your attention to the fact that solid bodies, on the behaviour of which the theory of the motion of the planets is founded, move as one piece, so that their motion is exactly represented by the motion of their surfaces; that they are not affected with any internal disorder which may affect their general motion. So surely is this the case that even those who have never heard of dynamics can predict with certainty how any ordinary body will behave under any ordinary circumstances, so much so that any departure is a matter of surprise. Thus I have here a cube of wood, to one side of which a string is attached. Now hold it on one side, and you naturally suppose that when I let go holding the string it will turn down so as to hang with the string vertical; that it does not do so is a matter of surprise. I place it on the other side, and it still remains as I place it. If I swing it as a pendulum it does not behave like one.

Would Galileo have discovered the laws of motion had his pendulum behaved like this? Why is its motion peculiar? There is internal motion. Of what sort? Well, I think my illustration may carry more weight if I do not tell you; you can all, I have no doubt, form a good idea. It is not fluid motion, or I should feel bound to explain it. You have here an ordinary-looking object which behaves in an extraordinary manner, which is yet very decided and clear, to judge by the motion of its surface, and from the manner of the motion I wish you to judge of the cause of the observed motion.

This is the problem presented by fluids, in which there may be internal motion which has to be taken into account before the motion of the surface can be explained. You can see no more of what the motion is within a homogeneous fluid, however opaque or clear, than you can see what is going on within the box. Thus without colour bands the only visual clue to what is going on within the fluids is the motion of their bounding surfaces. Nor is this all; in most cases the surfaces which bound the fluid are immovable.

In the case of the wave on water the motion of the surface shows that there is motion, but because the surface shows no wave it does not do to infer that the fluid is at rest.

The only surfaces of the air within this room are the surfaces of the floor, walls, and objects within it. By moving the objects we move the air, but how far the air is at rest you cannot tell unless it is something familiar to you.

Now I will ask you to look at these balloons. They are familiar objects enough, and yet they are most sensitive anemometers, more sensitive than anything else in the room; but even they do not show any motion; each of them forms an internal bounding surface of the air. I send an *aerial messenger* to them, and a small but energetic motion is seen by which it acknowledges the message, and the same message travels through the rest, as if a *ghost* touched them. It is a wave that moves them. You do not feel it, and, but for the surfaces of the air formed by the balloons, would have no notion of its existence.

In this tank of beautifully clear distilled water, I project a heavy ball in from the end, and it shows the existence of the water by stopping almost dead within two feet. The fact that it is stopped by the water, being familiar, does not raise the question, Why does it stop?—a question to which, even at the present day, a complete answer is not forthcoming. The question is, however, suggested, and forcibly suggested, when it appears that with no greater or other evidence of its existence, I can project a disturbance through the water which will drive this small disc the whole length of the tank.

I have now shown instances of fluid motion of which the manner is in no way evident without colour bands, and were revealed by colour bands, as I showed in this room sixteen years ago. At that time I was occupied in setting before you the manners of motion revealed, and I could only incidentally notice the means by which this revelation was accomplished.

Amongst the ordinary phenomena of motion there are many which render evident the internal motion of fluids. Small objects suspended in the fluid are important, and that their importance has long been recognised is shown by the proverb—straws show which way the wind blows. Bubbles in water, smoke and clouds, afford the most striking phenomena, and it is doubtless these that have furnished philosophers with such clues as they have had. But the indications furnished by these phenomena are imperfect, and, what is more important, they only occur casually, and in general only under circumstances of such extreme complexity that any deduction as to the elementary motions involved is impossible. They afford indication of commotion, and perhaps of the general direction in which the commotion is tending, but this is about all.

For example, the different types of clouds; these have always been noticed, and are all named. And it is certain that each type of clouds is an indication of a particular type of motion in the air; but no deductions as to what definite manner of motion is indicated by each type of cloud have ever been published.

Before this can be done it is necessary to reverse the problem and find to what particular type of cloud a particular manner of motion would give rise. Now a cloud, as we see it, does not directly indicate the internal motion of which it is the result. As we look at clouds, it is not in general their motion that we notice, but their figure. It is hard to see that this figure changes while we are watching a cloud, though such a change is continually going on, but is apparently very slow on account of the great distance of the cloud and its great size. However, types of clouds are determined by their figure, not by their motion. Now what their figure shows is not motion, but it is the history or result of the motion of the particular strata of the air in and through surrounding strata. Hence, to interpret the figures of the clouds we must study the changes in shape of fluid masses, surrounded by fluid, which result from particular motions.

The ideal in the method of colour bands is to render streaks or lines in definite position in the fluid visible, without in any way otherwise interfering with these properties as part of the homogeneous fluid. If we could by a wish create coloured lines in the water, these would be ideal colour bands. We cannot do this, nor can we exactly paint lines in the air or water.

I take this ladle full of highly coloured water, lower it slowly into the surface of the surrounding water till that within is level with that without; then turn the ladle carefully round the coloured water; the mass of coloured water will remain where placed.

I distribute the colour slowly. It does not mix with the clear water, and although the lines are irregular they stand out very beautifully. Their edges are sharp here. But in this large sphere, which was coloured before the lecture, although the coloured lines have generally kept their places, they have, as it were, swollen out and become merged in the surrounding water in consequence of molecular motion. The sphere shows, however, one of the rarest phenomena in nature—the internal state in almost absolute internal rest. The forms resemble nothing so much as stratus clouds, as seen on a summer day, though the continuity of the colour bands is more marked. A mass of coloured water once introduced is never broken. The discontinuity of clouds is thus seen to be due to other causes than mere motion.

Now, having called our attention to the rarity of water at rest, I will call your attention to what is apt to be a very striking phenomena, namely that when water is contained, like this, in a spherical vessel of which you cannot alter the shape, it is impossible by moving the vessel suddenly to set up relative motion in the interior of the water. I may swing this vessel about and turn it, but the colour band in the middle remains as it was, and when I stop shows the water to be at rest.

This is not so if the water has a free surface, or if the fluid is of unequal density. Then a motion of the vessel sets up waves, and the colour band shows at once the beautifully lawful character of the internal motion. The colour bands move backwards and forwards, showing how the water is distorted like a jelly, and as the wave dies out the colour bands remain as they were to begin with.

This illustrates one of the two classes of internal motion of water or fluid. Wherever fluid is not in contact with surfaces over which it has to glide, or which surfaces fold on themselves, the internal motions are of this purely wave character. The colour bands, however much they may be distorted, cannot be relatively displaced, twisted, or curled up, and in this case motion in water once set up continues almost without resistance. That wave motion in water with a free surface, is one of the most difficult things to stop is directly connected with the difficulty of setting still water in motion; in either case the influence must come through the surfaces. Thus it is that waves once set up will traverse thousands of miles, establishing communication between the shores of Europe and America. Wave motion in water is subject to enormously less resistance than any other form of material motion.

In wave motion, if the colour bands are across the wave they show the motion of the water; nevertheless, their chief indication is of the change of shape while the fluid is in motion.

This is illustrated in this long bottle, with the coloured water less heavy than the clear water. If I lay it down in order to establish equilibrium, the blue water has to leave the upper end of the bottle and spread itself over the clear water, while the clear water runs under the coloured. This sets up wave motion, which continues after the bottle has come to rest. But as the colour bands are parallel with the direction of motion of the waves, the motion only becomes evident in thickening and bending of the colour bands.

The waves are entirely between the two fluids, there being no motion in the outer surfaces of the bottle, which is everywhere glass. They are owing to the slight differences in the density of the fluids, as is indicated by the extreme slowness of the motion. Of such kind are the waves in the air, that cause the clouds which make the mackerel sky, the vapour in the tops of the waves being condensed and evaporated again as it descends showing the results of the motion.

The distortional motions, such as alone occur in simple wave motion, or where the surfaces of the fluid do not fold in on themselves, or wind in, are the same as occur in any homogeneous continuous material which completely fills the space between the surfaces.

If plastic material is homogeneous in colour it shows nothing as to the internal motion; but if I take a lump built of plates, blue and white, say a square, then I can change the surfaces to any shape without folding or turning the lump, and the coloured bands which extend throughout the lump show the internal changes. Now the first point to illustrate is that, however I change its shape, if I bring it back to the original shape the colour bands will all come back to their original positions, and there is no limit to the extent of the change that may thus be effected. I may roll this out to any length, or draw it out, and the diminution in thickness of the colour bands shows the extent of the distortion. This is the first and simplest class of motion to which fluids are susceptible. By this motion alone elements of the fluid may be, and are, drawn out to indefinitely fine lines, or spread out in indefinitely thin sheets, but they will remain of the same general figures.

By reversing the process they change back again to the original form. No colour band can ever be broken, even if the outer surface be punched in till the punch head comes down on the table; still all the colour bands are continuous under the punch, and there is no folding or lapping of the colour bands unless the external surface is folded.

The general idea of mixture is so familiar to us that the vast generalisation to which these ideas afford the key, remains unnoticed. That continued mixing results in uniformity, and that uniformity is only to be obtained by mixing, will be generally acknowledged, but how deeply and universally this enters into all the arts can but rarely have been apprehended. Does it ever occur to any one that the beautiful uniformity of our textile fabrics has only been obtained by the development of processes of mixing the fibres? Or, again, the uniformity in our construction of metals; has it ever occurred to any one that the inventions of Arkwright and Cort were but the application of the long-known processes by which mixing is effected in culinary operations? Arkwright applied the draw-rollers to uniformly extend the length of the cotton sliver at the expense of the thickness; Cort applied the rolling-mill to extend the length of the iron bloom at the expense of its breadth; but who invented the rolling-pin by which the pastrycook extends the length at the expense of the thickness of the dough for the pie-crust?

In all these processes the object, too, is the same throughout—to obtain some particular shape, but chiefly to obtain a uniform texture. To obtain this nicety of texture it is necessary to mix up the material, and to accomplish this it is necessary to attenuate the material, so that the different parts may be brought together.

The readiness with which fluids are mixed and uniformity obtained is a byword; but it is only when we come to see the colour bands that we realise that the process by which this is attained is essentially the same as that so laboriously discovered for the arts—as depending first on the attenuation of each element of the fluid—as I have illustrated by distortion.

In fluids, no less than in cooking, spinning and rolling—this attenuation is only the first step in the process of mixing—all involve the second process, that of folding, piling, or wrapping, by which the attenuated layers are brought together. This does not occur in the pure wave motion of water, and constitutes the second of the two classes of motion. If a wave on water is driven beyond a certain height it leaps or breaks, folding in its surface. Or, if I but move a solid surface through the water it introduces tangential motion, which enables the fluid to wind its elements round an axis. In these ways, and only in these ways, we are released from the restriction of not turning or lapping. And in our illustration, we may fold up our dough, or lap it—roll it out again and lap it again; cut up our iron bar, pile it, and roll it out again, or bring as many as we please of the attenuated fibres of cotton together to be further drawn. It may be thought that this attenuation and wrapping will never make perfect admixture, for however thin each element will preserve its characteristic, the coloured layers will be there, however often I double and roll out the dough. This is true. But in the case of some fluids, and only in the case of some fluids, the physical process of diffusion completes the admixture. These colour bands have remained in this water, swelling but still distinct; this shows the slowness of diffusion. Yet such is the facility with which the fluid will go through the process of attenuating its elements and enfolding them, that by simply stirring them with a spoon these colour bands can be drawn and folded so fine that the diffusion will be instantaneous, and the fluid become uniformly tinted. All internal fluid motion other than simple distortion, as in wave motion, is a process of mixing, and it is thus from the arts we get the clue to the elementary forms and processes of fluid motion.

When I put the spoon in and mixed the fluid you could not see what went on—it was too quick. To make this clear, it is necessary that the motion should be very slow. The motion should also be in planes, at right angles to the direction in which you are looking. Such is the instability of fluid that to accomplish this at first appeared to be difficult. At last, however, as the result of much thought, I found a simple process which I will now show you, in what I think is a novel experiment, and you will see, what I think has never been seen before by any one but Mr. Foster and myself, namely, the complete process of the formation of a cylindrical vortex sheet resulting from the motion of a solid surface. To make it visible to all I am obliged to limit the colour band to one section of the sheet, otherwise only those immediately in front would be able to see between the convolution of the spiral. But you will understand that what is seen is a section, a similar state of motion extending right across the tank. From the surface you see the plane vane extending halfway down right across the tank; this is attached to a float.

I now institute a colour band on the right of the vane out of the tube. There is no motion in the water, and the colour descends slowly from the tube. I now give a small impulse to the float to move it to the right, and at once the spiral form is seen from the tube. Similar spirals would be formed all across the tank if there were colours. The float has moved out of the way, leaving the revolving spiral with its centre stationary, showing the horizontal axis of the spiral is half-way between the bottom and surface of the tank, in which the water is now simply revolving round this axis.

This is the vortex in its simplest and rarest form (for a vortex cannot exist with its ends exposed). Like an army it must have its flanks protected; hence a straight vortex can only exist where it has two surfaces to cover its flanks, and parallel vertical surfaces are not common in nature. The vortex can bend, and, with a horse shoe axis, can rest both its flanks on the same surface, as this piece of clay, or unite its ends with a ring axis, which is its commonest form, as in the smoke ring. In both these cases the vortex will be in motion through the fluid, and less easy to observe.

These vortices have no motion beyond the rotation because they are half-way down the tank. If the vane were shorter they would follow the vane; if it were longer they would leave it.

In the same way, if instead of one vortex there were two vortices, with their axis parallel, extending right across, the one above another, they would move together along the tank.

I replace the float by another which has a vane suspended from it, so that the water can pass both above and below the vane extending right across the middle portion of the tank. In this case I institute two colour bands, one to pass over the top, the other underneath the vane, which colour bands will render visible a section of each vortex just as in the last case. I now set the float in motion, and the two vortices turn towards each other in opposite directions. They are formed by the water moving over the surface of the vane, downwards to get under it, upwards to get over it, so that the rotation in the upper vortex is opposite to that in the lower. All this is just the same as before, but instead of these vortices standing still as before, they follow at a definite distance from the vane, which continues its motion along the tank without resistance.

Now this experiment shows, in the simplest form, the *modus operandi* by which internal waves can exist in fluid without any motion in the external boundary. Not only is this plate moving flatwise through the water, but it is followed by all the water, coloured and uncoloured, enclosed in these cylindrical vortices. Now, although there is no absolute surface visible, yet there is a definite surface which encloses these moving vortices, and separates them from the water which moves out of their way. This surface will be rendered visible in another experiment I shall show you. Thus, the water which has only wave motion is bounded by a definite surface, the motion of which corresponds to the wave; but inside this closed surface there is also water, so that we cannot see the surface, and this water inside is moving round and round, but so that its motion at the bounding surface is everywhere the same as that of the outside water.

The two masses of water do not mix. That outside moves out of the way of and past the vortices over the bounding surface, while the vortices move round and round inside the surface in such a way that it is moving in exactly the same manner at the surface as the wave surface outside.

This is the key to the internal motion of water. You cannot have a pure wave motion inside a mass of fluid with its boundaries at rest, but you have a compound motion, a wave motion outside, and a vortex within, which fulfils the condition that there shall be no sliding of the fluid over fluid at the boundary.

A means which I hope may make the essential conditions of this motion clearer occurred to me while preparing this lecture, and to this I will now ask your attention. I have here a number of layers of cotton-wool (wadding). Now I can force any body along between these layers of wadding. They yield, as by a wave, and let it go through; but the wadding must slide over the surface of the body so moving through it. And this it must *not* do if it illustrate the conditions of fluid motion. Now, there is one way, and only one way, in which material can be got through between the sheets of wadding without slipping. It must roll through; but this is not enough, because if it rolls on the under surface it will be slipping on the upper. But if we have two rollers, one on the top of the other, between the sheets, then the lower roller rolls on the bottom sheet, the upper roller rolls against the upper sheet, so that there is no slipping between the rollers or the wadding, and, equally important, there is no slipping between the rollers as they roll on each other. I have only to place a sheet of canvas between the rollers and draw it through; both the flannel rollers roll on the canvas and on the wadding, which they pass through without slipping, causing the wadding to move in a wave outside them, and affording a complete parable of the vortex motion.

I will now show by colour bands some of the more striking phenomena of internal motion, as presented by nature's favourite form of vortex, the vortex ring, which may be described as two horse-shoe vortices with their ends founded on each other.

To show the surface separating the water moving with the vortex from that which gives way outside, I discharge from this orifice a mass of coloured water, which has a vortex ring in it formed by the surface, as already described. You see the beautifully-defined mass moving on slowly through the fluid, with the proper vortex ring motion, but very slow. It will not go far before a change takes place, owing to the diffusion of the vortex motion across the bounding surface; then the coloured surface will be wound into the ring which will appear. The mass approaches the disc in front. It cannot pass, but will come up and carry the disc forward; but the disc, although it does not destroy the ring, disturbs the motion.

If I send a more energetic ring, it will explain the phenomenon I showed you at the beginning of this lecture; it carries the disc forward as if struck with a hammer. This blow is not simply the weight of the coloured ring, but of the whole moving mass and the wave outside. The ring cannot pass the disc without destruction with the attendant wave.

Not only can a ring follow a disc, but, as with the plane vane, so with the disc; if we start a disc, we must start a ring behind it.

I will now fulfil my promise to reveal the silent messenger I sent to those balloons. The messenger appears in the form of a large smoke ring, which is a vortex ring in air rendered visible by smoke instead of colour. The origination of these rings has been carefully set so that the balloons are beyond the surface which separates the moving mass of water from the wave, so that they are subject to the wave motion only. If they are within this surface they will disturb the direction of the ring, if they do not break it up.

These are, if I may say so, the phenomenal instances of internal motion of fluids. Phenomenal in their simplicity, they are of intense interest, like the pendulum, as furnishing the clue to the more complex. It is by the light we gather from their study that we can hope to interpret the parable of the vortex wrapped up in the wave, as applied to the wind of heaven, and the grand phenomenon of the clouds, as well as those things which directly concern us, such as the resistance of our ships.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—The Curators of the University Chest have been authorised by Congregation to pay the following sums.

To the Delegates of the Museum, a sum of £140 for each of the years 1894, 1895, for the general expenses of the Museum.

To the Curators of the Botanic Garden a sum not exceeding £200, to provide for expenses incurred in connection with the erection of new houses in the garden.

The Curators of the University Chest have been authorised to expend a sum not exceeding £700 in making the rooms in the south corridor in the Museum, and the lofts over them, available for the use of the Hope Professor of Zoology, and to pay to the Hope Professor of Zoology, in addition to the statutable grant, the sum of £100 for each of the years 1894–1898, to provide for the salary of the attendant and other expenses of the Department.

The Delegates of Local Examinations have approved of the introduction of a new examination in the course for junior candidates in elementary physiology and hygiene.

Amongst those on whom it is proposed to confer the honorary degree of D.C.L. at the Encænia, is the name of Mr. Francis Galton, F.R.S.

One or more Natural Science Demyships, and Natural Science Exhibitions will be awarded by Magdalen College in October this year, the examination to commence on Tuesday, October 9.

At Wadham College, in the Scholarship examinations which will begin on Thursday, November 29, no papers in natural science will be set, but in the election to one of the Exhibitions preference will be given to any candidate who shall undertake to read for honours in natural science, and to proceed to a degree in medicine in the University of Oxford.

At Keble College an election will be held to one Scholarship in natural science of the value of £60 per annum, with laboratory fees not exceeding £20 per annum, on December 11 next. The examination will consist of papers in biology and chemistry, and all inquiries respecting the examination should be addressed to Mr. W. Hatchett Jackson, Keble College. The examination will begin on Thursday, December 6.

Mr. R. Warington, F.R.S., has been elected to the Sibthorpian Chair of Rural Economy, in succession to Sir John Gilbert.

CAMBRIDGE.—This year, for the first time on record, there is a bracket of two for the Senior Wranglership. In 1887 four names were bracketed for the highest place. These are the only instances in which the Senior Wrangler of the year has not stood "alone in his glory." Messrs. W. S. Adie and W. F. Sedgwick, both of Trinity College, share the honour. There is one lady wrangler, Miss E. H. Cooke, of Girton, who is bracketed twenty-eighth. In the second part of the Mathematical Tripos, a lady of Newnham, Miss A. M. J. E. Johnson, who was between fifth and sixth in the first part last year, heads the list, as she is placed alone in the first division of the first class. The Tyson Medal, for astronomy, offered this year for the first time, is not awarded.

Seven names appear in the first list of the Mechanical Sciences Tripo, all three of those in the first class having already taken the B.A. degree on some other examinination.

The Harkness Studentship in Geology has failed of award, in the absence of candidates.

The degree of Sc.D. is to be conferred on Professor Demetri Ivanovitch Mendeléef, of St. Petersburg, who was not able to accept the honour when it was offered him in 1889.

The following are appointed examiners for the new diploma in Agricultural Science: W. F. Darwin, Mr. W. G. P. Ellis, Professor Liveing, Mr. T. B. Wood, Professor Foster, Mr. A. Eichholz, Mr. A. E. Shipley, Mr. C. Warburton, Professor Hughes, Mr. P. Lake, Mr. O. P. Fisher, Mr. E. Clarke, and Mr. R. Menzies.

THE Scottish Association for the Promotion of Technical and Secondary Education have presented a memorial to Mr. Acland asking that the yearly examinations of the Department of Science and Art shall be held in the day as well as in the evening. It is pointed out that originally arranged, as they were, to suit the convenience of artisan pupils who could not be expected to attend during the day, these evening examinations are now taken by large and increasing numbers of pupils of secondary and higher grade schools. While, therefore, fully recognising the necessity which exists for examinations in all stages of art and science subjects being continued in the evening as heretofore, the memorialists urge the desirability of provision being made by the Department for the examination, within school hours, of pupils attending day schools.

SIR PHILIP MAGNUS has been appointed to represent the University of London at the bicentenary celebration of Halle University, to be held in August next.

SCIENTIFIC SERIALS.

Bulletin de l'Académie Royale de Belgique, No. 3.—Experimental demonstration of the purely accidental character of the critical state, by P. de Heen. A small quantity of amylene was introduced into the bottom of a tube, and surmounted by mercury, the tube being so thin that the mercury remained at the top. The tube was placed inside a box with glass windows, which was then heated to temperatures ranging from 201° C., the critical temperature of amylene, to about 350°. The tube was connected at the top with a Cailletet compression apparatus. It was found that even under pressures less than 5 atmospheres the amylene could be heated to 350° without evaporating. The critical state, characterised by turbulent movements, was never exhibited, but if by some accident a small quantity of vapour was formed the critical state set in at once. The author concludes that the critical state consists of a non-homogeneous mixture of "liquidogenic" and "gazogenic" molecules. At a certain high temperature, estimated for most liquids at 800° or 900°, the former are completely dissociated, and the pressure-volume curve becomes a simple isothermal. But the state of a fluid is not defined by pressure and temperature alone, since at the critical temperature, and at zero pressure, the volume can vary from unity to infinity.—Facts relating to the properties of carbon bisulphide, by H. Arctowski. The boiling point of pure carbon bisulphide is 46°·27, but this rises steadily during the process of determining it. The bisulphide is partially decomposed by the sun's rays, by moist air, and by a slight elevation of temperature continued for some time.—On the solubilities of the haloid salts of mercury in carbon bisulphide, by the same author. These salts show different solubilities, the iodide being the most, and the chloride the least soluble. The solubilities show a point of upward inflection at about 15° C. From 15° to −10° the lines of solubility converge in such a manner that if produced they would meet the axis of solubilities at a point corresponding to −25°.—Some experiments in experimental pathological embryology, by P. Francotte. Some ova of *Leptoplana tremellaris* were opened with a find steel point to admit schizomycetes. The microbes were either digested or excreted. The author concludes that microbian diseases cannot be transmitted by either ova or spermatozoa.

THE *Meteorologische Zeitschrift* for May contains a discussion of the results of meteorological observations on the Pic du Midi, by Dr. F. Klengel. The observations dealt with are those made during the years 1874-81 (excepting 1877), at the Plantade station, situated at a Pass, at an elevation of 7760 feet, and they furnish important materials respecting the climatic peculiarities of the high Pyrenees. The mean temperature was 34°·2; the absolute minimum was −11°·2 in January 1878, and the maximum 77°·4, in August 1881. Frost was observed on an average on 224 days in the year; the absolute maxima in all months were above 32°, and the minima mostly below 32°, even in July and August. The rainfall was exceedingly copious, amounting in the year to no less than 93·5 inches, a quantity which is only equalled at a few other places in Europe. The wettest month was April, with 18 inches, and the dryest July, with 2·7 inches. The distribution of rainfall throughout the year was extremely irregular; the number of wet days in the year amounted to 184. The most prevalent winds were from northwest, 25 per cent., and from south-west, 23 per cent. The French Meteorological Office has published in its *Annales* the observations made at the summit of the mountain since October 1881, at a still greater altitude; these will, no doubt, be dealt with in a subsequent paper.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 24.—"Measurements of the Absolute Specific Resistance of pure Electrolytic Copper." By J. W. Swan and J. Rhodin.

This paper is a record of measurements of the absolute specific resistance and temperature coefficient of pure electrolytic copper. The authors compared a large number of different specimens of electrolytic copper. Several of the specimens were at first roughly examined, and the best chosen for further investigation. The best of these was then electrolytically refined. This, without previous fusion, was drawn through sapphire dies to the requisite diameter, and the resulting wire subjected to careful measurements. The first specimen, "A," was measured both when hard and also after annealing at a red heat in an atmosphere of carbon dioxide gas; the second sample, "B," was only examined after annealing. The authors took extreme care in finding the dimensions of the wires and the temperatures at which they were measured.

The values of the two specimens in C.G.S. units were as follows, the density being 8·9587 at 15° C.

	Absolute specific resistance. C.G.S. units.	Temp. coefficient. Δt.
Sample A. Hard, as drawn......	1603	0·00408
,, A. Soft, as annealed....	1566	0·00418
,, B. Soft, as annealed....	1559	0·00415

May 31.—"On Rapid Changes of Atmospheric Temperature, especially during Föhn, and the Methods of observing them." By J. Y. Buchanan, F.R.S.

In July 1893, on the west coast of Scotland, föhn of a well-defined type prevailed. It was characterised by puffs of very hot air occurring every two or three minutes in the midst of the abnormally warm air of the day. On July 7 and 8 these hot puffs were felt very strongly, and especially on the water. Attempts to measure their temperature with a thermometer proved unavailing, as their temperature was so high and their duration so short that the thermometer had only begun to rise when the heating cause had passed. Between August 18 and 23 exactly the same character of weather was observed in the valleys around Pontresina in the Engadine. The hot puffs were very remarkable. The weather was recognised by the people as "föhn." Here the inadequacy of the thermometer as usually employed was again apparent. Observations were made on the exchange of heat taking place between the hot föhn wind and the Morteratsch glacier over which it was blowing. The temperature of the air was observed at a station on the glacier, and at a station at the same altitude on the mountain at its side. The temperature of the air at the land station was found very variable, altering as much as 2° C. in five minutes. By making a number of observations during quarter of an hour a mean value was obtained for comparison with the temperature over the ice. On land the average temperature of the air in the afternoon was 16·5 C.; over the ice, and at a height of one metre above it the temperature was 10° C., and when the thermometer was laid horizontally with its bulb at distances between two centimetres and two millimetres from the ice, the lowest temperature of the air in that position was 5°·5 and the highest 7°·5. The wind blew over the glacier at a speed of eight to ten kilometres per hour, and was a fresh breeze, which might have been expected to thoroughly mix the air, yet the result of repeated observations showed that well-defined temperature gradients were produced and maintained in the air between the ice and a height of a metre above it. Between one metre and one millimetre above the ice the gradient is moderate, averaging 3°·5 per metre. In the thin layer next the ice the gradient is precipitous. The occurrence of the highly-heated puffs of air due to the föhn directed attention to the measurement of rapid variations of temperature generally. An approximation was made to their estimation by noting the rate at which the thermometer began to rise in one of these puffs, and then determining experimentally the excess of temperature of the air required to produce this effect. This could not be satisfactorily done at the time, but attention was paid to it later.

This method seemed to be the only one by which ordinary thermometers can be made to indicate truthfully changes of temperature which are not extremely slow. The method was applied in the case of a series of temperatures observed at very close intervals during the first two hours after sunrise on several days in February at St. Moritz. The temperature of a thermometer freely exposed to the north was observed at intervals of twenty seconds. These are summarised in a table. The temperature exhibited generally two falls for every three to four rises; the largest rise or fall in twenty seconds was 0°·5 C. From careful experiments on the rate of cooling of the thermometer, both in a room and in the open air when the air was still, it resulted that to produce a rise of temperature of 0°·5 in twenty seconds, the temperature of the air at the beginning of the interval must have been at least 2°·25 C. higher than that of the thermometer at the same instant. If there had been a fall of the same amount, then the temperature of the air must have been as much lower than that of the thermometer at the beginning of the interval. So that if, in any two consecutive intervals of twenty seconds, the thermometer showed a rise of 0°·5 and a fall of the same amount, the apparent temperature of the air at the beginning and the end of the interval is the same, whereas the true temperatures differ by 2 × 2·25 − 0·5 or 4°·0 C. A table is given in the paper of the temperatures observed at intervals of twenty seconds during a few minutes on February 26, when the variations were considerable. The differences of temperatures required to produce the observed changes are given, and from them the amended or true temperatures are deduced and tabulated. The true variations of temperature are naturally much more abrupt than the apparent ones.

The concluding part of the paper deals with the employment of the thermometer as a calorimeter. For this purpose it is necessary, besides the rate of cooling, to know the "thermal mass" or water value of the bulb. A method is indicated by which this can be ascertained with very considerable accuracy by the measurement of the volume of the bulb. The circumference of the bulb is best determined by winding fine thread round it in a close spiral for a certain number of turns, then measuring the length of the unrolled thread. When the specific heat of mercury and that of ordinary glass are expressed in terms of unit volume they are very nearly identical; namely, 0·449 for mercury, and 0·466 for glass. It is clear that if the mean of the two is taken to represent the specific heat of the bulb, an error of not more than two per cent. is made in the extreme case when the bulb consists of all mercury or all glass. When the thermal mass and the rate of cooling of a thermometer have been determined, its usefulness as a metereological instrument is increased manifold.

Chemical Society, May 17.—Dr. Armstrong, President, in the chair.—The following papers were read:—The influence of moisture on chemical change, by H. B. Baker. Highly purified lime and carefully dried copper oxide do not combine with sulphur trioxide; dry ammonium chloride may be sublimed from a mixture with lime without the liberation of ammonia. Pure dry nitric oxide gives no brown fumes with dry oxygen, although the addition of a trace of moist air causes immediate interaction. Carefully dried ammonium chloride does not dissociate on volatilisation, the vapour having the density 28·7.—New volatile compounds of lead sulphide, by J. B. Hannay. The observed volatility of lead sulphide in water vapour may be explained by assuming the existence of gaseous compounds of lead sulphide and water; the author concludes that a definite compound of the composition PbS,H_2O exists. Evidence in support of the existence of a compound of the composition PbS,SO_2 is also brought forward; both these substances are colourless gases at a red heat, but decompose below 800°.—Notes on the cupellation of bismuth-silver alloys, by E. A. Smith.—Azo-*p*-cresol derivatives, by R. Meldola and F. Southerden. The authors have endeavoured to determine the constitution of several ortho-azo-derivatives of paracresol by treating their acetyl derivatives with nitric acid or bromine.—Effect of heat on iodates and bromates, by E. H. Cook. During the fusion of potassium bromate and iodate, bromine and iodine are respectively evolved; no halogen is given off after melting is complete, and after continued heating to drive off all the oxygen, only potassium bromide or iodide remains.

Geological Society, May 23.—Dr. Henry Woodward, F.R.S., President, in the chair.—On the stratigraphy and physiography of the Libyan Desert of Egypt, by Captain H. G. Lyons, R.E. The Nubian sandstone, wherever seen, rests unconformably on the old rocks called by Sir J. W. Dawson Archæan, and the author found no case of alteration of sandstone by these rocks, though in one case it is altered by an intrusive dolerite. The author considered the Nubian sandstone to be an estuarine deposit which was formed on an area afterwards gradually invaded by the Cretaceous sea. He considered the whole of the sandstone in the region which he had examined to be of Cretaceous age. He described a series of anticlinals, one set running W.N.W.-E.S.E., and the other N. by E. and S. by W. Many springs of the oases seem to occur along these anticlinals, owing to the beds which contain the water being brought nearer to the surface. Historical evidence was discussed which points to the Nile having reached a higher level in Nubia than it does at present, and it was suggested that variations in the level of the river were caused by earth-movement opposing obstructions to the river's flow. The sandstone of Jebel Ahmar near Cairo was described, and its occurrence over a wide area west of Cairo recorded. The author considered its age to be later Miocene. He believed that, with the exception of some erosion after the deposition of the Eocene beds, the greatest erosion, including the cutting-out of the Nile Valley, took place in Miocene times, while a certain amount, bringing the area to its present condition, was done in Quaternary times. This agrees with the observations of the French geologists in Algeria. The origin of the silicification of the fossil trees of the sandstone-deposits was discussed, and the action of water containing sodium carbonate suggested as a cause. The President, Mr. Hudleston, and the Rev. G. Henslow having made remarks upon the paper, Prof. Hull said he concurred with the view of the author that the course of the Nile above Cairo had been determined by the line of fault, which follows the valley for many miles upward. As regards the age of the Nile in Egypt, he considered it as referable to the Miocene stage rather than to the Pliocene. The Miocene period in that part of the world was one in which the main features of the present land-areas received their general contours. Referring to an observation by Mr. Hudleston regarding the absence of carboniferous beds in the Nile Valley, he reminded the Society that deposits of this age had been discovered by Dr. Schweinfurth in the Wady-el-Arabah between the Nile and the Gulf of Suez. Dr. Irving, remarking on the silicification of wood, said he wished again to emphasise the difference in the action of carbonic acid in petrological changes, according as it existed as a free acid or in combination with a base, as in sodium carbonate. The extent of the "Natron" deposits pointed to the supply of alkaline waters over large areas in former times, holding the mineral in solution. The reaction of such waters upon the potash-felspar of the sands, furnished by the disintegration of the crystalline rocks, would not lead to the deposition of free silica (as in the ordinary process of kaolinisation), because, while the potassium was taken up as a carbonate and carried away, the silica was also removed in solution, through combination with the sodium, to form sodium silicate. This last-named salt in solution would be readily decomposed by the organic acids and the carbonic acid furnished by decaying vegetable tissue, the silica being then deposited as a colloid *in situ*, and thus retaining the structural forms of the original tissue. The author briefly replied.—Notes on the geology of South Africa, by Mr. D. Draper. The district considered includes Natal, Zululand, Swaziland, the south-east part of the Transvaal, and the eastern part of the Orange Free State and of Basutoland. Physically it comprehends:—(1) The Drakensberg Range; divided into (*a*) mountain portion; (*b*) hill-covered plateau; (*c*) Highveld plateau; (2) the terrace along its foot; (3) the coast-belt. Their main features and characteristics were described. The geological formations are:—

Karoo Beds.	Upper.	1. Volcanic Beds.
		2. Cave Sandstone.
		3. Red Beds.
		4. Molteno Beds.
	Lower.	5. Beaufort Beds.
		6. Ecca Beds.
		7. Dwyka (Ecca) Conglomerate.
		[Bokkeveld Beds, wanting,]
Palæozoic.		8. Gats Rand (Zuurberg) Quartzite.
		9. Dolomitic Limestone.
		10. Table-mountain Sandstone.
		11. Malmesbury Schists.
		12. Gneiss and Granite.

—On the occurrence of dolomite in South Africa, by the same author. A peculiar calcareo-siliceous rock, near Lydenburg, described by Messrs. Penning and Crutwell as "Chalcedolite," and a similar rock mentioned by Mr. Penning as overlying the "Blackreef Series" of the Megaliesberg formation, have been recognised as a dolomite. Mr. C. Alford has described a "calcareous quartzite" as passing into dolomite and ultimately into chert, and known as the "Elephant-rock" in Transvaal, sometimes cavernous with underground waters. From his own experience Mr. Draper has recognised the "Elephant-rock" in the Potschefstroom, Lichtenburg, Malmani, and Lydenburg districts as a real dolomite, with interstratified siliceous bands, weathering into a brown earth like manganese oxide and superficial siliceous débris. It has its place between the Table-mountain sandstone and the quartzite of the Gats Rand (= Zuurberg quartzite of the Cape). It has auriferous veins in Malmani and Lydenburg. Dr. Schrenck has noticed a similar dark-blue dolomitic limestone in Great Namaqualand. The deep water-holes in it in Malmani are comparable with those found by F. Galton in West Central Africa. The great caves in Mashonaland may belong to it. The extensive tufaceous deposits in Griqualand-West, the Transvaal, and Orange Free State were probably derived from this extensive dolomite. Mr. Rutley, Mr. Nicol Brown, and Prof. T. Rupert Jones took part in the discussion that followed.—Contributions to the geology of British East Africa, by Dr. J. W. Gregory. The author described moraines, striæ, glacial lake-basins, perched blocks, and *roches moutonnées* below the present limits of the glaciers of Mount Kenya, which he maintained to indicate the existence of a "calotte" or ice-cap extending at least 5400 feet farther down the mountain than the termination of the present glaciers, and possibly farther, for in the belt of forest detailed observations could not be made. He agreed that this more extensive glaciation was produced by a greater elevation of Mount Kenya, and that any theory of universal glaciation is unnecessary, and indeed opposed by many facts in African geology. He discussed the probable influence of this former glaciation on the meteorological conditions of the surrounding area and the distribution of its flora and fauna.

PARIS.

Academy of Sciences, June 4.—M. Lœwy in the chair.—On the composition of apophyllite, by M. C. Friedel. No positive evidence of the presence of fluorine in this mineral could be obtained with specimens from Bou Serdoun (Algeria). Instead of an acid reaction, the water evolved possessed an alkaline reaction in the cases of specimens from Bou Serdoun, Andreasberg, Guanajuato (Mexico), Greenland, Nova Scotia, and Utö (Sweden). There is no fluorine in the samples examined; that reported by previous observers is probably due to the imperfect methods of analysis employed; on the other hand, they contain ammonia in quantity varying from 0·03 to 0·5 per cent., possibly replacing a part of the potassium. The evidence available is insufficient to settle the formula expressing the composition of apophyllite.—Report on a memoir by M. Bazin on experiments on the contraction of liquid jets and the distribution of velocities in their interior, by MM. Resal, Maurice Levy, Sarrau, and Boussinesq.—Transmission of sounds, by M. Henri Gilbault. The amplitudes of vibration being represented by y, and distances by x, it is shown that the law xy = a constant is not verified in practice for small values of x.—On the value of the theoretical ohm, by M. A. Leduc. The author shows that a part of a correction, considered unimportant by M. Wuilleumier, must be applied to the results obtained by the latter according to M. Lippmann's method. These results then give for the length of a column of mercury at 0° C. and of 1 sq. mm. section representing the theoretical ohm, the value 106·32 cm. in place of 106·267 cm. The revised value is in close accord with the mean of the best determinations made by other methods.—On the method of transformation of work into electric energy, by M. Vaschy.—On alternating currents and Wheatstone's bridge, by M. H. Abraham. A method is described for obtaining the frequency of the alternations by bridge measurements.—The *skiascope-optomètre*, by M. H. Sureau. A description of the use and parts of an instrument for the examination of the eye by opticians.—New researches on the chloroboracites, by MM. G. Rousseau and H. Allaire. The author describes the production and properties of compounds of zinc, cadmium, nickel, cobalt, and manganese having the general formula $6MO . 8B_2O_3 . MCl_2$.—On the *rôle* of the transformations of iron and carbon in the hardening of steel, by M. Georges Charpy. The following conclusions are drawn from the experimental results given. Hardening produces, among other modifications, a transformation of the iron (characterised by the breaking strain) and a transformation of the carbon (characterised by the variation of the results by the Eggertz test). The transformation of the iron appears to have but a feeble influence on the breaking strain, whereas the transformation of the carbon appears to be correlative with the augmentation of hardness.—On a hydrobromide of cupric bromide and on a red bromide of copper and potassium, by M. Paul Sabatier. The formula $CuBr_2 . HBr . 2H_2O$ is attributed to the substance obtained in black *chatoyant* crystals by cooling a concentrated solution of cupric bromide into which hydrogen bromide has been passed. The double compound with potassium is $CuBr_2 . KBr$. It forms fine, deliquescent, rhombic plates, which are very opaque and apparently black, but are seen to be red in thin sections.—On the analytical separation of chlorine and bromine, by M. R. Engel. The bromine is separated by oxidation with ammonium persulphate, and distilled off into a sulphurous acid solution, from which it is precipitated as silver bromide. Under the conditions given, the chlorine is not affected.—On the detection of hydrobromic acid, by MM. A. Villiers and M. Fayolle.—New derivatives of cyanacetic and cyanosuccinic esters, by M. L. Barthe.—Combinations of pyridine with the permanganates, by M. T. Klobb. A series of compounds parallel with the ammonia derivatives previously described and of the general formula $MMnO_4 . 2C_5H_5N$ or $MMn_2O_8 . 4C_5H_5N$ are given.—On the emetics, by M. Paul Adam. The conclusion is drawn that substances of the emetic type should be considered as ether salts and not double salts.—On monoethylphosphoric acid, by M. J. Cavalier. This acid exhibits, thermally, two clearly distinct functions and gives two series of definite salts, corresponding with the formulæ PO_4EtMH and PO_4EtM_2.—Action of trioxymethylene on alcohols in presence of ferric chloride, and on the new methylene derivatives which result, by MM. A. Trillat and R. Cambier. Mechanism of the action of chlorine on isobutylic alcohol, by M. A. Brochet.—Researches on the red pigmentary matter of *Pyrrhocoris apterus* (L.), by M. C. Phisalix.—On the relations between the dorsal cord and the hypophysis in birds, by M. G. Saint-Remy.—On a new *grégarine* of the family of the Dactylophorides, parasitic on Geophiles, by M. Louis Léger.—On a *Ustilaginée* parasitic on the beet-root (*Entyloma leproideum*), by M. L. Trabut.—On a vine disease caused by *Botrytis cinerea*, by M. L. Ravaz.—Contribution to the study of *géclases conjuguées*, by M. Stanislas Meunier.—Variations of the latent period of coagulation of milk soured by rennet, by M. C. Pagès.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JUNE 14.

ROYAL SOCIETY, at 4.30.—Flame Spectra at High Temperatures—Part II. The Spectrum of Metallic Manganese, of Alloys of Manganese, and of Compounds containing that Element. Part III. The Spectroscopic Phenomena and Thermo-chemistry of the Bessemer Process: Prof. Hartley, F.R.S.—The Complexity and the Dissociation of the Molecules of Liquids. Prof. Ramsay, F.R.S.—(1) The Molecular Surface-energy of the Esters, showing its Variation with Chemical Constitution; (2) The Molecular Surface-energy of Mixtures of Non-associating Liquids: Prof. Ramsay, F.R.S., and Miss Emily Aston.—On a Method of Determining the Thermal Conductivity of Metals, with Applications to Copper, Silver, Gold, and Platinum: James H. Gray.

MATHEMATICAL SOCIETY, at 8.—The Solutions of Two Differential Equations: F. H. Jackson.—A Theorem in Inequalities: A. R. Johnson.—Some Properties of a Circle: R. Tucker.—Note on Four Special Circles of Inversion of a System of Generalised Brocard Circles of a Plane Triangle: J. Griffiths.—On the Order of the Eliminant of Two or more Equations: Dr. R. Lachlan.

FRIDAY, JUNE 15.

QUEKETT MICROSCOPICAL CLUB (20 Hanover Square, W.) at 8.

SATURDAY, JUNE 16.

GEOLOGISTS' ASSOCIATION.—Excursion to Gravesend and Northfleet. Directors: Prof. T. Rupert Jones, F.R.S., and F. C. J. Spurrell.

YORKSHIRE NATURALISTS' UNION.—Meeting at Pontefract for the Investigation of the Neighbourhood of Ferrybridge, &c.

MONDAY, JUNE 18.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Survey of the English Lakes (with Illustrations): Dr. Hugh Robert Mill.

TUESDAY, JUNE 19.

ROYAL STATISTICAL SOCIETY (Museum of Practical Geology, 28 Jermyn Street, S.W.), at 7.45.—A Comparison of the Realised Wealth and of the Economic Condition of France and England, especially as relating to their Agricultural Production and their Security in case of War: Mr. William J. Harris.

ZOOLOGICAL SOCIETY, at 8.30.—On Lepidosiren and Protopterus: Prof. Ray Lankester, F.R.S.—Notes on some Specimens of Antlers of the Fallow Deer showing Continuous Variation and the Effect of Total or Partial Castration: Dr. G. Herbert Fowler.—On the Perforated Flexor Muscles in some Birds: Mr. P. Chalmers Mitchell.

MINERALOGICAL SOCIETY, at 8.—A Chemical Study of some Native Arseniates and Phosphates: Prof. A. H. Church, F.R.S.—The Occurrence of Mispickel in the Stewartry of Kirkcudbright: P. Dudgeon.

WEDNESDAY, JUNE 20.

GEOLOGICAL SOCIETY, at 8.—On Deep Borings at Culford and Winkfield, with Notes on those at Ware and Cheshunt: W. Whitaker, F.R.S., and A. J. Jukes-Browne.—On the Bargate Stone and the Pebble-beds of Surrey, with especial regard to their Microscopic Contents: Frederick Chapman.—On Deposits from Snowdrift, with special reference to the Origin of the Loess and the Preservation of Mammoth-remains: Charles Davison.—Additions to the Fauna of the Olenellus-zone of the North-West Highlands: B. N. Peach, F.R.S.—Questions relating to the Formation of Coal-Seams, including a New Theory of them: suggested by Field and other Observations made during the past decade on both sides of the Atlantic: W. S. Gresley.—Observations regarding the Occurrence of Anthracite generally, with a New Theory of its Origin: W. S. Gresley.—The Igneous Rocks of the Neighbourhood of Builth: Henry Woods.—On the Relations of some of the Older Fragmental Rocks in North-West Caernarvonshire: Prof. T. G. Bonney, F.R.S., and Miss Catherine Raisin.

ROYAL MICROSCOPICAL SOCIETY (20 Hanover Square, W.), at 8.—On the Unreliability of certain Characters generally accepted for Specific Diagnosis in the Diatomaceæ: Mr. T. Comber.—Foraminifera of the Gault of Folkestone: Mr. T. Chapman.

ROYAL METEOROLOGICAL SOCIETY, at 8.—Fogs reported with Strong Winds during the Fifteen Years 1876–90 in the British Isles: Robert H. Scott, F.R.S.—Some Characteristic Features of Gales and Strong Winds: Richard H. Curtis.

THURSDAY, JUNE 21.

ROYAL SOCIETY, at 4.30.—The following Papers will *probably* be read:—On the Absorption Spectra of Dilute Solutions: Dr. T. Swan.—On some Phenomena in Vacuum-tubes: Sir D. Salomons.—On Operators in Physical Mathematics, Part III.: O. Heaviside.—On the Structure and Affinities of Heliopora cærulea (Pal.), with some Observations on the Structure of Xenia and Heteroxenia: Albert C. Bourne.—On the Differential Invariants of Twisted Curves, with some Illustrations of the Application to Quartic Curves: R. F. Gwyther.—Degenerations consequent on Experimental Lesions of the Cerebellum: Dr. Risien Russell.—Measurement of Colour produced by Contrast: Captain Abney, F.R.S.—On the Singular Solutions of Simultaneous Ordinary Differential Equations and the Theory of Congruencies: Prof. A. C. Dixon.—And other Papers.

LINNEAN SOCIETY, at 8.—On Tabulation Areas: C. B. Clarke, F.R.S.

CHEMICAL SOCIETY, at 8.—The Specific Character of the Fermentation Functions of Yeast Cells: Adrian J. Brown.—The Interaction of Lead Sulphide with Lead Sulphate and Oxide: J. B. Hannay.—The Oxidation of Tartaric Acid in the Presence of Iron: H. J. H. Fenton.—The Relation between the Solubility of a Gas and the Viscosity of its Solvent: Prof. Thorpe, F.R.S., and J. W. Rodger.—And other Papers.

FRIDAY, JUNE 22.

PHYSICAL SOCIETY, at 5.—An Exhibition of Photographs of Flames: Captain Abney.—An Elementary Theory of Planimeters: Prof. Henrici.—The Hatchet Planimeter: F. W. Hill.—A New Integrating Apparatus: A. Sharp.—Other Papers if time allows.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Histoire de L'Alimentation, L. Bourdeau (Paris, Alcan).—On the Development and Transmission of Power: Prof. W. C. Unwin (Longmans).—Quain's Elements of Anatomy: edited by Profs. Schäfer and Thane, Vol. 3, part 3, 10th Edition (Longmans).—Ostwald's Klassiker der Exakten Wissenschaften, Nos. 46, 47, 52, 53 (Leipzig, Engelmann).—Report of the Department of Public Works (N. S. W.) for the Year 1892 (Sydney, Potter).—U.S. Commission of Fish and Fisheries Report, 1889-91 (Philadelphia).—Iowa Geological Survey, Vol. 1 (Des Moines).—Publications of the Washburn Observatory of the University of Wisconsin, Vol. 8 (Madison).—Report of the Chief of the Weather Bureau, 1891-92 (Washington).—The Freon Handbook, No. 2 (Beck).—Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Natural History), the Wealden Flora, Part 1: A. C. Seward (London).—Sitzungsberichte der K. B. Gesellschaft der Wissenschaften, 1893 (Prag).

PAMPHLETS.—Report on the Social Condition of the People: J. Nyland (Davy).—Sulla Solidificazione delle Amalgame: D. Mazzotto, i. and ii. (Venezia, Ferrari).—Sui Sistemi Nodali delle onde Elettriche: Ditto, ii. and iii. (Torino, Clausen).—Technogeography: O. T. Mason (Washington).—The Birth of Invention: O. T. Mason (Washington).—The Progress of Anthropology: O. T. Mason (Washington).—National Academy of Sciences, Vol. 64th; Memoir—The Proteids or Albuminoids of the Oat Kernel: T. B. Osborne.—Dry Methods of Sanitation: G. V. Poore (Stanford).—Rapport Annuel sur l'État de l'Observatoire de Paris pour l'Année 1893 (Paris).—North American Species of Sagittaria and Lophotocarpus: J. G. Smith (St. Louis).

SERIALS.—Gazetta Chimica Italiana, 1894, fasc. 5 (Roma).—Indian Museum Notes, Vol. 3, No. 3 (Calcutta).—Bulletin of the Essex Institute, Vol. 26, Nos. 1, 2, 3 (Salem).—Essex Institute Historical Collections, Vols. 29 and 30 (Salem).—Illustrated Archæologist, June (Clark).—Bulletin de la Société d'Anthropologie de Paris, No. 2, 1894 (Paris, Masson).—Mémoires de la Société d'Anthropologie de Paris, Tome 1 (3e series), 2e fasc. (Paris, Masson).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1893, No. 4 (Moscou).—Himmel und Erde, vi. Jahrg. Heft 9 (Berlin).—Journal of the Anthropological Institute, May (K. Paul).—Medical Magazine, June (Southwood).—Proceedings of the Edinburgh Mathematical Society, Vol. 1, Session 1883 (Williams and Norgate).—Proceedings of the American Philosophical Society, Vol. 31, No. 142 (Philadelphia).—American Meteorological Journal, June (Gion).—Verhandlungen des Naturhistorischen Vereins, Fünfr. Jahrg. Zweite Hälfte (Bonn).—Journal of the Asiatic Society of Bengal, Vol. 62, Part 2, No. 4 (Calcutta).

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THURSDAY, JUNE 21, 1894.

THE BROTHERS WILLIAM AND JOHN HUNTER.

Two Great Scotsmen: the Brothers William and John Hunter. By George E. Mather, M.D., F.F.P. and S. (Glasgow: James Maclehose and Sons, 1893.)

IF too long a time may seem to have passed away before we review this handsomely illustrated volume, we excuse ourselves by saying that before we determined to undertake the task we would read the work through conscientiously and thoughtfully from its alpha to its omega, and compare it with the sources of information from which it is compiled. We saw by the general tone of the press that the volume was being rather roughly treated, and hoped that some prejudice or carelessness had been at work, which might be corrected. It too often happens that treatises on science and on the labours and works of men of science are merely glanced at and spoken of from hastily gathered impressions bearing mainly on style and manner, not on actual matter of fact relating to the work and the mind that produced them. It happens also, not unfrequently, that in a work, difficult of comprehension at its first reading, one or two reviews set the tone for praise or dispraise to all others; so that a good work may, as it were, be, by accident, doomed to light or to darkness without just cause.

Let us say first then of this volume that as a work it is admirably got up and illustrated. The plates, whether they relate to men, buildings, or scenery, are simply perfect, and the volume altogether is just such an one as every scholar would be tempted to take down from the shelves and read at leisure. Let us say further, that through the narrative the author balances fairly between the two brothers, William and John Hunter. He discriminates wisely in regard to their characters, and shows how largely John Hunter was dependent for his success on his elder brother. But in his descriptions he has, too often, adduced sayings and thoughts which he has gathered from reading, and, with little alteration, has transferred to his own pages as if they were his own property. Thus, in comparing the two brothers, he makes use of a paragraph with which the life of William Hunter, by another author, is brought, in capital type, to a close.

"The brothers Hunter were twins in science, and William was the first-born."

A sentence which reads as follows, speaking also of the two brothers.

"Verily they were twin stars of the first magnitude, and William was the elder-born."

Such variations as these give to the volume the character of a compilation rather than a history, the whole appearing tinged also with a sense of weariness, as if its author were endeavouring to make old matter appear new, only too anxious to fill up his pages. To this must be added the introduction of matters almost altogether irrelevant. For example, at pages 40, 41, 42, we find a discussion, or colloquy, between Thomas Carlyle and Edmund Irving, with a long quotation from Carlyle, interesting enough in itself, but having not the slightest reference to the subject in hand. In like manner there is dragged in, at page 46, a description of the Manse at Mearns, where Christopher North received his early education, with a somewhat similar diversion on North Moorhouse, where Robert Pollok, the author of "The Course of Time," was born, together with a specimen of the poetry of the same poet, and a final digression containing snatches from the Ettrick Shepherd, Joanna Baillie, Prof. Wilson, and a rather long account of the famous Dr. Cullen, who, although a kind of master of William Hunter in his early life, is so much in evidence here, as to be made subject-matter for a third short biography, rather an intrusion when so much more admitted of being spoken of in reference to the two particular heroes of the book.

In noticing the labours of William Hunter, Dr. Mather is most at home in his description of the Hunterian Museum in Glasgow. With this palace of science he is evidently well acquainted. He remembers it in its old days, when it rose like an ancient temple in the grounds of that memorable old college which is now a railway station, and he knows it as it now stands, a part of the splendid new college which, as he says, "crowns the heights of Gilmorehill." The museum, he tells us, was begun for the purpose of illustrating the lectures of William Hunter, and at first its chief value consisted in the preparations showing the changes of the gravid uterus. "The Museum was not, however, confined," as he very properly explains, "to anatomical preparations, human and comparative, nor to specimens of disease merely, although the collection of these was wonderful, and thanks to hints from Albinus, all are in beautiful preservation. "Dr. Hunter was a man of very refined taste, and had a great desire to educate the members of his own profession, as well as the public, in this respect, and to afford opportunity to all of acquiring a rich and varied culture. William Hunter was a great teacher, and it was his ambition that his works, his bequests, should live and speak after him; it is not too much to say that there never has been gathered under one roof by one man a collection so vast and varied, and so well calculated to advance the wider culture of the members of the profession whose interests he had so greatly at heart.' And then he adds, copying word for word from a previous author, whom he immediately names, but not in connection with the passage: "Whether we turn to the Art Department, to the books, to the coins, to the natural history, or to the anatomy, there is to be discovered treasure upon treasure."

In the life and works of John Hunter presented in this volume, we find the same kind of faults as those which mark the life of William Hunter. There is compilation simply as the basis of all that is written, intermixed with a kind of philosophy which is also often the reflex of previous authorities, with more or less of acknowledgments. Much that might have been introduced and descanted upon is omitted, or so lightly touched as neither to be criticism nor narrative. Thus the great quarrel between the two brothers, which kept them practically apart for a long period, receives no new elucidation, and the life of John Hunter, at Earl's

Court, in the house recently pulled down and replaced by so many houses and streets that its site is now lost, receives the most scanty attention. Here, too, illustration fails us, which is much to be pitied, because illustration in the former part of the book has afforded its chief value.

There is nothing more painful to a reviewer than to find himself forced to discover faults and deficiencies in a work under his observation, and we have felt severely the task of pointing out the defects and deficiencies of the volume before us. But it would be false, even to the author of the work, if we did not notice its failures, for there is evidently an ardent desire on his part to be not only a faithful, but an enthusiastic biographer. What is wanted in his essay is work! work! work! expurgation of all that is irrelevant, introduction of all that can be added beyond what has been told by predecessors on the subject, with avoidance of the pitfalls of mere memory.

In a new edition, if it should appear, we will hope that the improvements suggested, in a perfectly friendly spirit, will be carried out. The volume as it now stands is a groundwork of a good treatise, which, under the influence of industry, learning, spontaneity, and art, might yet secure a good place in the literature of the century.

GOLD.

The Metallurgy of Gold. By T. Kirke Rose, B.Sc. (London: Charles Griffin and Co., 1894.)

A Handbook of Gold Milling. By Henry Louis. (London and New York: Macmillan and Co., 1894.)

THESE two books, which have been issued almost simultaneously, constitute important additions to the metallurgy of gold. They are both written by Associates of the Royal School of Mines, and it is singular that although the students of this great national institution have taken their full share in conducting mining and metallurgical operations in all parts of the world, and have gained wide experience, no treatise claiming to give a general account of the metallurgy of gold could hitherto have been attributed to a student of the School of Mines. No work on this subject of equal importance has appeared in English since Dr. Percy issued his volume on "Silver and Gold," in 1880, but his book, although unrivalled in accuracy of detail, is only a splendid fragment, and gold is alone dealt with in the sections devoted to the refining of bullion and to assaying.

Mr. Rose, who it appears gained his experience of gold and silver extraction in the Western States of America, is one of the able band of young men of whom Prof. Roberts-Austen is forming, in this country, a new school of metallurgists which is doing so much physical work in connection with metals and alloys. In the present volume Mr. Rose has made a successful effort to supply a succinct summary of the existing conditions of the metallurgy of gold for the use of students and others who are interested in the industries connected with the precious metals. In the second volume under review, Mr. Louis turns, it is true, more directly to an industrial application of the metallurgy of gold, and addresses the mill-man rather than the student; but Mr. Rose's volume is far from being only a student's manual, as he keeps steadily in view the needs of the managers of the gold mine and smelting works, a class who have hitherto considered that they had "little to learn from books."

The whole of the ground indicated by the title "metallurgy of gold" has been covered by Mr. Rose with equal care, and the space is carefully apportioned to the various branches of the subject according to their relative importance. Mr. Rose is probably at his best in dealing with the chemistry of the subject, as, for instance, in describing the MacArthur-Forrest process, which is now, for the first time, fully dealt with in a manual. Its importance may be gathered from the fact that nearly one-tenth of the world's annual production of gold is now being extracted by its aid. Among other processes which have not hitherto been described in a book, three deserve special mention. These are the process for separating gold from silver by the new Gutzkow process; the electrolytic process; and the modern barrel chlorination process, which is practised with great success in Dakota, where the Black Hills district is being rapidly developed by its aid. These processes are of special interest, but none which have stood the test of experience have been omitted. The four chapters devoted to chlorination, written from the point of view alike of the practical man and the chemist, teem with considerations hitherto unrecognised, and constitute an addition to the literature of metallurgy, which will prove to be of classical value.

The author has evidently taken great pains to secure details of gold-working from all parts of the world, and his descriptions range from Colorado to New Zealand and thence to South Africa, and as a result he has furnished practical men with details of working which should be of much service to them.

No less than eleven pages are devoted to an elaborate bibliography that is certainly more complete than any earlier ones, the latest of which—in Lock's work on the occurrence of gold—only brought us to the year 1882.

The illustrations are simple but effective; they are sufficiently accurate, and are characterised by much freshness, there being no time honoured diagrams from other metallurgical manuals. The same may be said of the illustrations in Mr. Louis' work.

Mr. Louis, in his book on "Gold Milling," has mainly limited his attention to the treatment of gold ores in stamp mills, and has, as the result of much personal experience, written a treatise of great practical value. He gives details of machinery with great fidelity, as a worthy pupil of the late Dr. Percy would be sure to do. While Mr. Louis clearly sets forth the general methods of working adopted in stamp mills, he reserves for full description those which he considers to be the best, instead of giving details of all methods, good, bad, and indifferent, that are to be met with in various parts of the world.

In a future edition the author would do well to devote additional space to considerations relating to the mill site, its building, modes of construction, and installation of machinery. These are of more importance to the mill manager, for whom the work is intended, than the shape of the cam-curve, and other points to which the maker of machinery should attend. The experience gained in the South African gold-fields, where the number of stamps at work is greater than in any other country, has led to great developments of practice, which it would be well to consider when the time comes for revising the work. If, however, the book be considered as a whole, Mr. Louis has undoubtedly offered the best account of gold milling that has yet appeared.

In concluding this review of both books, it may be well to remind the reader that, of all the phases of metallurgic art, that which leads to the consideration of gold is the most interesting. It is certain that modern chemistry had its dawn in the study of the properties of gold, while from the fourth to the fifteenth century chemists thought of little else than transmuting base metals into precious ones. The protest of the metallurgist against such wasted labour was, however, felt as early as the middle of the sixteenth century, and a book, "Rechter Gebrauch d'Alchemei," was published (1531), which by its title showed that the "right use of alchemy" was to bring chemical knowledge to bear upon industry. Hence it is that the modern metallurgist makes strenuous efforts not to transmute base metals into gold, but to extract it economically from a mass of material of which fifteen million parts may only contain one part of gold. It would be most interesting to know at what cost this is done, but upon this point Mr. Rose is unable to give us very definite information, though it is evident he considers that the ounce of fine gold which sells for about £4, should be produced for about £3, if it is to yield a profit to the miner and metallurgist.

Both books under review have each their special value. Mr. Rose has adopted a broad treatment of a very interesting subject, while Mr. Louis has shown how important a single branch of the metallurgy of gold can be.

OUR BOOK SHELF.

Geology. By Charles Bird, B.A., F.G.S. Pp. viii., 430. (London: Longmans, Green, and Co., 1894.)

LIKE the previous volumes in the series of Advanced Science Manuals published by Messrs. Longmans, this satisfies the requirements of the advanced stage of the Department of Science and Art. A sub-title informs us that the book is "a manual for students in advanced classes and for general readers." But while we believe the work to be well suited for use among students learning geology on South Kensington lines, we should be sorry to recommend it to the general reader, that is to say, to the person who reads geology for the pleasure it affords, and not with the idea of eventually exercising the acquired knowledge in an examination room. The author has collected together an abundance of facts, but the student who has to digest them all deserves our sympathy. There are, however, several good points about the book. One of these is the chapter on the industrial uses of rocks, in which numerous buildings, monuments, and other structures in London and elsewhere are noted as examples of various kinds of building materials. References to the practical application of geology to water supply, agriculture, and mining are also frequently made, and will doubtless endear the book to the man who measures the value of a science by its direct use in commercial life.

Mr. Bird has taken advantage of the splendid collection of photographs of geological formations published by Messrs. Wilson, of Aberdeen. The illustrations obtained from this source are among the best in the book, and many of them have not previously appeared in any work on geology or physiography. Another excellent feature in the pictorial part of the book is that a number of the figures of fossils, rocks, and minerals are from photographs of objects in the Jermyn Street Museum. The illustrations of some of the minerals are, however, not very instructive. The only use of a figure is to assist the student to distinguish the characteristics described in the text. It is doubtful, however, whether the figures of hornblende, heavy spar, fluor spar, iron pyrites, galena, and sulphur, given on pp. 24-30, are any help to identification, though one or two of them may serve to illustrate crystalline habit.

Scarcely any attention is paid to the microscopical examination of rocks, and we have vainly consulted the index for references to the use of the seismograph, earth-tremors, the permanence of ocean basins, secular movements of the sea, and several other subjects of recent work. Even if these matters are not specially mentioned in the syllabus which the book has been designed to meet, they might have been included with advantage. We note that Eozoon is still referred to as "the most ancient fossil known," though its mineral formation has been clearly made out. But taken altogether the book is trustworthy, and the student who assimilates its contents need not fear to present himself for the examination in Advanced Geology held by the Department of Science and Art.

The New Technical Educator. Vol. III. (London, Paris, and Melbourne: Cassell and Company, 1894.)

THE previous volumes of this series have been duly noticed in these columns, where it was pointed out that they very adequately fulfilled a useful purpose. The present volume is up to the level of its predecessors, treating as it does of every-day general engineering and other matters in their broadest sense. The information given is certainly of very recent date, and this is as it should be, from every point of view. There are, however, a few statements made that are not quite accurate: for instance, on p. 102 we are told that among other things wrought iron is supplied commercially in the form of rails. What railways now-a-days use iron rails? They are things of the past, steel having years ago taken their place. Further on we read that steel plates may now be obtained up to 70 square feet in area. Surely double this area would be nearer the mark? On page 105 we are told that fullering a rivetted joint means to caulk it with a narrow edge tool (as at C, Fig. 3). This is certainly not the case: to fuller a joint means to "set up" the plate edge with a tool at least the thickness of the plate, whereas the method shown in the figure is generally known as "narrow edge caulking." Further on it is stated that looseness at the rivets is sometimes guarded against by caulking the rivet-heads. This is all very well, but loose rivets should be cut out and replaced by sound ones.

Under the heading of "various types of steam boilers" we find much useful information, the locomotive type being represented by the standard boiler used on the Lancashire and Yorkshire Railway; it is, however, stated that in some cases the water spaces are carried down and across the bottom, thus constituting an ash-pan and called a wet bottom. This no doubt is true of a few boilers built at Crewe, but in the majority of cases the wet bottom is unknown to modern railway practice. In this chapter George Stephenson is said to have introduced the blast pipe in locomotives. Surely this invention is due to Richard Trevithick?

The marine type of boiler is represented by one made by the Central Marine Engine Company, West Hartlepool; it is of the single-ended type, and fitted with Fox's corrugated flues. Of water tube boilers there are two standard examples, viz. the Babcock and Wilcox for stationary engines, and the Thorneycroft for marine and other purposes. Considering the present rage for this type of boiler, other examples might have been given with advantage.

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 Hodgkins Fund Prizes.

THE time within which papers may be submitted to competition for the Hodgkins Fund Prizes of the Smithsonian Institution, for essays in regard to the nature or properties of atmospheric air, has been extended from July 1 to December 31, 1894. This action has been taken for the reason that many of the circulars announcing these prizes seem to have failed to reach the persons for whom they were intended.

Numerous inquiries have been received, which render it desirable to announce that while it is preferred that the name and address of each competitor should be attached to the manuscript, any one who desires it, is permitted to send his name and address in such a form that they can be detached from the manuscript, which he may identify by means of a motto. The manuscripts of unsuccessful competitors will be returned wherever they have been accompanied with the proper address; but the proprietorship of papers which have been awarded one of the named prizes, will rest with the Institution, which only desires to give them a wide publicity; and no copyright privileges are, in this case, to be expected by the author.

Papers which have been already published will not be accepted in competition for the prizes, but may be eligible for the medal. This medal will be awarded in the same way that medals are usually awarded by the principal scientific societies, the medallists being chosen from all investigators known to the Committee of Award, and not necessarily from among those who have submitted papers.

Information regarding the Hodgkins Prizes and the Smithsonian Institution may be obtained from the Secretary of the Institution, S. P. Langley, Washington, D.C., or from the Agents of the Institution, Messrs. William Wesley and Son, 28 Essex Street, Strand, London. S. P. LANGLEY.

Washington, June 6.

Electrical Theory of Vision.

IN reference to the hypothesis concerning vision which I suggested at the Royal Institution on June 1, Dr. Obach has favoured me with the enclosed letter detailing an observation of his on his own eyes, which may be worth placing on record. I therefore send it on to you. OLIVER J. LODGE.

University College, Liverpool.

IN your very interesting discourse at the Royal Institution on Hertz's work, which is reproduced in NATURE of June 7, you suggested that the susceptibility of the eye to light-waves might be analogous to that of your "coherer" to Hertzian waves, and that the light merely causes a diminution of electric resistance of some badly-conducting material interposed between a source of electricity and the sensitive nerves of the eye. The sensation of darkness you explain by the return of the interposed body to its original state, produced by an automatic tapping back on the part of the tissues.

In reference to this matter, I should like to bring to your notice an observation, made some three years ago, which seems to me to support your views as to the *modus operandi* of the eye. One evening, after having watched the famous Rhine Falls, near Schaffhausen, for a considerable time in the full glare of the sun, which produced a dazzling whiteness of the spray, I felt intense pains in the head and eyes, which did not diminish much even after I retired to bed in a perfectly dark room. I thereupon resorted to a remedy, which had given me relief on previous occasions with pains in the eyes caused by overstrain, *i.e.*, I placed the thumb and forefinger on the eyes over the closed eye-lids and imparted gentle vibrations to the eye-balls. After two or three vibrations I was compelled to stop, as the remedy was not only very painful, but also produced the sensation of a bluish-white light of dazzling brightness (like an electric arc) being brought almost into contact with the eyes. After the lapse of a few minutes the luminous phenomenon subsided, and I again commenced the vibrations of the eye-balls, which now I could do a little longer than before ere it became unbearable. This operation I repeated, with intervals of rest, perhaps eight or ten times, till finally the vibrations were almost painless and produced no longer any luminosity; the pains in the eyes and head had then nearly disappeared, and I slept soundly the whole of the night.

The explanation of this curious observation seems to me the following:—The intense brightness of the light reflected from the spray had not only reduced the resistance of the intercepting medium to a minimum, but at the same time overtaxed the elastic tissues whose duty it would have been to shake the material back into its normal condition, after the cessation of the light. The energy thus lost by the tissues was then suppressed from without by the vibrating fingers.

For what reason the return of the intercepting substance to its original insulating condition should also be attended by the sensation of light is difficult to conjecture, unless it be directly due to the physiological effect produced on breaking the circuit.

Similar effects, only not so pronounced, can be observed on vibrating the eye-balls after any ordinary overstrain of the eyes.

Old Charlton, Kent, June 10. E. OBACH.

Ophiophagus.

THE family of the venomous snakes called Elapidæ is divided into two sections, the Najidæ, or snakes with hoods, and the Elapidæ, without hoods. The Najidæ is represented by the Cobras and Ophiophagus; it has two genera, Naja and Ophiophagus.

The genus Ophiophagus has but one species, the *Ophiophagus elaps*, or *Hamadrayas ophiophagus*. This is probably the largest and most formidable venomous snake known. In size and deadliness it rivals the Crotaline snake, *Lachesis mutus*, the Bushmaster, found in South America. The Ophiophagus grows to the length of 12 or 14 feet, or even more. It is hooded like the cobra, and resembles it in configuration and character. The colour varies according to age and locality, being some shade of olive-green or brown; young specimens have a different colouring, and might easily be mistaken for another genus.

This deadly snake, though widely distributed, is fortunately not very common, and consequently its bite, though fatal, does not contribute largely to the 20,000 deaths that occur annually from snake-bite in India. It is found on the Indian Continent and Burmah, in the Andaman and Philippine Islands, in Java, Sumatra, Borneo, and perhaps in New Guinea. It is not known much, if at all, in North-Western and Central India; it is more common in the damp climates of Bengal, Burmah, Assam, and Southern India.

The Ophiophagus, like other snakes, takes readily to the water. It is found in the forest and grass jungle and in hollow trees; it climbs readily, being frequently found in the branches. As its name implies, it feeds upon other snakes, but probably, when its usual food is not forthcoming, it will take small mammals, birds, fish, or frogs.

It resembles the cobra, except that it is longer in proportion to its size, and that the hood is relatively narrower. The poison is of a golden yellow colour. It is even more graceful in its movements than the cobra, and turns more rapidly. The snake-charmers in India prize it highly, but they say it is exceedingly dangerous to catch and difficult to handle before its fangs are removed. It is said by the Rev. Dr. Mason, who knew it in Burmah, to be very aggressive, and Cantor describes it as being very fierce, and ready, not only to attack, but to pursue when opposed. Its Bengali name is Sunkerchor.

Three remarkably fine specimens of this rare snake have been received at the Zoological Society's Gardens. A few years ago a specimen died, which had lived for a long time in the Gardens and excited great interest. That and the individuals under notice are probably the only specimens that have been brought alive to this country.

It will be of interest to numbers of naturalists and others to know that this rare snake is now alive in the Society's Gardens, Regent's Park, where it can be seen to great advantage in the large and well arranged reptile-house. J. FAYRER.

London, June 12.

Mohl's "Primordial Utricle."

I SHOULD like to inquire, through the medium of NATURE, whether the way in which botanists now use Mohl's term "primordial utricle" is strictly accurate? In Sachs' "Lehrbuch," and in the English translation, it is applied to the *parietal layer of protoplasm* found in plant cells which are old enough to have a large central vacuole, and this practice is now generally followed by English botanists.

Now, in Henfrey's translation of Mohl's "Principles of the Anatomy and Physiology of the Vegetable Cell," it appears to be used in a different sense. On pp. 36–37 we have a description of *the young cells* of plants, in which the "primordial utricle" is spoken of as "a *very thin granular membrane*," which by appropriate methods becomes "*detached from the inside of the wall*," . . . "and consequently removes all the contents of the cell, *which are enclosed in this vesicle*, from the wall of the cell." (The italics are mine.) After this Mohl briefly refers to the nucleus, and then goes on to say that "the remainder of the cell is more or less densely filled with an opake, viscid fluid of a white colour, having granules intermingled with it, which fluid I call protoplasm."

Thus even in *young cells*, Mohl recognises not only the protoplasm and the nucleus, but a "primordial utricle" also, and save that he says it is granular, one might take it as the equivalent of what we now speak of as the ectoplasm.

Proceeding with his description, Mohl describes, on p. 38, how as plant cells become older, a large vacuole is gradually formed in the interior of the protoplasm, which then becomes differently distributed. In the result he tells us, "the protoplasm is then accumulated at one side in the vicinity of the nucleus; on the other side *it coats the inside of the primordial utricle*." (Italics again mine.)

Thus in the older cells, as well as the younger, we have a clear distinction drawn between the protoplasm and the "primordial utricle," a distinction which recent writers seem to ignore.

It is possible, though scarcely likely, I think, that Henfrey has not faithfully reproduced Mohl's conception of the "primordial utricle," or it may be that my interpretation of the above passages is at fault. In any case, it would be an advantage to have the opinions of our leading botanists on this point, as it is one which, to my own knowledge, brings some perplexity to students.

THOMAS HICK.

Owens College, June 14.

Hailstones at Cleveland, Ohio.

A REMARKABLE hailstorm occurred at Cleveland, Ohio, on the afternoon of Thursday, May 17, of a character to be remembered but probably not repeated during the present generation. Larger hailstones are rarely seen than fell on that day, and very likely few, if any, people living in this part of the country have ever witnessed a more severe bombardment.

The air was intensely sultry up to twenty eight minutes past three o'clock in the afternoon (sun-time), when it commenced to rain. Hailstones of moderate size rattled down in profusion, and it soon appeared that an ordinary thunderstorm had begun. At the east end of the city the wind increased rapidly in force, and it grew very dark. Presently the hail became violent, and for about twenty minutes the streets and lawns presented a most animated appearance. The impact of the icy bullets against the roofs of houses sounded like the rattle of musketry. The snow-white balls glistened upon the close-cropped lawns, where they kept up a lively dance, and in the street were shattered against the flags and paving stones.

The stones, many of which were as large as billiard balls, and some of the size of goose eggs, weighed from one to five or six ounces, and probably many that fell were much heavier than this. Their shape was very various, some being spheroidal, others discoidal or exceedingly irregular. The accompanying figures represent to some extent the forms of two stones which fell on the Adelbert College lawn, and were picked up by some of our students.

A hailstone was found by Prof. F. P. Whitman to weigh nearly an ounce and a half after it had melted considerably. Its measurements were $2\frac{3}{4} \times 2\frac{1}{2} \times 1\frac{1}{4}$ inches. The surface was fissured and raised into tubercles, while many others had an exaggerated mulberry appearance, suggesting a composite structure. Sections of such stones showed, however, that they were as a rule formed about a single nucleus, and were not the result of the regelation of a number of separate pellets.

The specimen represented in Fig. 1 measured three inches in length, two in breadth, and about one in thickness. There were two opaque central masses, the larger of which contained the original nucleus, while the smaller spot probably represents a stone which became welded to the larger and older one.

A somewhat flattened, or discoidal form, which was very common, presented a beautiful agate-like core, embedded in a clear mass. A section of one of the stones, which was sawn in two, is shown in Fig. 2. There is a central ball of snow-ice,

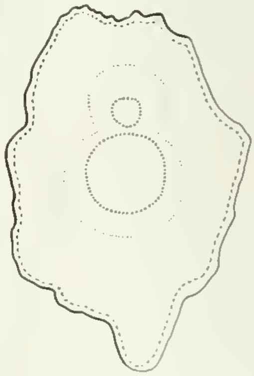

Fig. 1.—Outline of hailstone two-thirds natural size. Dimensions $3 \times 2 \times 1$ inch.

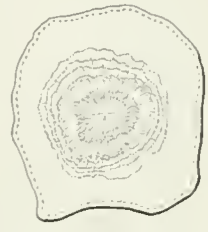

Fig 2.—Section of hailstone, two-thirds natural size.

and this is surrounded by alternating light and dark layers of varying density, and by a very much thicker clear, outer envelope, unshaded in the drawing, showing that the stone had passed through at least two distinct regions of condensation. There were also usually one or two thin superficial strata.

A stone which was examined by one of the observers at the United States Signal Office, was $3\frac{1}{2}$ inches long, 3 inches wide, 2 inches thick, and measured $10\frac{1}{2}$ inches in circumference. Another, which fell near Board of Education Building on Euclid Avenue, was weighed and measured by Principal Theo. H. Johnston. It was oval in shape and measured $3 \times 2{\cdot}5 \times 2{\cdot}75$ inches, and weighed, after some melting, $4\frac{1}{2}$ ounces. The surface of this stone was deeply pitted as by impact of warm raindrops. A second, brought in by one of Mr. Johnston's pupils, weighed 5·5 ounces. It had a large pear-shaped snow-iced centre.

The hailstorm was restricted to a belt a few miles in length, and formed a part of a general westerly storm, which was felt in this region for four or five days. During the thunder and hailstorm of May 17, the air-pressure remained nearly constant, the temperature fell from 84° to about 64° F. At the beginning of the storm the wind was south, and blowing at a rate of ten miles an hour, and increased to a rate of only 24 miles an hour. On the same day a destructive cyclone accurred at Kunkle in the north-western part of the State, in which a number of people lost their lives.

Everything in glass exposed to the brunt of the storm, when not of the strongest kind, was destroyed. Electric light globes, photograph galleries, and greenhouses suffered most. Canvas awnings were riddled. Flowers were cut down, and fruit and shade trees badly injured in many places. Horses and other animals, often too terrified to stir, winced under the stinging shot which they could not avoid. A few cases occurred of persons who were cut or stunned by the falling stones or glass. A man at the Winton Bicycle Factory was struck in the head as he stooped to pick up an unusually large stone, and was brought into the workshop in an unconscious condition. The stone went through his straw hat, and cut into his scalp.

FRANCIS H. HERRICK.

Adelbert College, Cleveland, Ohio.

Finder Circles for Equatorials.

ON p. 64 of the current volume of NATURE, I find a paragraph on "Finder Circles for Equatorials," which demands notice on my part because it impugns not only the verbal statements made to many astronomers who have inspected the instruments of the U.S. Naval Observatory, but also the correctness of an official report made by me to the Superintendent of the Naval Observatory, and appended by him to his report for the year 1893, printed copies of which have been distributed to nearly all the observatories in the world.

The paragraph in question is based upon an illustrated article in the *Zeitschrift für Instrumentenkunde*, 1894, 14 Jahrgang, pp. 125–130, which purports to be a description of the 12-inch equatorial telescope of the Georgetown College Observatory, and in which it is asserted (1) that the instrument was constructed *nearly three years ago* by Mr. Geo. N. Saegmuller, of Washington, D.C.; (2) that its principal novelty is a pair of star dials, or finding circles; and (3) that similar instruments have been constructed by Mr. Saegmuller for the U.S. Naval Observatory at Washington, and for other institutions which are named. From these statements the writer of the "Astronomical Column" very naturally inferred that Mr. Saegmuller constructed these dials, or finding circles, three years ago, when in reality he did nothing of the kind. The facts are as follows:—The idea of these finding circles first occurred to me while the question of building a 12-inch equatorial mounting for the U.S. Naval Observatory was under consideration, and in the specifications for that instrument, which were dated May 20, 1891, I embodied it in these words: "Connected with them (the quick motions) and arranged so as always to face a person operating them, suitable indicators shall be provided for showing automatically the right ascension and declination of the point to which the telescope is directed." Mr. Saegmuller got the contract for building that mounting, and the details of these indicators were arranged between us. The erection of the mounting at the Naval Observatory was completed in November 1892, and almost immediately thereafter Mr. Saegmuller put an exact copy of its indicators upon the Georgetown College telescope, *which had been erected some time previously*. Finally, the two woodcuts which illustrate the *Zeitschrift* article are not pictures of the Georgetown College telescope, but of the Naval Observatory telescope, which differs from the Georgetown instrument in many details.

Wm. Harkness.

Washington, D.C., June 7.

On the Use of Quartz Fibres in Telescopes.

Perhaps it may interest some of your readers to know that the quartz fibres of Prof. Boys affords an excellent material for providing the eye-lens of telescopes, and specially the instruments used in combination with reflecting galvanometers and electrometers, with threads required for their adjustment on the divisions of the scale. I thought at first that as the fibres appear, when examined with the microscope, to be semi-transparent and have a silver-grey colour, they would, when seen behind the ocular lens, not present themselves as distinct and clear lines, but as a matter of fact, when they were put at the proper distance, they showed an intense black colour, even darker than the divisions made with ink on the scale on which the instruments were focussed. I used threads of 20 microns diameters, and they can be fixed on the diaphragm without much difficulty by means of a mixture of resin and mastic applied with a heated wire, and this mixture answers better than brittle shellac. It is obvious that the threads, when laid down in the diaphragm, are at once stretched, and remain in good condition, as they are not affected in any appreciable degree by the influence of heat and atmospheric moisture.

L. Bleekrode.

The Hague, June 18.

Bullet-Proof Shields.

In reply to a letter on bullet proof shields, in the last number of Nature, I wish to state that some preliminary experiments with spheres show that the energy of the shot is transmitted to the spheres nearly in line with the direction of the blow, to such a degree that great damage is done to the board to which the spheres are attached. This is not the case when rods are used. I hope shortly to give the details of my experiments on the subject.

Frederick J. Smith.

Oxford, June 10.

THE HORN EXPEDITION FOR THE SCIENTIFIC EXPLORATION OF CENTRAL AUSTRALIA.

Information has been received of the organization and despatch from Adelaide of a new and well-equipped expedition for the scientific exploration of the Macdonnell Ranges which lie about eleven hundred miles to the northward of that capital and nearly in the centre of the Australian continent. The expense of this expedition is borne by a wealthy and public-spirited colonist of South Australia, Mr. William Austin Horn, who thirty years ago carried out on his own account some explorations in the Gawler Ranges, and has since taken a very active part in the development of the mineral resources of the country, besides being a prominent member of the colonial legislature and of the Council of the University of Adelaide. Mr. Horn himself is the leader of the present Expedition, but has wisely associated with him some scientific gentlemen of great experience in Australian travel. Among them are Mr. Charles Winnecke, of the Trigonometrical Survey of South Australia, who in the performance of his duties has repeatedly traversed some of the most arid country of the continent, and has mapped out some thirty thousand square miles of its surface. With him also goes as medical officer, Dr. E. C. Stirling, C.M.G., F.R.S., of the University of Adelaide, the well-known discoverer, a few years since, of *Notoryctes*, and latterly the investigator of the *Diprotodon*-deposits, the results of which so many are impatiently expecting, though now it is clear that for them they will have to await his return from this new undertaking, the charms of which he found it impossible to resist. Besides these there are of the party, Prof. Ralph Tate, also of the University of Adelaide, and President of the last meeting of the Australasian Association for the Advancement of Science, eminent as a palæontologist, and especially as a palæobotanist, as well as Prof. Baldwin Spencer, whose name, from his connection with Owens College and Oxford, will be at once recognised by all; while there is also Mr. J. Alexander Watt, of the Geological Survey of New South Wales, to pay special attention to mineralogy and petrology. In the capacity of collecting naturalists, Mr. F. W. Belt, of Adelaide, and Mr. G. A. Keartland, of Melbourne, complete the staff of the expedition, which will be accompanied by three camel-drivers, a cook, and two prospectors sent by the Government. The Expedition was to leave Adelaide on May 3rd for Oodnadatta, and thence proceed along the telegraph line as far as Lilia Creek, where it will turn to the westward towards the Ayers Range and Goyder's Springs, after which it will make for the Palmer River, and then, deviating again to the westward towards Petermann Creek, will return to the upper valley of the Finke River, and then push on to Glen Helen at the foot of the Macdonnell Ranges. It will of course be understood that circumstances may cause this plan to be modified more or less extensively; but from the previous experience of those who have laid down the route to be taken it will probably be carried out pretty much as is intended, though some of the country to be traversed is absolutely unexplored, and much of it very imperfectly known. Wherever a prospect of doing work is found, a longer or shorter halt will be made, and as the Expedition is to be well furnished with camels—no fewer than twenty-three being taken with it—the difficulties that attend the needful supply of water will be reduced to a minimum, while it is said that owing to recent good rains in the latitudes to be passed through everything looks promising for a successful journey.

The importance of this undertaking is not easily to be over-rated. Expeditions of one kind or another to the interior of the continent have been numerous, and productive of results that we should be the last to impugn; but this we believe is the first attempt at a purely scientific investigation of Central Australia, while the names of the distinguished men whom Mr. Horn has been so fortunate as to engage in it, are a guarantee of the serious way in which it will be conducted. We doubt not that he and his companions will find plenty of rough work before them, and possibly some risk; but if good wishes can help them they may rely on those of all our readers, together with their high and hearty appreciation of the spirit which has prompted that gentleman not only to defray the cost of the Expedition, but to put himself at the head of it at a time of life when most men think of retiring upon the fruits of their labours.

THE ENRICHMENT OF COAL-GAS.

IT is almost impossible to over-estimate the importance of the influence which coal-gas has exercised upon the advancement of civilisation during the past fifty years, and at the present time it has reached a phase in its existence upon which its future career and utility is very largely dependent.

Up to the middle of the century but little attention was paid to the quality of the gas supplied for illuminating purposes; the gas manager made the best gas he could with the coals at his disposal, and the consumer was content as long as he obtained a reasonable amount of light.

In 1850 a Bill was passed which enacted that the light emitted by a brass argand burner with 15 holes, consuming five cubic feet of gas per hour, should be equal to the light of 12 wax candles of the size known as "sixes." These wax candles were, however, only equal in illuminating power to 10·3 of the sperm candles at present used for testing purposes. In 1860 an Act changed the illuminating power to 12 sperm candles, and in 1868 this was again raised to 14 candles, and by the Act of 1876 this was increased to 16 candles, and remains so to the present time.

In 1864 the 15-hole brass argand was discarded as a standard testing burner, and was replaced by a 15-hole steatite burner, which by increasing the temperature of the flame developed more light, whilst in 1869 the "London argand" 24-hole burner was introduced, and gave a still further increase in the light obtained from the gas, so that when we speak of London being supplied with 16 candle-power coal-gas, it means that the light emitted by the gas when burning at the rate of 5 cubic feet per hour from a London argand shall be equal to the light of 16 sperm candles of the size known as sixes consuming 120 grains of sperm each per hour.

When we come to consider what this in reality amounts to, we find that by one of those subtle strokes of humour in which our legislative body occasionally indulges, it means to the consumer almost anything except a light equal to 16 candles. The illumination which can be obtained by the consumption of coal-gas is entirely dependent upon the method by which the gas is burned. From a so-called 16-candle coal-gas the consumer rarely obtains a value of more than 12 candles per 5 cubic feet of gas consumed; whilst by using burners of rational construction, upwards of 40-candle illuminating power could be obtained for the same consumption of gas.

The light emitted by a coal-gas flame is dependent upon its temperature, and flat flame burners, exposing a thin sheet of flame to the cooling action of the air, give the worst results. Argand burners are better, as the cooling is not so great, whilst the regenerative burners lately introduced, by utilising the heat of the products of combustion for raising the temperature of the gas and air supplied to the flame, give an enormous increase in the light emitted.

If the gas companies could only get an Act passed authorising the use of the regenerative burner as the standard, there is no reason why they should not call the gas at present supplied 40-candle gas; the consumer, however, using the flat-flame burner would still be only obtaining the same light as at present. Incandescent mantle burners, which act on a totally different principle, also yield a high illuminating value.

On carefully testing the burners in ordinary use we find that for an equal consumption of gas the results at once show the enormous advantage to be obtained by regeneration, and also how serious is the loss which attends the employment of ordinary burners.

Light obtained per cubic foot of 16-candle gas consumed.

Burner.	Candle units.
Regenerative and incandescent	7 to 10·00
Standard argand	3·20
Ordinary ,, ...	2·90
Flat-flame No. 7	2·44
,, ,, 6	2·15
,, ,, 5	1·87
,, ,, 4	1·74
,, ,, 3	1·63
,, ,, 2	1·22
,, ,, 1	0·85
,, ,, 0	0·59

These burners were by well-known makers; but there are plenty of cheap German nipples in the market which will give even worse results. In the above table No. 7 is the largest flat-flame burner given, as any larger size would never be used for indoor illumination; but with some of the big flat-flame burners employed for outdoor work as much as three candle power per cubic foot of gas is developed by the best make, while it is also quite possible to find cheap imitations of them, which can scarcely be distinguished by their appearance, only developing a little more than one candle per cubic foot. It seems probable that 10-candle units represent the maximum light to be obtained in practice per cubic foot from the so-called 16-candle coal-gas, as, although greater regeneration will increase it as high as sixteen units, the heat is so intense that the burner is quickly destroyed. Taking 10-candle units as being the maximum amount of light for a consumption of one cubic foot of gas per hour, an approximate idea of the waste of illumination which attends the ordinary methods of burning the gas can be formed.

If the burners most commonly in use in houses be examined they will be found to consist chiefly of No. 4 and No. 5 flat-flame nipples, and it would not be over-estimating the number in use to put them at 85 per cent. of the total. The remaining 15 per cent. is made up of larger flat-flame burners, argands, and regenerative lamps, which give a higher service: but it will be found that the total value obtained will not exceed 2·5 candles per cubic foot. This means that 75 per cent. of the total value obtainable from the gas is wasted, and that for our present expenditure in coal-gas we could obtain four times as much light.

Mr. George Livesey some time ago proposed that unenriched coal-gas should be supplied to the consumer at a lower rate than is at present charged for the enriched 16-candle gas, and this question is of such interest and importance to both consumer and gas company that it deserves the gravest consideration.

In large towns like London, where the gas companies have to supply a gas of specific illuminating power, and where the gas is continually subjected to photometric tests at stations spread over the whole area supplied (any deficiency in the lighting value of the gas being visited with rigorously enforced penalties), enrichment in some form or other becomes a practical necessity. In London the gas has to have an illuminating power of sixteen candles; and in order to ensure this over so enormous an area, the gas must be sent from the works testing up to from 16·5 to 17 candles. With seaborne Durham coals of the character most largely used in the metropolis for gas-making, the illuminating value of the gas will be about fifteen candles, and the gas manager has to enrich the gas by from 1½ to 2 candles before he can with safety send it out for distribution. This enrichment is done in several ways: (*a*) by the admixture of a certain percentage of cannel coal with the original gas coal; (*b*) by carburetting the coal-gas with the vapours of volatile hydrocarbons; (*c*) by mixing the gas with carburetted water-gas: (*d*) by admixture with rich oil-gas.

Up to four years ago the admixture of a certain percentage of cannel coal with the Durham coal was the only method of enrichment employed by the metropolitan companies, and was perfectly satisfactory, as the coal being mixed, the gases came off together under the same conditions in the retorts, and a uniform gas was the result. During the past few years, however, the increase in price of cannel has forced the gas companies to find some other process which should take its place, and the Gas Light and Coke Company tried experiments which led to their largely adopting carburetted water-gas for this purpose.

When steam acts upon carbon at a high temperature, the resulting action may be looked upon as giving a mixture of equal volumes of hydrogen and carbon monoxide, both of which are inflammable but non-luminous gases. The water-gas is then carburetted, *i.e.* rendered luminous by passing it through chambers in which oils are decomposed by heat, and the mixture of oil-gas diluted with water-gas is made of such "richness" as to give an illuminating value of 24 or 25 candles, and this, mixed with the poor coal-gas, brings up its illuminating value to the required limit. During the winter months the gas supplied by the Gas Light and Coke Company has mostly contained about 10 per cent. of the carburetted water-gas.

This form of enrichment has several serious drawbacks: it increases the percentage of the highly-poisonous carbon monoxide in the gas, and so makes leakage more dangerous, whilst carburetted water-gas burns with a short but very brilliant flame, far shorter than coal-gas, a 22 candle water-gas flame burning from a London argand at the rate of 5 cubic feet an hour, with a flame only 2½ inches in height; whilst a 16-candle flame of the gas supplied up to three years ago gave a flame three inches in height; and the gas now supplied and enriched with the carburetted water-gas only gives a flame 2·6 inches in height, in order to emit a light of 16 candles.

When a householder lights his gas-burners, he invariably turns on the gas until he gets the largest possible flame without roaring or smoking, and from the alteration in the composition of the gas which has taken place, this means using far larger quantities of gas than heretofore, so that although an increase in illuminating power is obtained, a substantial increase in the quarter's gas bill is also found.

Another objection to this form of enrichment applies even still more to the admixture of rich oil-gas with the poor coal-gas, and is that although gases of different gravities mix perfectly well in small vessels, yet when you come to deal with the huge gas-holders used in the modern gas works, stratification of the gas takes place, and even if the enriching gas be mixed with the ordinary gas in the foul mains, so that they may pass through the scrubbers and purifiers together, uniformity in illuminating power is never obtained, and with the London coal gas variations of from 16 to 18 candles in value are found at the testing stations.

A burner which is giving its best duty with a 16 candle gas, will be very apt to smoke when burning a gas of higher quality, and under these conditions the products of combustion become more injurious to health from the presence in them of a larger proportion of the products evolved during incomplete combustion.

Enriching gas by the vapours of volatile hydrocarbons enables the manager to bring his gas up to the legal requirements as regards the illuminating value at the testing stations, which are mostly fixed where the great trunk mains deliver the gas to the districts to be supplied, and it is only under exceptional circumstances that the illuminating value of the gas is ever found to be below the required limit at these points. The consumers, however, reap but little benefit from it, as the loss of illuminating value during distribution is very great where this method of enrichment is employed.

No matter how enriched, change of temperature, and other troubles incidental to distribution generally reduce the illuminating power of the gas to a considerable extent before it reaches the consumers' burners, so that its actual value is far more often fifteen candles, although it may have been tested over sixteen at the station.

In the big mains the gas is continually flowing at a fairly steady rate, and is neither exposed to any great alteration in temperature, nor from the size of the mains to any very great amount of "skin friction," *i.e.* rubbing of the gases against the sides of the pipes; but as soon as distribution commences, both these factors come into play, and as some of the chief illuminants of the gas are vapours and not permanent gases, lowering of temperature causes condensation of some of them, whilst the power which friction against the sides of the main service pipes, coated with deposited hydrocarbons, has of withdrawing the illuminants from the gas, still further decreases its light-giving value, and anywhere near the dead end of a service, stagnation of the gas during a large portion of the twenty-four hours when gas is not being consumed, adds still further to the trouble, so that even at the testing stations, the influence of the small consumption of gas on Sundays, and consequent stoppage in the manufacture on that day, can be traced in the illuminating value found on Monday morning.

Coal-gas, as made from Durham coal at the temperature employed in the Metropolitan Gas Works, has an illuminating value of about fifteen candles, and the enrichment of this gas up to the required value costs far more *pro rata* than the amount of light obtained from the unenriched gas.

This cost has entirely to be borne by the consumers, and the whole practical question to be decided resolves itself into—"Is the game worth the extra candle and a half?"

If coal-gas were used for illuminating purposes only, the consumer would be a considerable gainer by having the unenriched gas supplied at a lower price; and when we consider the amount of gas used as a fuel, and that the quantity so employed is daily increasing, the cost of the enriched gas becomes of the greatest importance.

The value of one candle in illuminating power in the gas supplied in London at 1½*d.* per candle is £180,000, and if this calculation be correct, consumers in the metropolis would be saved about £270,000 a year by using unenriched coal gas, and probably not one of them would notice the slightest difference in the light emitted by the gas in the burners ordinarily in use.

In the regenerative burner the increase in illuminating value is almost entirely due to the rise in temperature causing methane, which forms about 34 per cent. of the coal-gas by volume to become a very valuable illuminant, and as there is just as much or more methane in the unenriched gas, it is manifest that this increase will still be found.

In the incandescent burner the coal-gas is burnt in an atmospheric burner, and the non-luminous flame is made to heat a mantle of refractory material up to incandescence, and for this purpose the 15-candle gas will do as well as the 16.

One argument which has been raised against the lowering of the standard is that if a 16-candle gas is reduced to 15 candles during distribution, a 15-candle gas will be lowered to 14. This I think is a mistake. An enriched gas is lowered in illuminating value because certain vapours are condensed from it; but it will be found that with an unenriched gas, made at a high temperature, this action is decreased to a minimum, on account of the small proportion of vapours present.

One of the most important experiments ever tried on a large scale has been made this year, the London County Council having given permission to the South Metropolitan Company to supply unenriched gas to South London for the space of a fortnight, in order to practically ascertain the result during distribution and the loss of light to the consumer.

At the testing stations the gas for the fortnight showed the average value of about 15 candles, ranging from 14 to 16 according to the coal used at the various works, whilst tests made with portable photometers on the consumers' premises gave identical results, before, during, and after this period, clearly showing that the whole value of the enrichment consisted in satisfying the legal requirements, whilst the consumer gained absolutely nothing but the privilege of paying for it.

It is to the interest of the gas consumer and gas company alike that the price of gas should be reduced to the lowest possible figure, and the possibility of reduction in price is entirely dependent upon the discarding of the costly enrichment.

Under the present legal conditions the companies gain nothing by supplying a gas a candle better than the standard, and if they fall a candle below have to pay the absurd fine of 40*s.*, a state of things which if the London companies did not show the greatest anxiety to fulfil all their obligations might lead to a considerable reduction in the value of the gas distributed, as to pay a daily fine and to send out gas of a value of 15·1 candles would save the companies many thousands a year.

This is all manifestly wrong, and if the consumers are to get the full benefit of coal-gas, and if coal-gas is to take its proper place as a fuel as well as an illuminant, its sale must be placed on a sound commercial basis. Enrichment should be entirely given up, and the gas that can be made direct from the coal supplied to the consumer.

A minimum of illuminating value should be fixed for each town based upon the coal used, and any fall below this should be visited by a fine of £50 for the first half-candle, and an increment of £100 for each half-candle below that, whilst the price charged for the gas should be governed by its illuminating value for the quarter as averaged from the testing station returns, a low initial price, say 2*s.* 2*d.* per thousand, being charged for 14-candle gas, and 1½*d.* a candle for each candle above it, with a maximum price of 2*s.* 5*d.* If some such scheme as this could be adopted, not only would the consumer obtain the full value for his money, but the gas companies would reap the benefit of an enormously increased consumption for fuel purposes, and the atmosphere of our big cities would gain in proportion.

Vivian B. Lewes.

NOTES.

The Council of the Society of Arts have, with the approval and sanction of the President, H.R.H. the Prince of Wales, awarded the Albert Medal to Sir Joseph Lister, Bart., F.R.S., "for the discovery and establishment of the antiseptic method of treating wounds and injuries, by which not only has the art of surgery been greatly promoted and human life saved in all parts of the world, but extensive industries have been created for the supply of materials required for carrying the treatment into effect."

We are requested to state that before long a memoir of the late Dr. James Croll, F.R.S., will be ready for publication. Persons having letters from Dr. Croll, or information likely to be of interest, are requested to forward such to J. C. Blackwell, 10, Royal Terrace, Edinburgh. The letters will be returned when their contents have been noted.

A Pasteur Institute was opened at Tunis on Tuesday by Dr. Loir, a nephew of M. Pasteur.

The death is announced from Paris of M. Ed. Lefèvre, known for his work in entomology and botany.

Prof. Cannizzaro has been elected a correspondent of the Paris Academy of Sciences, in the place of the late M. de Marignac.

We learn from *La Nature* that a department of agricultural entomology has recently been formed at the Institut National Agronomique, and placed under the direction of Prof. Brocchi. The work of the department will be to identify insects sent for that purpose by agriculturists, and to point out the means of destroying insect pests or diminishing their ravages.

The *Cape Times* says that among the latest accessions to the South African Museum are an old imperfect skull and other bones of a white rhinoceros, presented by Mr. W. G. Schmidt. These remains of the now all but extinct "white" or Burchell's rhinoceros were found at a depth of about 8 feet, in black turfy soil, at about twelve miles from the Vaal River.

A complete statement has been issued of the different sections of the Mining and Metallurgical Exhibition to be opened at Santiago in September next. The classification is as follows:—(1) Motive Power; (2) Electricity; (3) Mining Machinery; (4) Mechanical Preparation of Minerals; (5) Metallurgy; (6) Chemical Industries; (7) Statistics and Plans; (8) Mining and Metallurgical Products.

The Paris correspondent of the *Times* reports that, at the first meeting of the 1900 Exhibition Commission, the following scheme of classification was read:—The first group of exhibits is entitled "Education," and contains six classes. Group II. comprises "Works of Art," containing paintings, drawings, engraving, lithography, sculpture, the cutting of precious stones, and architecture. Group III. is called "Instruments and General Processes of Literature, Sciences and Arts," including typography, photography, binding, newspapers, maps, instruments of precision, coins and medals, medicine and surgery, musical instruments, and the theatrical art. The IVth Group is "The *Matériel* and General Processes of Mechanics," including steam engines, motors, divers apparatus of general mechanics, and implements. The Vth Group deals with electricity, including the production and mechanical application of electricity, electro-chemistry, electric lighting, telegraph, and telephone. Then come locomotion, agriculture, horticulture, forestry, alimentation, mines, furniture, textiles, chemicals, social economy, and military weapons.

It is reported by the *British Medical Journal* that a committee of the Calcutta municipality have resolved to recommend that a sum of money be voted for two years in order to test thoroughly M. Haffkine's system of cholera inoculation. This method, worked out by M. Haffkine in the Pasteur Institute in Paris, and applied extensively in India by the investigator himself, was recently put to the test of actual experience near Calcutta. Dr. Simpson, the health officer, took special steps to make the inoculations in the neighbourhood of Calcutta serve as tests, as severely scientific as possible, of the efficacy of the method in man. Of the 200 inhabitants of a native hamlet, 116 were inoculated with the protective vaccine. Not long afterwards, an outbreak of the disease occurred in the hamlet: ten persons were affected, none of whom had been inoculated, and seven died, whereas all those who had been inoculated remained free. If the results of future experiments are favourable, a permanent department will probably be established to carry on the inoculations.

THE Hong Kong correspondent of the *British Medical Journal* gives the following particulars with regard to the epidemic noted in our last issue:—"The plague commenced here on May 5; it presents all the symptoms of the true bubonic pest which devastated Europe in the Middle Ages, and produced the terrible ravages described by Defoe during the great plague in London. This bubonic pest, although extinct in Europe, has never ceased to prevail in China from time to time, and has also spread from there to Persia and Asiatic Russia. The present outbreak is characterised by intense symptoms corresponding to those of typhus, and by the bubonic boils characteristic of the disease. The deaths up to to-day have amounted to 1708, but I am glad to say that the Europeans here are unaffected except in the case of ten of the military employed by the authorities in carrying out disinfecting work in the native quarter where the plague is located; one of them has unhappily died." It is pointed out by our contemporary that this bubonic pest is extremely contagious from person to person, and though aerial infection is not unknown in connection with it, it is so probably only to a slight extent. Like typhus, the plague is mainly diffused by personal contact, and its diffusion is one of the results of overcrowding and dirt.

The U.S. National Academy of Sciences is in a quandary. According to the *American Naturalist*, it has been in a state of paralysis for two years as regards the election of members, owing to the impossibility of concentrating a sufficient number of votes on any one candidate to elect him. At present fifty-eight members are devoted to the physical sciences, and thirty-one represent the natural sciences. Members of the latter class desire to destroy this disproportion, but they cannot procure enough votes to elect an additional member on their side, and the result is a deadlock. It has been proposed by a committee that the Academy be divided into classes, each having a fixed membership, such as exists, for instance, in the Paris Academy of Sciences. Three of these classes were to embrace the physical sciences; two, natural science; and one, the sciences that could not be well classified under either of these heads. This, however, has been objected to, and Prof. E. D. Cope has submitted the following division to the consideration of the committee. Class I. (35 members).—Physical Science (Sciences of Energy), to include Physics, Astronomy, Chemistry, Physiology, and Dynamical and Chemical Geology. Class II. (35 members).—Natural Science (Sciences of Morphology); Structural Geology, Mineralogy (apart from Chemistry), Biology including Embryology and Palæontology. Class III. (15 members).—Anthropological Science (Sciences treating of phenomena determined by psychic conditions); Anthropology, Statistics, Philology, Psychology. Class IV. (15 members).—Applied Science. Applications in the Arts of any of the Sciences previously enumerated), including Hygiene, Engineering, &c.

SUESS' famous work, "Das Antlitz der Erde" (the Face of the Earth), is to be translated into French by M. de Margerie. Abroad, the book is almost as well known to the general public as to geologists, but there seems to be no immediate prospect of an English translation.

WE are reminded of what we lose in this respect by a current article in the German "Weekly Magazine of Science" (*Naturw. Wochenschrift*, May 27 and June 3), on "the Flood and the Ice Age Question." The writer, Richard Hennig, discusses the views so amply stated by Suess in the aforesaid work, also those of Neumayr in the "Erdgeschichte" (History of the Earth). Suess and Neumayr may be said to have proved that the Mosaic account of the flood was copied, with but little alteration, from the original Assyrian version, and that the actual events took place in the plains of the Euphrates and Tigris, and not on the banks of the Jordan. Suess suggested a comparison with the occasional calamities caused in the lower parts of the rivers of India when a cyclonic storm whirls the sea inland, and the rivers overflow wide reaches of town and country. In Suess' opinion the Mosaic flood was of local nature:—"The traditions of other peoples do not in the least justify the assertion that the flood extended beyond the lower course of the Euphrates." Science went with Suess, and the true tale of the flood, while it remained picturesque, lost its magnificence.

NOW, however, Hennig brings forward persuasive arguments in favour of the independent origin of the flood Saga found among so many peoples. He associates it with some of the striking facts which indicate a general increase of rainfall and lowering of the temperature over the whole earth during the Quaternary period—*e.g.*, the presence of enormous lakes in the west of North America, whose water-level rose 1000 feet above the present Salt Lake of Utah, the Ice age and glaciation in North America and in Northern and Central Europe (without which geology would have lost a pet hobby), the floods which accompanied the retreat of the glaciers, the moist climate of Siberia, and the fertility and forest-growth in the now arid Sahara. Hennig concludes that the flood was contemporaneous with the Ice age, and was produced by the unknown causes which then lowered the temperature of the globe. The period was a prolonged one, during which the countries in milder latitudes were converted into swamp and sea, or underwent higher floods of local character under special meteorological conditions. Isolated lands remained free from inundation, Egypt for example, owing to their distance from any region of ice and dry climatic conditions.

THE German Saga tells how "the floods of the north came far from their home and were turned into ice, and the ice stood still, and the mist which hung over it froze . . . . till the hot sun-glow from the south met the hoar, and the frost fell in drops. The sun was strong and his heat gave life to the drops, so that a great frost-giant in the form of a man arose—Ymir of the Hrimthursen. But Bors killed the giant Ymir, and when he fell there ran so much blood from his wounds that the race of the Hrimthursen was drowned, all except him they called Bergelmir. In a boat he saved himself and his wife, and from them sprung the new race of Hrimthursen." The German Saga is scarcely less dramatic than the Eastern. After reading it we feel willing to believe that the Germanic Ossian was *bona fide*.

IN the *Programm des Gymnasium Ernestinum* (Gotha 1894), Dr. A. Schmidt has published an essay on the employment of a trigonometrical series in meteorology, which will be very useful to students of the mathematical branches of that science. It is divided into four sections, the first two of which are devoted to the history of the subject, from their earliest use by Euler, in 1748. Their first application to meteorology is attributed to T. Mayer, whose investigations were published after his death, by Lichtenberg, in 1775, although the principal merit for their employment in meteorology is undoubtedly due to Bessel, who explained their use in a treatise published in 1814. The last two sections deal with the means of deducing the harmonic constants from the usual formulæ, and the need of further investigations by this method. The *Programm* will probably not be generally accessible, but a careful summary of it, by Dr. Grossmann, will be found in the *Meteorologische Zeitschrift* for May of this year.

THE results of meteorological observations lose much of their interest when published four years late. Such is the report of the meteorological service of the Dominion of Canada for 1889, a copy of which has just reached us. We note in glancing through the volume that meteorological instruments are supplied to the experimental farms established in different provinces of the Dominion. There were 1126 warnings of approaching storms made during the year, 82·2 per cent. of which were verified. The railway companies in Canada give assistance in many ways to the meteorological service. One of these is by permitting trains to carry discs showing the weather forecasts for the districts through which they travel. A few weeks ago we noted that our Board of Agriculture intended to distribute in rural districts during harvest time, weather forecasts prepared at the Meteorological Office. It may be worth consideration whether such a system could not be usefully extended by displaying the predictions on trains running through agricultural districts.

THE earthquake in Baluchistan, described in NATURE of August 10, 1893, was also felt in South Russia and in Germany, and a comparison of the records at Nikolaiev and Strassburg is given by Herr E. von Rebeur-Paschwitz in the *Astronomische Nachrichten*, No. 3234. The epicentre of the earthquake was a spot fifty miles to the N.N.W. of Quetta. The main shock occurred at 12h. 19m. G.M.T. on December 19, 1892. The distances from Strassburg and Nikolaiev are 5290 and 3480 km. respectively. The first waves from the disturbance reached Strassburg in 16 min. with a velocity of 5·51 km. per second, this being about the same velocity as that observed in the case of the Wjernoje earthquake of July 11, 1889. The first maxima took 18 mins. and 30 mins. respectively to traverse the distances. It is very evident that the wave motion at some distance from the epicentre is very complicated. For several hours before and after the earthquake earth tremors, were recorded by the instruments, the two kinds of disturbances appearing to proceed independently of each other.

SOME interesting experiments with a rectangular glass prism are described by W. C. Röntgen in *Wiedemann's Annalen*. Those who have tried looking at themselves as reflected by two mirrors, placed at right angles to each other, will remember the amusing effect created by the image, contrary to the usual reflection in a mirror, not being reversed right and left. We can see ourselves "as others see us," also, by looking straight at the surface subtending the right angle of a rectangular prism. Herr Röntgen observes that in no case is the pupil divided into two equal parts by the faintly visible edge of the prism. This is an illustration of the angle between the line of vision and the axis of the eye, which is different in different people. Rectangular prisms can be easily tested for correctness of the angle by observing whether the two images of the cross-wires in a telescope, as seen in the two surfaces, coincide. The same test would tell us whether two mirrors are exactly at right angles—a fact which might be usefully applied for testing instruments like Gauss's heliotrope. Such a pair of mirrors, or a rectangular glass prism, give rise to another peculiar phenomenon. If they are rotated about the axis of vision, the image rotates in the same direction with twice the speed. If, therefore, the object, say a cardboard disc with writing on it, rotates twice as quickly as the mirrors or prism, it will appear to stand still. This might be applied to investigate the effects produced upon bodies by rapid rotation. Another peculiarity is that such an instrument will reflect rays falling upon the hypotenuse at any angle up to 45° to the same spot. By rotating such a prism about a line at right angles to its edge and to its hypotenuse the author was enabled to reflect the light from an electric lamp through a distance of 1 km. with ease and certainty.

IN a communication to the *Electrician*, Prof. Fitzgerald criticises Herr Lenard's last paper, a short abstract of which appeared in NATURE for May 31, 1894, p. 114. In a former note on Herr Lenard's previous paper, Prof. Fitzgerald had pointed out that the experiments so far would be consistent with the supposition that the cathode rays were rays of light of very high frequency, except for the fact that they were deflected by magnetic force, a phenomenon of which we have no other evidence, and which makes it practically impossible at present to suppose that cathode rays are of this nature. It was further pointed out that if this deflection were an action on the emitting surface, and not on the ray, it might be again possible to explain these cathode rays by the supposition that they are rays of light. Herr Lenard's more recent experiments seem entirely at variance with any such supposition, while Prof. Fitzgerald considers that there is nothing in them that, in the same conclusive way, proves that they are not streams of electrified molecules or atoms. From Herr Lenard's observation that the deflection of the ray depends on the pressure of the gas in the tube in which the rays are generated originally, and not on the nature and pressure of the gas in the tube in which deflection takes place, it follows that, if the rays are paths of projectiles, they must either pass through the window, or else be projected from it, by some action which behaves like a blow given to it from the other side. A study of the spectrum of the cathode light might settle whether any of the molecules actually traversed the partition. The fact that there is no increase in the pressure within the tube only shows that as many molecules traverse the partition in one direction as in the other. Blows delivered on one side of a plate would project molecules from the other side, with different velocities depending on the nature of the blow and on the mass of the molecule, so that a hypothesis of this kind would be quite in accord with Herr Lenard's observations. The fact that the magnetic effect is independent of the mass of the molecule struck is explicable by supposing the electrical charge to be the same for all molecules. Even though sufficient reasons were forthcoming for rejecting the theory that these rays are due to projected molecules, Prof. Fitzgerald considers that there are other possible suggestions which are worthy of consideration, such that they are straight Grotthüs chains of molecules which bend under magnetic force. This might account for a velocity of propagation of actions along them, comparable with the velocity of light, without requiring the component matter to move with this velocity. In fact, until the residual matter within the tube has been reduced very much beyond what has been attained, and it has been shown that these phenomena increase instead of diminish, and that there is no very slow projection of the material of the plates, such as darkens the glass in glow-lamps, it will be very difficult to prove that any of the phenomena hitherto observed are due to the ether, and not to the matter present. So far the phenomena described are quite like those that would be due to moving electrified matter, and the actions are quite unlike anything we know of the properties of the ether.

THE anomalies which are constantly observed in culture for bacteriological researches have, up to the present, been generally ascribed to abnormal conditions or to involution. Although the existence of polymorphism among bacteria may be inferred from the records of Metschnikoff, Weibel, Cornil and Babes, Kiessling, Karlinski, and especially those of Guignard and Charrin, as yet no absolute proof had been adduced to make it a fact. The *Weekblad v. h. Tydschrift v. Genesk* of April 28 contains an article in which the writers contend that among pleomorphic bacteria there are some species which, under different conditions, present different forms. Last year, when testing the water from the waterworks of Groningen, Ali Cohen and Uffelie, of the Hygienic Laboratory of that city, succeeded in cultivating in pepton Na Cl, fluid, spirilla which possessed all the morphological and biological properties generally ascribed to this species of organism. These spirilla, transplanted in nutritive gelatine, speedily developed colonies, but exclusively consisting of bacilli. These bacilli, replaced in a solution of pepton, Na Cl, reproduced again spirilla, not all identical, however, but consisting of commas, S forms, and short spirella. They repeated their experiments for several consecutive months, always with the same result. During these investigations another curious fact came under their notice. An organism which for several months, in alternate solid and fluid nutriment, had produced the alternate form of spirillum and bacillus, although the conditions of culture had not been altered in any way, lost at last the power of reproducing spirilla. The organism had retained all its individual characteristic properties, but it was impossible to revive this power. These observations led the writers to the conclusion that the present state of bacteriological science does not admit of ignoring the signs of polymorphy in bacteria, and that it is inaccurate to speak of normal and abnormal conditions, or to recommend as appropiate only those nutrients in which bacteria most speedily develop and accurately retain the form under which they are described in the text-books. The fact that most species of bacteria cultivated under glass gradually lose their power of multiplication, their loss of pathological and other biological properties, make this apparent. Even increased power of growth does not necessarily prove the exterior conditions to be favourable. It is well known that the bacillus of diphtheria loses its virulence in proportion as its power of development increases. In their opinion, therefore, it will henceforth be unsafe to deny, on morphological basis only, that the cholera spirillum may have developed from a certain form of bacillus, and that it is not invariably produced from an individual whom it morphologically resembles.

The first volume has been issued of Dr. Bowdler Sharpe's "Handbook to the Birds of Great Britain." The book belongs to the new edition of Allen's Naturalist's Library, of which Dr. Sharpe is the editor, and Messrs. W. H. Allen and Co. are the publishers.

We have received an excerpt from the Transactions of the Academy of Science of St. Louis (vol. vi. p. 481). Mr. Milton Updegraff is the author of the extracted paper, the subject of which is the determinations of the latitude, longitude, and height above sea-level of the Laws Observatory of the University of the State of Missouri, and the Observatory building and instruments.

The *Bulletin* of the Royal Gardens, Kew, Appendix ii. for 1894, is entirely occupied by a list of new garden plants brought into cultivation for the first time in the year 1893, including botanical varieties and hybrids, as well as the most noteworthy of those which have been reintroduced after being lost from cultivation, and others now for the first time described or published with authenticated names.

Part ii. No. 4, of vol. lxii. of the "Journal of the Asiatic Society of Bengal" contains two papers by Dr. G. King, the Superintendent of the Royal Botanic Garden, Calcutta: "On some Indian Species of *Canarium*," and a continuation of his "Materials for a Flora of the Malayan Peninsula"; also an account of the Deep Sea Collection made during the season of 1892-93 in H.M. Indian Marine Survey steamer *Investigator*, by Dr. A. Alcock, Superintendent of the Indian Museum.

We have received two important reprints from the "Sixth Annual Report of the Missouri Botanical Garden": North American species of *Sagittaria* and *Lophotocarpus*, by Jared G Smith, illustrated by twenty-nine beautifully executed plates; and a description, by W. Trelease, of *Leitneria Floridana*, a Floridan tree now for the first time discovered in south-eastern Missouri. The systematic position of this monotypic genus is still uncertain; the author being doubtful whether to place it near the Platanacea among Apetalæ, or near the Dipterocarpeæ or Balsamifluæ among Polypetalæ. This paper is also illustrated by fifteen excellent plates.

The first edition of Dr. J. E. V. Boas' "Lehrbuch der Zoologie für Studirende und Lehrer" (Gustav Fischer, Jena) was reviewed in these columns at the beginning of 1891 (vol. xliii. p. 268). A second edition of the manual has now been published. No alterations have been made in the plan of the book, but emendations and numerous additions have been inserted here and there, so as to bring the matter in line with recent work. Nearly fifty illustrations have also been added.

The tenth edition of "Quain's Elements of Anatomy" edited by Profs. E. A. Schäfer, F.R.S., and G. D. Thane, is slowly approaching completion. Messrs. Longmans, Green, and Co., the publishers of the work, have just issued the third part of vol. iii., dealing with the Organs of the Senses, and it is announced that the second part of this volume (Peripheral Nerves) will be published shortly. The fourth part (Visceral Anatomy) is in preparation, and will complete the work.

So long ago as 1883 we reviewed (vol. xxviii. p. 195) the first part of "Field and Garden Crops of the North-Western Provinces of Oudh," by Mr. J. F. Duthie, the Director of the Botanical Department of Northern India. The second part was published a year after the first, but the third and concluding part, dealing almost entirely with garden crops, has only just reached us. All important plants of this kind, grown in India on comparatively small plots, are described and excellently illustrated. Mr. Duthie has added to the usefulness of his work by giving at the end of the part just received a general index to all the parts.

In the Report of the U.S. National Museum for the fiscal year ending June 30, 1891, there are several papers describing and illustrating collections in the Museum, in addition to the reports of the various curators. Dr. G. Brown Goode describes the genesis of the Museum in an article full of information. The ethnological collections in the Museum from Kilima Njaro, East Africa, are enumerated by Dr. W. L. Abbott, and the Korean collections by Mr. Walter Hough, both papers being well illustrated. Mr. Romyn Hitchcock contributes three papers to the volume, one on Shinto, or the mythology of the Japanese, another on the ancient burial mounds of Japan, and a third on some ancient relics found in Japan. Finally, Mr. George H. Boehmer's exhaustive history of the prehistoric naval architecture of the North of Europe is included. This paper should be referred to by all who are interested in the development of the art of shipbuilding.

Scarcely a week passes without our receiving several voluminous reports on scientific work carried out under the auspices of the United States Government. One of the last volumes to come to hand is the Report of the U.S. Commissioner of Fish and Fisheries for 1889 91. The Commissioner's report alone is a valuable summary of work, but this covers less than one hundred pages, and the remaining 550 pages consist of papers upon various branches of inquiry. The subjects of these investigations are food-fishes and fishing-grounds, methods and statistics of the U.S. fisheries, the work of the U.S. Fish Commission steamer *Albatross*, the oyster resources and oyster fishery of the Pacific Coast of the United States, the coast fisheries of Texas, a review of the sparoid fishes of America and Europe, fish Entozoa from the Yellowstone National Park, and last, but not the least important, a translation of Prof. Haeckel's "Plankton-Studien," being "a comparative investigation of the importance and constitution of the marine fauna and flora." All these papers will be read with interest by students of marine biology.

SINCE 1844, Müller-Pouillet's "Lehrbuch der Physik und Meteorologie" (Vieweg und Sohn, Braunschweig) has passed through eight editions, and the ninth edition, edited by Dr. L. Pfaundler, only wants the second part of the second volume to complete it. There are three volumes altogether. Vol. i. treats of Mechanics and Acoustics, and vol. iii. of Magnetism and Electricity. The former appeared in 1886, and the latter in 1890. The publication of the second volume, dealing with Light and Heat, has been delayed owing to the removal of the editor to Graz University. Dr. Otto Lummer has, however, taken up the work where it was left, and the publishers have been able to issue the first part of the second volume, containing four chapters on Light. It is hoped that the remainder of the volume will be published at no very distant date. The whole edition has been thoroughly revised and greatly enlarged, the work, so far as yet published, running into more than 2200 pages. It is unfortunate that so many years should have elapsed between the publication of vols. i. and iii. and that the issue of vol. ii. should have been so long delayed. Owing to these differences of dates, the edition cannot be said to represent, as a whole, the state of physical science at any particular epoch. Like Jamin's and Ganot's and Deschanel's works on physics, that of Müller-Pouillet is amply illustrated. All experimental apparatus is fully described, and the objects accomplished with it explained in detail without the use of advanced mathematics. In a prefatory announcement the work is commended to those "welche nicht Gelegenheit finden, akademische Vorträge mit Experimenten zu besuchen." From this one could be led to believe that the manual was suitable for reading by a public debarred from seeing physical experiments performed. This, however, is not the case. The place of the work is among books of reference suitable for elementary students of natural philosophy, not with those designed for general readers.

THE additions to the Zoological Society's Gardens during the past week include a Bornean Ape (*Macacus inornatus*, ♀) from Borneo, presented by Mrs. Florence Firman; a Puma (*Felis concolor*, ♀) from South America, presented by Miss Florence Dickinson; a Leopard (*Felis pardus*, ♂), a Cheetah (*Cynælurus jubatus*) from East Africa, presented by Major Owen; an Isabelline Bear (*Ursus isabellinus*, ♂) from Cashmere, presented by Mr. E. Haag; a Sloth Bear (*Melursus ursinus*) from the Hills of Orrissa, Bengal, presented by Mr. J. W. Currie; a Downy Owl (*Pulsatrix torquatus*) from Brazil, presented by Dr. E. A. Goeldi; an Eroded Cinixys (*Cinixys erosa*) from Cape Lopez, Gaboon, presented by Commander J. L. Marx, R.N.; a Greek Tortoise (*Testudo græca*) from Greece, presented by Mr. H. K. Bartlett; a Hoolock Gibbon (*Hylobates hoolock*) from Assam, a Black-handed Teetee (*Callithrix melanochir*) from Brazil, a Black-winged Peafowl (♂) from Cochin China, five Helodermas (*Heloderma suspectum*) from Arizona, deposited; a Great Anteater (*Myrmecophaga jubata*) from South America, a Black Stork (*Ciconia nigra*), European, two Japanese Teal (*Querquedula formosa*) from North-East Asia, purchased; a Wapiti Deer (*Cervus Canadensis*, ♂), a Mouflon (*Ovis musimon*, ♀), a Yellow-footed Rock Kangaroo (*Petrogale xanthopus*, ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

BRIGHT-LINE STARS.—Exact information about stars with bright lines in their spectra is appreciated by all who have the advance of celestial science at heart. In a paper in the June number of *Astronomy and Astro-Physics*, Prof. W. W. Campbell brings together all that is known with regard to objects of this spectroscopic character, and adds to the literature a number of important observations made by himself. Since 1867, when MM. Wolf and Rayet discovered three bright-line stars in Cygnus, fifty-two objects of the same type have been found, forty-two of this number being placed to the credit of the Harvard College Observatory. Prof. Campbell has made visual determinations of the positions of the lines in the spectra of thirty-two of these stars, and has also photographed the spectra in juxtaposition with a hydrogen comparison spectrum. One of the most noteworthy facts brought out by the observations is that the hydrogen lines in the spectra present a variety of forms and intensities. In many of the stars they are dark; in others, they are dark with bright borders. The bright hydrogen lines vary from faint to very bright, from monochromatic lines to very broad bands, and from those clearly single to those apparently multiple. Like many lines in the spectra of nebulæ, those of bright-line stars are difficult to identify with terrestial substances. The ubiquitous lines of hydrogen are certainly present, and Prof. Campbell finds that prominent lines of iron and other elements appear to coincide with a few of the star lines, while a line at wave-length 4480 suggests to him a magnesium origin, but the identifications are not sufficient to lead him to make any definite conclusions. Much more can be learnt from his comparison, in tabular form, of lines in stars of the Wolf-Rayet type with those found in the solar chromosphere, in Nova Aurigæ, and nebulæ; also with dark lines in Orion stars, and in β Lyræ. The hydrogen lines are shown to be prominent in all the six spectra. With the exception of the lines of hydrogen, D_3, and that at λ 4472, lines in the chromosphere do not furnish any striking coincidences with lines in Wolf-Rayet stars. The parallel columns of lines also fail to indicate any connection between these stars and Novæ, the only point of similarity being that the lines in both these classes of celestial objects are broad. As is well known, the nebular spectrum and that of bright-line stars are much alike. A close examination, however, has led Prof. Campbell to think that nine prominent star-lines do not occur in nebulæ; while, on the other hand, five nebular lines were unsuccessfully looked for in the stars. His deductions from the whole of the observations are summed up as follows:—"In conclusion, I think we can say that the spectra of the Wolf Rayet stars are not closely related to any other known type. They appear to have several points in common with the nebular and Orion type spectra; but the last two appear to be much more closely related to each other than to the Wolf-Rayet spectra. It is therefore difficult to place these stars between the nebulæ and Orion stars. They certainly do not come *after* the Orion stars, and one does not like to place them *before* the nebulæ. We can probably say that the bright lines are chromospheric, owing their origin to very extensive and highly heated atmospheres, but showing very little relation, in constitution and physical condition, to that of our own sun. For the present, at least, this type of spectrum must be considered as distinct from every other known type, just as the nebular spectrum is distinct, and like the nebular spectrum containing lines whose origin cannot now be assigned."

EPHEMERIS FOR GALE'S COMET.—The following positions for Gale's comet are from the ephemeris given by Prof. Kreutz in *Astronomische Nachrichten*, No. 3229:—

Ephemeris for Berlin Midnight.

1894.		R.A. h. m. s.		Decl. ° ′		Brightness.
June 23	..	11 54 33	...	N. 43 1·4	..	0·14
27	...	12 2 16	...	43 15·9	...	0·12
July 1	...	12 9 47	...	43 25·5	...	0·10
5	...	12 17 7	...	43 31·0	...	0·09
9	...	12 24 19	...	43 33·5	...	0·07
13	...	12 31 26	...	43 33·1	...	0·06

THE ROYAL SOCIETY CONVERSAZIONE.

THE rooms of the Royal Society were crowded with a distinguished gathering on Wednesday evening, the 13th inst., the occasion being the annual Ladies' Conversazione of the Society. In accordance with our usual custom, we give descriptions of the most important exhibits not previously mentioned in these columns.

Prof. McKenny Hughes, F.R.S., exhibited specimens illustrating the evolution of the breeds of English oxen. The earliest breed, *Bison priscus*, belongs exclusively to the Palæolithic age. The next, *Bos primigenius*, commenced with *Bison priscus*, but outlived that species, and is characteristic of the Neolithic age. Both the above forms had disappeared before the arrival of the Romans in Britain. *Bos longifrons* appeared with *Bos primigenius*, but survived to Roman times. The Romans improved *Bos longifrons* by crossing it with some larger breed having straighter and more upturned horns. As there was no large native breed surviving, and, moreover, the characters of *Bos primigenius* do not appear in the cross, the Romans must have imported the breed with which *Bos longifrons* was crossed. The type of the Roman breed is still seen in the tawny Highland cattle (a larger variety of which is still common in Italy), in the black Welsh and Highland (such as were killed for funeral feasts); and in the Chillingham cattle (the descendants of the white sacrificial bull). All these are whole-coloured: the parti-coloured cattle are a much later introduction. After the withdrawal of the legionaries, there was soon no care of selection of stock, and the cattle, except those preserved in enclosures or isolated in the far West and North, reverted to the type of *Bos longifrons* as seen in specimens from the mediæval ditches round Cambridge.

Mr. Shelford Bidwell, F.R.S., exhibited illustrations of recurrent vision and retinal oscillations. For recurrent vision a moving patch of light, white or coloured, projected upon a screen, was followed at a short distance by a "ghost" or recurrent image, generally of a violet hue. To show retinal oscillations a modified form of Charpentier's experiment was used, demonstrating the brief period of insensibility to luminous impression which follows the impact of light upon the eye.

The shell musical instruments (trumpets and flutes), exhibited by Dr. George Harley, F.R.S., included: (1) Shell fog-horn used by fishermen on the banks of Newfoundland (*Strombus gigas*). (2) Welsh shell trumpet used as a dinner [illegible] (small *Strombus gigas*). (3) Miner's blasting signal horn, used in the Guernsey granite quarries (*Strombus gigas*). (4) Conch trumpet, blown at funerals and religious festivals in Southern India (*Turbinella rapa*—peeled and decorated with brass [illegible]). (5) Triton shell flute from New Guinea (*Triton* [illegible]). (6) Helmet shell trumpet from New Guinea (*Cassis cornuta*). (7) Figure-ornamented triton trumpet from Japan. (8) Triton shell flute from Solomon Islands. The exhibitor expressed the opinion that shells were the first forms of trumpets and flutes ever employed.

Sketches of clouds, by Luke Howard, F.R.S., were exhibited by his granddaughter, Lady Fry. These sketches were lately found, unmounted, amongst the family papers of the late Luke Howard. In many cases they bear his initials, or remarks in his handwriting. They appear to have been drawn by him from instances which came under his own observation, during the time that he was conducting those studies which resulted in his work on "The Modifications of Clouds," and in his well-known nomenclature and classification. Some of them were copied for, and appeared in, his work. See also the "Einleitung" to Prof. G. Hellmann's recent reprint of Howard's work. (Berlin: A. Asher and Co., 1894.)

Original drawings of the "Milky Way," made at Birr Castle Observatory, were exhibited by Lord Rosse. These drawings, comprising one general view and three sections of same on an enlarged scale, represent the "Milky Way," as seen with the naked eye as far as 2[illegible] South Declination. They were reproduced by lithography on half the original scale by Mr. W. H. Wesley and published by Messrs. Longmans.

The Postmaster-General exhibited (1) Wheatstone's automatic transmitter, running up to 600 words per minute, driven by Willmot's air motor. The air motor in this instrument dispenses with the 132 lb. weight which, when the instrument is running at 600 words per minute, requires rewinding by the operator every few seconds. And since the motor is applied directly to the [illegible] axle, it dispenses with the whole of the train of wheel-work, the friction regulator and complicated fly-wheel. The speed of the instrument is regulated by opening or contracting the nozzle regulating the supply of air. The power required is so small that the instrument can be driven at a moderate speed by simply blowing into it with the mouth. (2) Prof. Hughes' type printing telegraph, driven by Willmot's air motor. The air motor in this instrument takes the place of the 132 lb. weight previously used, and dispenses with the whole of the winding gear, and nearly all the train of wheel-work, the motor being applied directly to the printing shaft. The motor is self-starting in any position, and will run continuously without any aid from the operator.

Messrs. John I. Thornycroft and Co. had on view a case containing models of torpedo boats, light-draft patrol steamer, and the "Thornycroft" water-tube boiler.

A sonometer for measuring the relative and comparative perception of hearing was exhibited by Mr. T. P. Hawksley. The instrument consists of two primary coils of unequal winding; between them slides a secondary coil, two dry cells, or a thermopile supply current, which is made intermittent by an adjustable rheotome. The secondary coil is connected to a deep note telephone, from which proceeds a tube to be applied to the ear. A condenser may be used. At one point on the scale the interruptions of the rheotome are not heard in the telephone, but on approaching the secondary coil to one of the primary coils, the interruptions gradually increase in loudness until they become unbearable to the ear.

Mr. J. Wimshurst exhibited models showing an improved method of communication between shore stations and light-ships, or other like purposes. The method consists in arranging suitably wound coils of insulated wire upon the swivel pin of the moorings, the one coil being in communication with the shore station and the second coil in communication with the ship. Signals, or sound, are transmitted by induction, or by electromagnetic induction.

Mr. Charles Bradbury's exhibit was the "Brunsviga" calculating machine, for plain figures or decimals. The "Brunsviga" is an arithmometer constructed on an entirely new system, and will add, multiply, subtract or divide with absolute accuracy, giving products up to 13 figures (ordinary size) or 18 figures (large size). The handle is turned in one direction for addition or multiplication, and in the reverse direction for subtraction or division. This machine is used at the Royal College of Science, the City and Guilds Technical College, the Millard Laboratory at Oxford, the Postal Telegraphs Department, &c.

Mr. Charles Baker showed apparatus for obtaining instantaneous photo-micrographs, and viewing the image until exposure is made. The apparatus consists of a case containing a metal shutter, carrying a prism, and connected with a pneumatic release. When this shutter is set the image in the microscope is projected, by means of a prism, on to a screen, which is fixed in an adjustable tube at right angles to the optic axis, and can be viewed and focussed up to the moment of exposure. To ensure accurate focus, the screen in the adjusting tube should be placed the same distance from the microscope as the plane of the sensitised plate. A slit in the shutter can be opened or closed to regulate the exposure.

The exhibit of the Marine Biological Association included: (1) Living pelagic larvæ, &c., from Plymouth. (2) Examples of the echinoderm fauna of Plymouth. (3) Hybrid between brill and turbot (North Sea). (4) Sole with an eye on each side of the body. The usual distortion, due to the shifting of the left eye to the right side, had not occurred (North Sea). (5) Plaice larvæ, up to 28 days' old, reared from eggs hatched in the Plymouth Laboratory. The organisms exhibited were either of economic or of scientific interest.

A method of heating by electricity for hospital purposes was shown by Mr. C. F. Snelckor. By means of this electrical mode of generating heat it is possible to obtain and maintain uniform any required degree of temperature. The apparatus is enclosed in an elastic and flexible case, with a silk or woollen covering, so that it can be applied to and envelope any part of the body as a fomentation. It can also be used for a domestic Turkish bath, or used as a footwarmer, and generally for warming purposes in the bedroom or carriage.

Prof. Oliver Lodge, F.R.S., exhibited a compact and sensitive detector for electric radiation, and a spherical radiator of short Hertz waves. The apparatus consisted of a small copper cylinder containing a piece of zinc and sponge, forming a battery, a coil and suspended needle-mirror, forming a galvanometer, and a ball contact or ' coherer," or else a tube of filings, in circuit with the other two. Electric surgings in the air, or in a scrap of wire pegged into the lid, increased the conductance of the circuit. A light tap on the cylinder reduced it again. A handy lamp and scale enabled the deflexion of the needle to be seen. The surgings could be excited by giving sparks to an insulated sphere not far off, especially if the knobs supplying the sparks are well polished.

The exhibit of Dr. E. C. Stirling, C.M.G., F.R.S., was a series of fourteen photographs, with two maps and a geological section illustrating the researches carried on at Lake Callabonna, in South Australia, for remains of Diprotodon and other extinct animals, in 1893. A description of the work to which these photographs refer is given in another part of this number.

Gold leaf made by electro-deposition was exhibited by Mr. J. W. Swan, F.R.S. This exhibit illustrated an attempt to produce gold leaf by electro-chemical instead of mechanical means. The leaves were prepared by depositing a thin film of gold on a highly polished and extremely thin electro copper deposit. The copper was then dissolved by perchloride of iron, leaving the gold in a very attenuated condition. The leaves were approximately four millionths of an inch thick, and some of them mounted on glass showed the transparency of gold very perfectly when a lighted lamp was looked at through them.

Miss Edna Walter and Mr. H. B. Bourne had on view a projective goniometer. By means of this instrument, devised and constructed by the exhibitors, the projection of a crystal on a sphere is actually accomplished, realising in practice the fundamental assumption of the theory of crystallography: the instrument is thus of value in demonstrating the axioms of the science. If necessary, angular measurements could be made from the image, but these only attain an accuracy of about 40' in 60° = one per cent., which is inferior to that attained with a goniometer.

Lord Kelvin showed a model illustrating the molecular tactics of a quartz crystal. The crystalline molecule was represented by a regular hexagonal prism of wood, the long diagonal of the hexagon being ·95 of the length of the prism. This gave in the assemblage representing a quartz crystal of regular form, the correct angle (38° 13' between the faces of the prism and the faces of the terminal six sided pyramid. Each crystalline molecule was marked on alternate sides with slips of blue and red paper, to show the orientational difference between the alternate sides of the prism and the absolute difference between the alternate faces of the pyramid. The coloured slips were placed obliquely to give the chiral quality of the crystalline molecule and of the assemblage. Right-handed and left-handed molecules were shown. All the piezo-electric and pyro-electric properties of the crystal (including the chiral piezo-electric property discovered by Voigt) would be actually produced in the model, if copper and zinc were substituted for the red and blue paper, and the individual prisms separated by elastic insulating material. The model showed the well-known orientational macling on two faces of the prisms, and the contiguous pair of faces of the terminal pyramid.

Dr. Isaac Roberts, F.R.S., showed original negatives and enlarged photographs of the spiral nebulæ Messier 74 Piscium, Messier 101 Ursæ Majoris, Messier 65 and 66 Leonis, Herschel I. 168 Ursæ Majoris, Herschel I. 56 and 57 Leonis. These photographs revealed the forms and structures of the spiral nebulæ with much greater detail and accuracy than had previously been known. They also clearly showed that the spirals were almost perfect geometrical figures, but broken up into numerous stars, or star-like condensations of the nebulosity, or of the meteoric matter, of which they are probably composed, and thus furnish strong evidence of the truth of the nebular or of the meteoric hypotheses.

A number of specimens illustrating locomotion phases in decapod crustacea were exhibited by Prof. Stewart, who also showed mummy cloth, of not later than 4000 B.C., compared with finest Irish linen of to-day. The piece of mummy cloth, made not later than 6000 years ago (IVth Egyptian Dynasty), was shown by the side of a piece of finest Irish linen 140 · 140 of to-day. The strands of the mummy cloth were 300 150 per inch.

Specimens of metallic chromium, manganese, tungsten iron, &c., free from carbon, also fused alumina, obtained during reduction of the metallic samples, were exhibited by Mr. Claude Vautin. The specimens of metallic chromium, manganese, &c., had been reduced from their oxides by means of metallic aluminium. The oxide of the metal to be reduced was intimately mixed with finely divided aluminium, and heated in magnesia-lined crucibles. The heat produced by the oxidation of aluminium during the operation was sufficient to fuse alumina, specimen of which was exhibited.

Prof. A. M. Worthington, F.R.S., and Mr. R. S. Cole exhibited photographs of a splashing drop. The photographs shown were obtained by allowing a drop to fall in absolute darkness, and illuminating it at any desired stage of its splash by a suitably timed Leyden jar discharge taking place between magnesium terminals. The exhibit comprised (1) shadow photographs obtained when a drop of mercury fell on the sensitive plate itself, which was laid horizontally and illuminated from above; (2) objective photographs, showing much more detail than has usually been obtained in such instantaneous work, and illustrating the exquisite sensitiveness of the very rapid modern plates. To obtain these photographs the spark was produced at the focus of a deep, silvered watch glass subtending an angle of nearly 180°, and was brought very near to the place of impact. A single quartz spectacle lens was substituted for the usual lens of the camera, and thus the absorption of photographic rays by glass was avoided.

Mr. W. Kurtz (New York) exhibited photographic prints in the natural colours, obtained by printing in the three primary colours only (Dr. Vogel's process). The prints shown were all of them printed in *three* colours only, some by surface-printing, the others by lithography; but in all cases the printing blocks were produced by photography. The process employed is as follows:—By the intervention of suitable media, three photographs are obtained, severally appropriate to the three primary colours composing the original picture or view required to be reproduced. From these three photographs, respectively due to the chemical action of the red, yellow, and blue rays of the spectrum, printing blocks are prepared, which being printed from in red, yellow, and blue ink, give the multi-coloured effects shown by the specimens.

Prof. Elisha Gray exhibited the telautograph, an instrument for transmitting intelligence by electricity. The writer at one station using a lead-pencil, attached mechanically to the apparatus, and writing upon ordinary paper, transmits to the distant station a facsimile of his handwriting, at his ordinary writing speed. Sketches, sketch-portraits, diagrams, plans, trade-marks, and the like, as well as the characters of hieroglyphic alphabets may also be transmitted.

The following exhibits, with demonstrations by means of the electric lantern, took place in the meeting room of the Society:—

The magic mirror, by Mr. J. W. Kearton. It was shown that the English magic mirror owes its peculiar properties to curved elevations and depressions in the polished metallic face, the elevations producing figures in shade by scattering of light, and the depressions, figures in light by condensing rays reflected from the mirror on to a screen. The figures in relief and intaglio are first produced by the action of any suitable acid on the metal plate, and are then polished down until they disappear to direct vision The figures of the Japanese type of mirror are by-products in the process of manufacture, and arise from local yieldings of the face and back during polishing: the more rigid parts of the face, which correspond to raised metallic figures on the back, suffer a somewhat greater reduction from opposing greater resistance to the polishing tool.

As at the previous conversazione, Prof. E. B. Poulton gave illustrations of recent work upon the influence of environment upon the colours of certain lepidopterous larvæ.

Mr. D. Morris, C.M.G., exhibited and described a series of views illustrating the leading features of tropical vegetation.

A CHEMICAL METHOD OF ISOLATING FLUORINE.

A NEW salt of exceptional interest, the first member of a series of fluorplumbates, is described by Dr. Brauner, of Prague, in the June issue of the *Journal* of the Chemical Society. Dr. Brauner is well known in this country, having been Berkeley Fellow of the Owens College, Manchester, previous to his appointment to the chair of chemistry in the Bohemian University. Twelve years ago he described two compounds very rich in fluorine, $CeF_4 . H_2O$ and $3KF . 2CeF_4 . 2H_2O$, and showed that when heated they first gave up their water and subsequently evolved a gas which possessed an odour similar to that of hypochlorous acid, and which exhibited the chemical properties expected of free fluorine. The compound now described is a fluorplumbate of the composition $3KF \cdot HF \cdot PbF_4$. It may be obtained by three methods. The first consists in treating the freshly precipitated hydrated oxide of lead, $Pb_3O_4 \cdot 3H_2O$, a substance described by Dr. Brauner in the year 1885, with a mixture of hydrogen potassium fluoride and hydrofluoric acid. The fluorplumbate is separated from the lead difluoride simultaneously formed by crystallisation from hydrofluoric acid. The second method consists in substituting fluorine for oxygen in the plumbates of Fremy. Peroxide of lead and caustic potash, in the proportions of the compound $3KOH \cdot PbO_2$, are fused in a silver crucible; the product is moistened with water, and then added gradually to excess of pure hydrofluoric acid. The filtered solution is evaporated to the crystallising point in a current of air, and as soon as crystals commence to form is placed in a vacuum desiccator. Crystals of the salt are then deposited. The third method consists in displacing the acetic acid in lead tetracetate by fluorine. One molecular equivalent of lead tetracetate is added to three equivalents of hydrogen potassium fluoride, $HF \cdot KF$, dissolved in hydrofluoric acid; crystals of potassium fluorplumbate are formed upon evaporation, either in the air or *in vacuo*. Analyses of the crystals prepared by all three methods indicate the composition $3KF \cdot HF \cdot PbF_4$.

The needle-shaped crystals, which frequently attain the length of a centimetre, and are grouped radially, have been found to be in all probability monoclinic in symmetry, and isomorphous with the analogous fluorstannate described by Marignac.

Potassium fluorplumate is permanent in dry air, but becomes brown in moist air, being decomposed by water, with formation of hydrated peroxide of lead, hydrogen potassium fluoride, and free hydrofluoric acid The effect of heat upon the salt is most interesting and important. The experiments should be carried out in a platinum tube. At 100°–110° the crystals remain unaltered. At 200 hydrogen fluoride commences to be evolved in small quantity. When subjected to a much higher temperature, after previous heating for several hours at 230°–250°, a gas commences to be evolved endowed with the odour ascribed by Moissan to fluorine. This occurs much below a red heat. The gas liberates iodine in such large quantities from iodised starch paper as to cause it to be deposited in crystals, and small crystals of silicon held in the open end of the tube not only burn with a vivid incandescence, but even with explosive violence. There can, therefore, be no question that the gas is free fluorine, and it would thus appear that Dr. Brauner has discovered a trustworthy purely chemical process of isolating the element. Potassium fluorplumbate loses its hydrogen fluoride almost completely at 230°, without losing more than a trace of fluorine from the lead tetrafluoride. Any small traces of hydrogen fluoride subsequently evolved along with the fluorine at the higher temperature may be readily removed by Moissan's method of passing the gas over potassium fluoride.

Dr. Brauner has already obtained evidence of the existence of a whole series of fluorplumbates, analogous to Marignac's fluorstannates, and is now engaged in studying the sodium salt.

A. E. TUTTON.

A SURVEY OF THE ENGLISH LAKES.

AT the last meeting of the Royal Geographical Society a paper was read by Dr. Hugh Robert Mill, on the Lake District of North-western England, of which the following is an abstract The lake district is a remarkably definite and symmetrical geographical unit. It may be roughly described as a circular mass of elevated land, highest in the centre, and furrowed by a series of valleys running from the centre toward the circumference like the spokes of a wheel. Most of these valleys contain long narrow lakes of considerable size, and of a different type from the small round mountain tarns which also occur in the district.

An account was given in the paper of the methods employed for ascertaining the depth and fixing the position of each sounding, and for mapping the resulting information. The lakes considered were Windermere, Ullswater, Coniston Water, Wastwater, Ennerdale Water, Buttermere and Crummock Water, Derwentwater, Bassenthwaite Lake, and Haweswater, each of which was found to have certain special characteristics which distinguished it from all the others. The soundings were carried out by the author, assisted by Mr. E. Heawood, Mr. Shields, and others.

There are two main types amongst these lakes, the shallow and the deep. The former, including only Derwentwater and Bassenthwaite, are the broadest of all the lakes; they average 18 feet in depth, their mean depth being only 25 per cent. of the maximum depth, a smaller ratio than for any other lakes. The bed of these lakes may be roughly described as an undulating plain, grooved and ridged into shallow hollows, and low shoals running parallel to the long axis of the lake. The configuration suggests that they may have been shallowed by glacial accumulations.

The second, or deep type, the shallowest of which has an average depth of 40 feet, and in which the average depth varies from 36 to 61 per cent. of the maximum depth, comprises all the other lakes except, possibly, Ennerdale, which combines the characteristics of both types. They are long, narrow, sometimes winding like Ullswater, or slightly curved in outline like Wastwater and Haweswater. The most characteristic lie in long narrow valleys with steeply sloping sides, and the slopes are continued under water with almost equal steepness, in some cases with greater steepness, and terminate in a nearly flat floor. The typical form of this class of lake is thus a steep-sided flat-bottomed trough, diversified along the slopes by the still steeper conical mounds of débris thrown down at the mouths of streams. In Haweswater the largest example of a delta occurs, nearly cutting the lake in two; while Buttermere and Crummock, lying in one uniform valley, are entirely separated, probably by the same action, and Derwentwater is also divided from Bassenthwaite by a broad alluvial plain. Although most of the lakes show only one clearly defined trough, the two largest are divided into distinct basins. In Windermere, the shoal on which Belle-isle and the other islands off Bowness, rise separates the deep and wide upper basin from the less deep and much narrower lower basin. In Ullswater each of the three reaches of the lake contains a definite basin separated from the others by broad or narrow bars. From one of these the island of House-holm rises, a mass of strongly glaciated rock; but while the position of the basin to the south of it seems to confirm the glacial theory of the excavation of the hollow, the hollow to the north of the island is so situated as to make its origin by glaciation somewhat difficult to understand.

Three of the lakes have depths which descend below sea-level. In Wastwater 217 acres lie beneath sea-level, so that if drained to that extent it would present the appearance of a lake still 58 feet in depth at one point. Windermere, if similarly drained, would show a northern lake 3¼ miles long with a maximum depth of 90 feet, and 3 miles further south a narrower lake 1 mile in length and only 14 feet deep at its deepest, while south of this there would be a still shallower lagoon half a mile long. In Coniston reduced to sea-level there would probably appear one narrow lake 2½ miles long and 42 feet in maximum depths. All the other lakes are situated at such elevations that they do not approach sea-level in their greatest depths.

Altogether, the lakes which have been sounded and mapped cover an area of 20 square miles of unexplored territory. Contoured maps of the ten lake basins under consideration have been supplied to the Ordnance Survey for incorporation on the official maps of the country.

THE RECENT DISCOVERY OF FOSSIL REMAINS AT LAKE CALABONNA, SOUTH AUSTRALIA.[1]

I.

FROM time to time notices have appeared of a remarkable discovery of fossil bones at Lake Mulligan in the interior of South Australia, but so far there has been no connected statement of what has been done in the way of developing the discovery. For reasons which will be evident, it is not yet possible to announce the results with anything more than a rough approximation, which leaves many interesting questions unsolved, or even untouched. Still, in view of its palæontological importance, it seems desirable that any available information should be given without further delay.

Necessarily a fragmentary and imperfect record, I trust the following account will, at least, afford evidence that the authorities of the South Australian Museum are fully alive to the interest of the issues involved, and that, so far as their not

[1] By Dr. E. C. Stirling, F.R.S., C.M.G., Hon. Director, South Australian Museum.

too ample means will allow, they are doing their best to prosecute successfully a work of some magnitude and difficulty.

One other preliminary statement seems necessary. Though the so called lake in which the fossils were found has been hitherto spoken of as Lake Mulligan, that name has never been officially conferred or recognised, and indeed it will not be found on any of the maps of South Australia. There prevails a very proper sentiment, unfortunately not always carried into action, that the native names of localities should, so far as possible, be retained. In this particular instance the euphonious native name Callabonna, which applies to a large water-course leading into the lake and to an adjoining sheep-run seemed appropriate in all respects, save that the association of sound and idea might erroneously suggest the possession of the scenic beauties of an Italian lake by an area which is not only waterless, but also almost unsurpassable for barrenness and utter desolation. The name, however, has been approved by the Executive, and in future the locality will be known as Lake Callabonna, and will be so called in the following notes:—

PHYSICAL FEATURES OF THE LAKE EYRE BASIN.

As has often been observed, those who might form their estimate of the physical geography of South Australia from an inspection of its maps alone, would come to very erroneous conclusions. The numerous, and often immense, areas marked as lakes, and the plentiful streams which appear to supply them, deserve their names on rare occasions only. Ordinarily the lakes are only shallow, mud-bottomed, or salt-encrusted clay-pans, and the rivers dry water-courses, or it may even be that a definite channel is unrecognisable. Only after the heavy tropical rains, which at too rare intervals descend to these latitudes, do the rivers run for a brief period and the lakes contain water, though for some time afterwards the deeper parts of the water-courses may remain as water-holes, or chains of water-holes of greater or less size and permanence. Those, however, who have only seen the river channels dry, can have little idea of what torrents they may become under such circumstances. The flood waters of the Barcoo or Cooper, some few years ago, spread over a breadth of from forty to fifty miles on its way to reach Lake Eyre. Lake Eyre itself has occasionally been filled, and is then a vast inland sea over a hundred miles long and fifty broad, and, when full of water, might well have suggested great possibilities of internal navigation.

The area of these inland lakes presents roughly a division into a Western system, comprising Lake Gairdner and numerous adjacent smaller clay-pans; a Central system, of which Lake Eyre, Lake Eyre South, and Lake Torrens are the chief members; and an Eastern system, comprising, in their order from north to south, Lakes Gregory, Blanche, Callabonna and Frome. These three systems have no direct communication with one another; in fact, they are separated by more or less elevated ground.

From the fact of some of the early explorers, in proceeding northwards, having struck the apparently unending margins and impassable beds of the huge clay-pans, either of Lake Torrens, of Lake Eyre, or of those of the Eastern group, all of them were for some time supposed to be continuous and to form one great lacustrine surface. Indeed, for many years a familiar feature on the maps of Australia was an immense crescentic, or horse-shoe shaped, area with its two horns, formed by the present Lakes Torrens and Frome, directed southwards. Eventually the progress of discovery enabled this horse-shoe to be broken up into the constituents now called Lakes Torrens, Eyre, Gregory, Blanche and Frome, as they now appear. It is easy to see, on reference to the map, how great the chances were that explorers, having once passed into the then unknown region enclosed within the concavity of this great system of clay-pans, should have had their further progress checked at the shores of one or other of them.

The constituents of the Eastern system, with which we are more immediately concerned, form a chain of clay-pans connected by intervening channels, and together they present a curve with its concavity directed towards the west. The whole of the series is, according to the most recent maps, included between the meridians of longitude 138° 50′ and 140° 20′ East of Greenwich, and the parallels of south latitude 31° 12′ and 28° 50′.

On those rare occasions when the flood waters of the Barcoo come down in sufficient volume, from the immense area which it drains in Southern Queensland, they pass into the Strzelecki, a large effluent which leaves the main channel at Innamincka, a place of melancholy memory in the history of Australian discovery, as close by the present settlement lie the remains of the ill-fated Burke, who perished in 1861 after a successful transit of Australia. These floods may then fill Lakes Gregory and Blanche; the latter lake, indeed, was filled two years ago, when its waters remained fresh for six months. A channel from the Strzelecki leads into Lake Callabonna, and I am informed that this depression also was filled from the same source some years ago, a statement which is supported by the presence upon the sand-hills of numerous fragments of the eggs of fresh-water fowl and of bones of water-rats. On the older maps Lake Callabonna was depicted as a northerly extension of Lake Frome, and indeed these two are actually connected by a channel, but whether water has ever been known to flow from one into the other I have not been able to learn.

There is compensation for the unpromising physical features of Lake Callabonna, that will be afterwards described, in the fact that its bed has lately been shown to be a veritable necropolis of gigantic extinct Marsupials and Birds, which have apparently died where they lie, literally in hundreds. The facts that the bones of individuals are often unbroken, close together and frequently in their proper relative positions, the attitude of many of the bodies, and the character of the matrix in which they are embedded, negative any theory that they have been carried thither by floods. The probability is rather that they met their death by being entombed in the effort to reach food or water, just as even now happens in dry seasons to hundreds of cattle which, exhausted by want of food, are unable to extricate themselves from the boggy places that they have entered in pursuit either of water or of the little green herbage due to its presence. The accumulation of so many bodies in one locality points to the fact of their assemblage around one of the last remaining cases in the region of desiccation which succeeded an antecedent condition of plenteous rains and abundant waters. An identical explanation has been suggested by Mr. Daintree in his notes on the Geology of Queensland (*Journal Geol. Soc.* 1872, p. 275).

LAKE CALLABONNA.

Lake Callabonna, the description of which is, in its main features, applicable to its kindred clay-pans, has a length of over fifty miles. About ten miles wide at its northern extremity it narrows to four or five at the site of the recent excavations, which is some fifteen miles to the southward, and becomes still further constricted in the remainder. Its shores, especially on the eastern side, are as yet imperfectly surveyed, nor have, I believe, any levels been taken of its bed. Possibly, like Lake Eyre, it may actually be below the sea level, but in any case it is relatively low lying, for water-courses lead into it on three sides. The Mount Hopeless, Verila, Woratchie, Hamilton, Parabarana, and Pepegoona Creeks, all of which rise in the Flinders Range, enter it on the western side, and the Callabonna and Yandama Creeks, rising in the Grey Range, on the east. Though these only run after heavy rain, they may then bring down a considerable quantity of flood water. As I have already stated, water can flow into it at the northern end by the Moppa-Collina Channel which communicates with the Strzelecki. The occasional character of the surrounding country may be best appreciated by reference to some of the names given by the early explorers and settlers, such as Mount Hopeless, Dreary Point, Illusion Plains, Mount Deception, Mirage Creek, which tell their own story of drought, difficulties, and disappointments.

Speaking generally, the bed of the lake is a great flat clay-pan, depressed, but very little, below the surrounding country. In the neighbourhood of the fossiliferous area, however, this prevailing flatness is broken by the existence of an aggregation of dunes or hillocks of fine drift sand, not exceeding thirty feet in height, and with the ridges running more or less north and south at right angles to the direction of the prevalent westerly winds. These dunes are so far discontinuous that, did the lake contain a very few feet of water, they would be converted into a number of irregularly-shaped sand islets. From a foot to eighteen inches below their surface is a layer of loosely compacted sand rock in which were found the bivalve *Corbicula desolata*, Tate, now living in the Cooper River system, and the univalve *Blanfordia stirlingi*, Tate, not yet known to be living, though related to the common littoral species *B. striatula*.

The sand-dune area is about four miles long from north t south, and about three miles wide. The camp of the working party was at first pitched on the east side of the most southerly hillock, but the extreme exposure of the site to the prevalent winds and sand-storms soon compelled a change to the opposite side. Northward of the sand-hills, so far as the eye can reach, the whole lake bed is an unbroken flat expanse, covered with gypsum crystals of all sizes, from which the reflection of the bright sunlight causes a glare painful to the eyes. The greatest distance in this direction reached by members of the party was eight miles. Here there are a number of brackish springs in the bed of the lake, each surrounded by a fringe of "bull-rushes" (*Typha* sp.), and on the way thither a peculiar oval mound was passed, consisting of an interior mass of soft black mud covered by a greyish crust, the whole structure quaking on pressure like a jelly. The size was about twelve feet long by eight feet broad and four feet high.

South of the camp is another flat expanse on which water very readily collects even after a light fall of rain. When this is dry the surface is white from the presence of a saline efflorescence, probably sulphate of sodium. East and west the group of sand-hills are separated from the mainland by salt-encrusted flats of about half a mile in width, which in dry weather are passable for camels and even for light vehicles, but are extraordinarily boggy and sticky after rain.

There are a few shallow water-courses near the camp, the general direction of which is from north to south, and in some parts of these salt water stands permanently. The soft black mud which forms their bed contains in many places much decomposing vegetable matter, and often stinks horribly from the evolution from it of sulphuretted hydrogen gas. In one place there is, in the bed of the water course, a round black-looking hole standing full of water, which gave no bottom with soundings at twenty five feet.

After a continuance of dry weather, the flats around the camp become coated with a white amorphous saline crust with this peculiarity, that it does not form on surface tracks, and these thus appearing dark amid the surrounding white ground, the scene suggests with singular force the appearance of footprints on a snow field. On the other hand, whenever water collected in the tracks and other indentations has evaporated, which very soon takes place under the influence of the strong, dry winds of the locality, there are left behind large flat glistening prismatic crystals which, in excess of dryness, crumble into a fine white powder. Unfortunately, the nature of these crystals cannot now be precisely stated, as the samples collected have not reached Adelaide, but, from their shape and behaviour, there is little doubt but that they are composed of sodium sulphate.

Scarcely any vegetation relieves the prevailing desolation beyond stubbly "samphire plants" (*Salicornia*), which grow in patches upon the sand hills, and rarely exceed two feet in height. Judging by the unusual thickness of their stems, some of these bushes must be very old. A few scattered and still more stunted bushes of the same plant grow upon the intervening flats. To the north and south of the sand-hills not a bush relieves the unbroken monotony of the level, white crystalline surface.

On the western side, not far from the margin of the lake, are the Mulligan Springs, where a station hut was formerly in occupation, but this has been for some time abandoned. The [illegible] country is now under pastoral lease to the Beltana [illegible] Company, whose holding extends continuously to the westward for a distance of 150 miles. The eastern spurs of the [illegible] Range, the highest summits of which reach an elevation of [illegible] 3000 feet, approach to within about twenty miles of the lake, and at [illegible], on the eastern slope of the range, there are [illegible] springs. [illegible]onna Station, belonging to Messrs. [illegible] Brothers, borders the lake on the east, and consists [illegible] of [illegible] plains which stretch to, and beyond, the boundary of New South Wales. The station-house stands on [illegible] Creek, about four miles from the lake, and six from [illegible]. Farther south is the Mulloowurtina Station, belonging to Mr. D. McC[illegible]. The distance from Adelaide in a [illegible] line is about 400 miles, but to reach the lake by the [illegible] route necessitates a journey by rail of about that length and an additional 150 to 200 miles by road, according to the route selected. The whole journey thither occupies five to six days, or longer in bad seasons.

Such are the physical characters of this uninviting region; its geological features will be afterwards considered.

History of the Discovery.

During many years, and from many parts of South Australia, notably from the Lake Eyre district, the South Australian Museum has from time to time received teeth and fragments of *Diprotodon* bones, which were occasionally associated with fragmentary remains of Macropods, Crocodiles, Turtles, and large Birds.

Among such donations were some teeth and portions of the lower jaw, sent to us in 1885 by Mr. John Ragless, which were found by his son, Mr. F. B. Ragless, in a water-course at a depth of five feet, about two miles east of the margin of Lake Callabonna, and about twelve miles north-east of the place where the more recent discoveries have been made. It was not, however, until 1889 that the Museum obtained a very perfect skull, and several other bones in their entirety, from Baldina Creek, near Burra, a locality about a hundred miles due north of Adelaide. In the same year, from fragments found at Bundey, in the same district, we were able to restore incompletely another skull, which differs very considerably from the former. A little later a third, but more imperfect, skull was found at Gawler, twenty-five miles north of Adelaide.

Since the first discovery of *Diprotodon* remains in the Wellington Caves, by Sir Thomas Mitchell, in 1830, teeth and bones of this animal have been found over an extensive area which extends from the Gulf of Carpentaria to Victoria, and from the Darling Downs to the Lake Eyre Basin. They have also been found at Kimberley, in North-west Australia, and to the west of the head of the Great Bight; so that the *Diprotodon* appears to have had an immense range, and probably wandered over the whole continent of Australia.

The existence of bones in the actual bed of Lake Callabonna was made known to Mr. F. B. Ragless on January 10, 1892, by an intelligent aboriginal who described them as being very large and numerous, and two days afterwards Mr. Ragless himself visited the locality, which subsequently became the seat of operations. A few days later the place was visited by John Meldrum, who had been for some months in Mr. Ragless's employ, and by him some fragments were brought to Adelaide. These facts having come to the notice of the Museum authorities, Mr. H. Hurst, who had been previously engaged in geological and palæontological work in Queensland, was commissioned to inspect and report. The promising nature of the report of this gentleman ultimately led to the despatch to the lake of a party under his charge in January 1893.

The Work at Lake Callabonna.

Operations under Mr. Hurst's superintendence were continued for four months, during which time a considerable amount of material was obtained. Towards the end of June 1893, however, work, having been previously interrupted by rain, had to be finally discontinued in consequence of a heavy fall, and Mr. Hurst, with one of his party, returned to Adelaide, bringing with him as many bones as could be carried in a "buck-board" buggy.

At this stage it appeared desirable for various reasons that the work of excavation should be continued under the direction of a responsible Museum officer, and accordingly, at the desire of the Board of Management, I left for the field on August 11, 1893, in company with Mr. Zietz, the assistant director, and another member of the Museum staff. On our arrival at Lake Callabonna Mr. Hurst, who had by that time returned to the camp, resigned his appointment, with another member of his previous party.

As the result of Mr. Hurst's labours about a ton of bones were soon despatched to Adelaide. Shortly after our arrival a fall of rain, though not exceeding half an inch in amount, was sufficient to cause considerable sheets of water to collect on the low-lying flats, to fill up the holes which had been excavated, and to render the clay surface of the lake, at the best of times very soft and sticky, so boggy that further work on the field became for a time impossible. Further, it became a matter of great difficulty for the camels to pass over to the mainland for the requisite supplies, and it was occasionally necessary to remove their loads and dig them out of the glue-like mud in which they had sunk nearly to their bellies.

In consequence of the rain it was a fortnight before excavations could be properly resumed; meanwhile, being unfortunately obliged to return to Adelaide, I left the camp in charge of Mr. Zietz, the other members of the party being three assistants, a cook, and two Afghans in charge of five camels. The absence of all feed near the camp rendered it necessary that these latter should have their encampment on the eastern shore, at a distance of about two miles and a half.

The number of the party thenceforth remained unchanged.

Without the camels, which were lent to us by the liberality of the South Australian Government, it would have been quite impossible to carry on the work. By them meat, which sometimes went bad before the day was out, had to be brought a distance of six miles from Callabonna Station, as well as water from the same place, until, with the advance of summer, the station supply fell short, when it became necessary to send to a well at a still greater distance, and every stick of firewood had to be fetched several miles. From the ravages of rabbits, of which there will be more to say directly, it was difficult to keep the camels in sufficiently good condition for their work, and each journey for wood and water generally required two days.

were found lying close together. It may be mentioned that underground bones were usually discovered by probing with a wire rod, the sense of touch easily detecting the impact even with those that were soft.

CHARACTER OF LAKE BED.

The Lake bed in the fossiliferous area adjacent to the camp comprises what appears to be one of its most low-lying parts. Its superstratum is a layer of stiff yellowish clay of variable depth, but usually of not less than about a foot in thickness, not of uniform character, but marked by streaks or veins of a rusty colour, containing much fine, sharp sand, due apparently to surface cracks having been filled up with drift-sand. In some places this veining is so irregular and contorted as to give the clay a marbled appearance. On drying, the clay separates readily, along these streaks, into quadrangular or polygonal masses somewhat after the manner of coal.

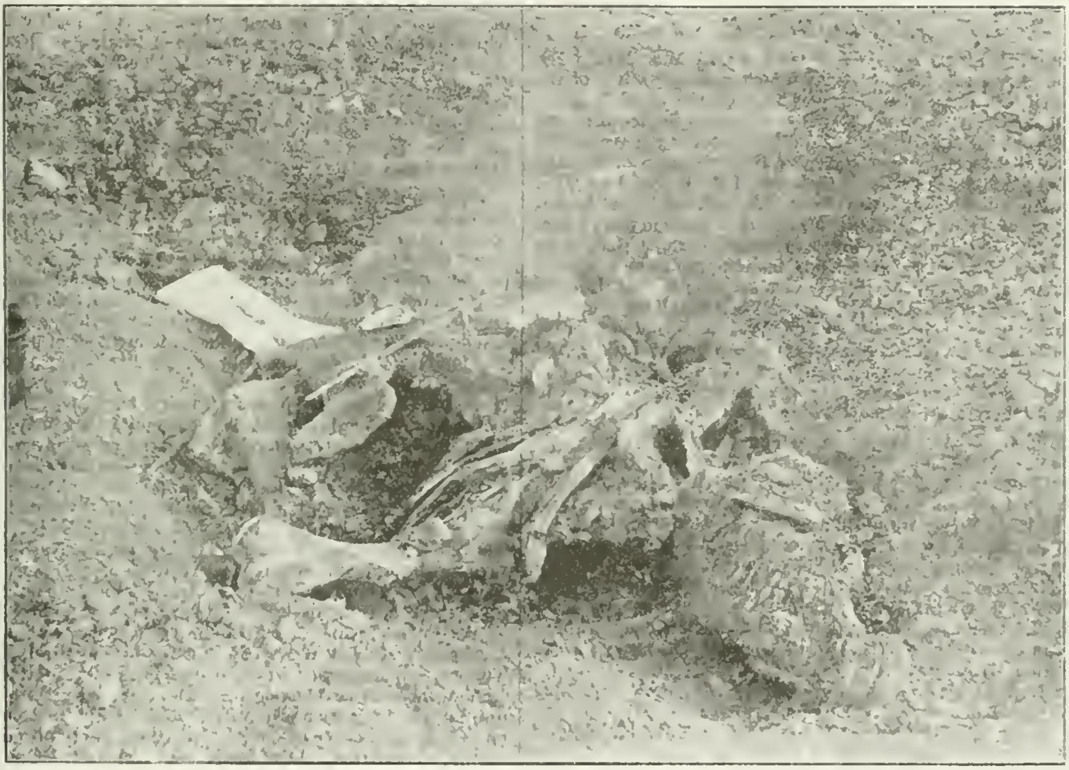

FIG. 1.—Diprotodon skeleton partially excavated.

When in the course of a fortnight after the rain, the ground had sufficiently dried to permit of the excavations being resumed, operations were commenced by Mr. Zietz at a place about a mile north-west of the camp from which his predecessor, Mr. Hurst, had obtained a number of bones. The subsequent yield, however, was inconsiderable in quantity, and such as were found were much broken and decomposed. They represented, however, a variety of species, odd bones of large and small Diprotodons, of the giant Wombat (*Phascolomys*), of Kangaroos, and of Birds being mixed together in great confusion; or it might be that the bones apparently of a single Diprotodon, even in previously unopened ground, were widely separated and broken, the fractures being sharp, and the missing pieces not discoverable.

This locality was consequently abandoned in favour of parts nearer the camp; from these good results were continuously obtained, and among them one apparently complete, and one nearly complete Diprotodon skeleton (Fig. 1), which were found in ground that had been tramped over hundreds of times in going to and fro between the camp and the more distant workings. Here also the remains of four birds

Beneath this superstratum is a layer of unctuous blue clay, of about two feet in thickness, resting upon a band of coarse sharp sand, beneath which no bones were ever found by Mr. Zietz. Below the sand the same blue clay occurs again for an undetermined depth, and shows in parts a laminated structure, with salt water lying in the interlaminar spaces. The greatest depth actually reached was between six and seven feet.

On physical analysis this clay yielded 15-20 per cent. of fine, sharp quartz-sand, while an approximate chemical analysis, kindly made for me by Mr. Turner, Demonstrator of Chemistry in the University, yielded the following results:—

Water	13 per cent.
Silica	40 ,,
Calcium carbonate	8·5 ,,
Alumina and iron	11·3 ,,
Magnesia	1·5 ,,
Alkaline chlorides and sulphates (mainly sodium sulphate)	25·7 ,,
Total	100·0 ,,

In the dry state numerous minute crystals of sulphate of calcium were visible in the clay.

In the least low-lying parts of the area salt water is reached at from two feet and a half to three feet; in the most depressed it remained permanently on the surface during the whole period of the excavations, which extended over the dry months of August, September, October, and November. In parts which are neither the highest nor the lowest the surface clay remains merely damp, and it was in ground of this character that the bones in best condition were found, provided that the underlying water did not approach the surface too nearly. In such cases, and in the very low places where the water remained permanently on the surface, it was impossible to excavate on account of the excessive inflow into the holes.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Sir Henry W. Acland, Bart., and Prof. J. S. Burdon Sanderson have been appointed representatives of the University at the eighth International Congress of Hygiene and Demography, to be held at Buda-Pesth in September.

The Sixth Annual Report of the Delegates of the University Museum has been published, and gives evidence of steadily increasing activity in the scientific work of the University. With increasing activity increased wants are felt, and the Regius Professor of Medicine, the Professor of Experimental Philosophy, and the Hope Professor of Zoology state that extra space is required for particular subjects required to be taught or exhibited in their departments. The reports of the Linacre Professor, and of the Curator of the Pitt Rivers Museum, contain long lists of specimens which have been added by gift, purchase, or exchange to the collections under their care, and one of the most satisfactory features of the report is the statement of the various researches which have been carried out in different laboratories during the past year.

CAMBRIDGE.—In addition to the honorary doctor's degrees to be conferred in connection with the visit of the Royal Agricultural Society to Cambridge, the honorary degree of M.A. will be conferred on June 27 on Mr. Ernest Clarke, secretary, and Dr. J. A. Voelcker, consulting chemist, to the Society.

Mr. A. E. Shipley, of Christ's College, has been appointed University Lecturer in the Advanced Morphology of the Invertebrata for five years from Michaelmas 1894, in the room of Prof. S. J. Hickson.

Mr. S. Ruhemann, of Gonville and Caius College, has been reappointed University Lecturer in Organic Chemistry for five years from Michaelmas 1894.

Mr. J. J. Lister, of St. John's College, has been appointed University Demonstrator of Comparative Anatomy.

At St. John's College the following awards in Natural Science were announced on June 18:—

Foundation Scholarships assigned or continued: W. L. Brown (Physiology); W. McDougall (Physiology and Anatomy); S. S. F. Blackman (Zoology); W. C. Brown, Butler, Orton, and R. J. Horton-Smith (subjects of Natural Sciences Tripos, Part I.); V. H. Blackman, Northcott, Tallent, West (second year subjects); Hemmy, Morgan (first year subjects). Hutchinson Studentship (for research in Pathology): F. Villy. Hughes Prize (third year): S. S. F. Blackman. Wright's Prizes: Tallent (second year), Hemmy (first year). Herschel Prize (for Astronomy), Fearnley.

SCIENTIFIC SERIALS.

The American Meteorological Journal for June contains a summary of an interesting article by Dr. F. Umlauft, on the names of the winds, originally published in the *Deutsche Rundschau für Geographie und Statistik* (vol. xvi. No. 3). The winds are mostly named according to the regions from which they come; thus winds blowing from land to sea are called land breezes, and *sea breezes*. The original names of the east and west points of the compass, and of the winds from those points, were derived from words connected with the appearance and disappearance of daylight; the names of north and south were principally associated with the kinds of weather that came from those points. Other names for the winds are associated with certain definite characteristics. In some places, on lakes, the winds are termed lower or upper winds, according to whether they originate at the lower or upper end of the lake; on the lake of Garda the upper wind is called *Sopero*, from the Italian *Sopra*, on the lake of Geneva; the wind coming down from the Vaud country is known as *Vaudaire*; and in the Rhine valley, the breeze blowing from the Wisp Valley is called *Wisperwind*. The Italians call their north-east wind *Greco*, and the Romans called the south-west wind *Africus*, while the Italians still call it *Affrico*. Homer names four winds only: Boreas, the north wind coming from Northern Greece; Zephyros, the west wind, from the word meaning darkness; Euros, indicating light, means a wind from the east; and Notos, from the word *Notios*, wet, a south wind in Greece. Winds are further named according to their influences and effects for good or evil; in Switzerland and the Tyrol the warm wind which melts the snow is known as *Aperwind*; while *Bise*, *Bis* or *Beiss* are the names given to the cold north wind; and *Maestro*, or master-wind, is the name given to the north west wind which prevails in summer over the Adriatic; in France the word becomes *Mistral*, and it is a destructive wind. The word *Samoom*, given to the destructive desert wind of Arabia, is derived from the Arabic word *Ssim*, poison. For further particulars we refer our readers to the original article, which has also been reprinted in the *Meteorologische Zeitschrift* for January last.

Wiedemann's Annalen der Physik und Chemie, No. 6.—On the radiation of gases, by F. Paschen. The long-wave spectrum of water vapour and the absorption spectrum of liquid water is here dealt with. Rubens's latest re-determinations of the dispersion curve of fluorspar show that all the author's wave-lengths above 2·6 μ, based upon Rubens' and Snow's previous results, are untrustworthy. The author deals fully with Pringsheim's criticism of his work.—On some methods of determining the pitches of high notes, by F. Melde (see p. 155).—On the relation between the lowering of the freezing-point of solutions and their osmotic pressures, by C. Dieterici. The author works out an equation by which the osmotic work may be calculated from the depression of the freezing point, even in cases where the latter amounts to 50° C.—On the absorption of hydrogen by water and aqueous solutions, by Paul Steiner. The coefficients of absorption may be roughly divided into two groups—those of solutions of monad salts, of K, Li, and Na, and those of dyad salts, such as K_2CO_3, $CaCl_2$, Na_2SO_4. The curves exhibiting the relation between absorption and concentration form two bunches for the two groups. The curve for sugar solution is approximately a straight line, intersecting the curves of the second group.—On the electric conductivity of some salts dissolved in ethyl and methyl alcohol, by B. Vollmer. The molecular conductivities of the electrolytes tested in the alcohol increase as the concentration decreases. With extreme dilution they approach a limiting value, except those of $CaCl_2$ and CaN_2O_6 in ethyl alcohol. The conductivity also decreases as the molecular weight of the solvent increases.—On the similarity of the light emitted by an after-glowing Geissler tube and the beginning of the glow of solid bodies, by Carl Kirn. The spectrum of the after glow contracted into a space between the wave-lengths of 555 and 495 $\mu\mu$, and appeared greyish-yellow. This is in accordance with Weber's observation, who noticed that a solid does not begin to glow red, but that the first colour to appear is a greenish-yellow band in the region of maximum luminosity of the solar spectrum.—On the electric and magnetic forces of the atoms, by F. Richarz.—On the forms of motion upon which electromagnetic phenomena may be based, by Hermann Ebert.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 24.—"On the Measurement of the Magnetic Properties of Iron." By Thomas Gray, Professor of Dynamic Engineering, The Rose Polytechnic Institute, Terre Haute, Indiana.

This paper gives the results of a continuation of the investigation which formed the subject of a paper communicated to the Royal Society in 1892, and published in the *Philosophical Transactions*, vol. clxxxiv. A. pp. 531–542. The results now given have been to a large extent obtained by the same method, namely, from the curves giving the relation of the current flowing in the circuit to the time measured from the application or the reversal of the impressed E.M.F. on the circuit. In this case, however, the personal element has been eliminated from the curves by the application of the autographic recorder referred to as under construction in the previous paper. This apparatus, which is a modification of the "Thomson siphon-recorder," has been found to work satisfactorily, and has considerably increased the ease and the accuracy with which the curves can be produced. A description of the apparatus and specimens of the curves drawn by it are included in the paper. There is also included in the paper a description of the apparatus and method of experiment in the application of a wattmeter to the determination of the energy dissipated by transformers under E.M.F.'s of different frequency of alternation. The accuracy of the measurements so made were checked by comparison with the results of measurements made by Joubert's instantaneous contact method. The apparatus and method of experiment adopted for the application of this method were to some extent different from those commonly employed, and they are therefore described.

The results of some further experiments on the large electromagnet used in the previous experiments, and described in the paper above referred to, are given, but a large part of the results quoted in this paper refer to closed circuit transformers of the types manufactured by the Westinghouse and the Genera Electric Companies. The experiments have been chiefly directed to the following points:—

(1) *A Comparison of the Total Energy required to produce Different Magnetic Inductions, and the Corresponding Dissipation of Energy.*—In connection with this, the effect of air gap in the magnetic circuit has been investigated somewhat more fully. It is shown that, by introducing a moderate air gap, the energy dissipated for a given induction through the coils may be reduced one-third.

(2) *The Law of Variation of Hysteresis with Variation of Induction.*—The experiments indicate that, although for any special case the energy dissipated can be approximately expressed by an equation of the form $E = AB^{\alpha}$, that both A and α are different for different kinds of iron. It seems probable, also, from the results obtained, that α is not absolutely constant for any one iron, but that it increases with increase of B.

(3) *The Effect of Increased Frequency of Cyclic Variation of Magnetism on the Dissipation of Energy.*—In this investigation a transformer, the iron case of which was made up of very thin sheets, was used. The thickness of the sheets was about 16-tooths of a millimetre, and the sheets were insulated from each other by means of thin paper. The full load capacity of the transformer was about 6000 watts. The range of frequency including the autographic recorder, the wattmeter and the Joubert's instantaneous contact method experiments) was about from 3 per minute to 8000 per minute. The results indicated that, throughout this range, there is no variation in the dissipation of energy per cycle when the inductions are equal.

Data deduced from these experiments as to the magnetic qualities of the iron used in the different transformers is given in the paper.

Zoological Society, June 5.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the society's menagerie during the month of May.—Mr. Sclater made some remarks on the chief animals that he had observed during a recent visit to the Zoological Gardens of Rotterdam, Amsterdam, Hanover, Berlin, and Hamburg.—A communication was read from Dr. E. A. Goeldi, containing critical remarks on the opossums of the Serra dos Orgãos, Rio de Janeiro, Brazil.—Mr. O. Thomas gave an account of the gazelles of Algeria, chiefly based on specimens brought home by Sir Edmund Loder, and distinguished three unquestionable species, *Gazella dorcas*, *G. cuvieri*, and *G. loderi*, the last being a new species of which examples had been obtained by Sir Edmund Loder in the sand-hills three days south of Biskra. A fourth gazelle, of which a skin and skull had been bought by Sir Edmund Loder in Algiers many years ago, was referred with some doubt to *Gazella corinna*, the Corinne of Buffon.—Sir Edmund Loder then gave an account of his expedition in search of the "Reem," as the *Gazella loderi* is called by the Arabs, and stated what he had learnt of its habits and distribution.—A second communication from Sir Edmund Loder contained remarks on the period of gestation of the Indian antelope, as observed in captivity.—A communication was read from Dr. W. B. Benham, containing notes on a particularly abnormal vertebral column of the bull-frog (*Rana mugiens*), and on certain other variations in the anurous column of this frog.—Mr. Lindsay Johnson read a communication on the pupils of the felidæ, and stated that, after an examination of the eyes of 180 domestic cats, as well as the eyes of all the felidæ in the society's gardens, he had come to the conclusion that the natural shape of the pupil in *Felis* is circular. Although under various degrees of light one might get every shape from the circle through all degrees of oval to a perfectly vertical line, yet instillations of atropine or cocaine solutions caused every pupil to become a true circle. The younger the cat the greater the tendency for the pupil to become pointed oval in ordinary light, and, conversely, the older the cat the more frequently did we find a circular pupil. Brilliant light always caused contraction to oval, and direct sunlight to a thin line in the smaller felidæ; in the larger felidæ Mr. Johnson had frequently found the pupils contract to a small circle. Suddenly alarming a cat had the effect of momentarily dilating the pupil; while in sleep the pupil was always contracted The communication was illustrated by models and diagrams.

Entomological Society, June 6.—Henry John Elwes, President, in the chair.—Mr. W. F. H. Blandford exhibited a series of eleven male specimens of *Rhina barbirostris* from British Honduras, of which the largest and smallest examples measure respectively 60 and 17 mm. The difference in bulk, supposing the proportions to be identical, is as 43 to 1. He remarked that this variation of the size is especially common in the *Brenthidæ*, *Cossonidæ*, and other wood-boring Coleoptera. The President, Dr. Sharp, F.R.S., the Rev. Canon Fowler, Mr. Jacoby, the Hon. Walter Rothschild, Mr. Merrifield, and Mr. Champion took part in the discussion which ensued.—Mr. A. J. Chitty exhibited specimens of *Cardiophorus equiseti* taken near Braunton, on the north coast of Devon, in May 1891. Mr. Champion and Mr. Blandford made some remarks on the species.—Mr. McLachlan, F.R.S., exhibited for Mr. J. W. Douglas male specimens of a Coccid (*Lecanium prunastri*), bred from scales attached to shoots of blackthorn (*Prunus spinosa*) received from Herr Karel Sulç, of Prague. Mr. Douglas communicated notes on the subject, in which he stated that the species was common on blackthorn in Germany, and should be found in Britain.—Lord Walsingham, F.R.S., exhibited a series of *Cacœcia podana*, Scop., reared from larvæ feeding on *Lapageria* and palms in Messrs. Veitch's conservatories in King's Road, Chelsea, including some very dark varieties. The Hon. Walter Rothschild stated that he had taken the species on lime. Mr. Hampson and Mr. Tutt also made some remarks on the habits of the species.—Mr. C. Fenn exhibited a long series of *Selenia lunaria*, bred from one batch of eggs, which included both the spring and summer forms; and also two unforced specimens, which emerged in November. He remarked that the variation between the two emergences, viz., spring and summer, is considerable, and also the range of variation *inter se*, especially in the spring form; but it is very remarkable that the summer form has one or two representatives among the specimens of the spring emergence. He said that the parent female was taken at Bexley in May 1893.—Mr. F. Lovell-Keays exhibited a variety of *L. alexis* (female), having the marginal ocelli on the hind wings entirely without the usual orange-coloured lunules. The specimen was captured at Caterham on May 22, 1894, and was the first example of the species observed by the captor this season. Mr. Barrett made some remarks on the specimen.—Mr. J. H. Durrant exhibited a series of *Steganoptycha pygmæana*, Hb., taken at Merton, Norfolk, between March 25 and the middle of April last. Lord Walsingham made some remarks on the species.—Mr. H. Goss read an extract from a report from Mr. J. R. Preece, her Majesty's consul at Ispahan, to the Foreign Office, on the subject of damage caused to the wheat crop in the district of Kafsinjan by an insect which was called "Sen" by the natives, and which he described as "like a flying bug, reddish-olive in colour, with heavy broad shoulders." Mr. Goss said he had been asked by Mr. W. H. Preece, F.R.S., to ascertain, if possible, the name of the species known to the natives as "Sen." Dr. Sharp said that in the absence of a specimen of the insect it was impossible to express an opinion as to the identity of the species.—The Rev. Canon Fowler exhibited for Miss Ormerod specimens of *D[illegible]*, Sturm, *[illegible]*, Brull., and *Megathopa violacea*, Blanch., which she had received from the La Plata district of the Argentine territories, where they were said to be damaging the grass crops. He also read notes from Miss Ormerod on the subject.—Mr. Hampson raised an important point as to what was the legal "date of publication" of part i. of the *Transactions* of the Society, 1894. He pointed out that the question of the priority of the names of certain new species described therein would depend upon the date of publication. A long discussion then ensued, in which Dr. Sharp, the Hon. W. Rothschild, Mr. Goss, Mr. McLachlan, Lord Walsingham, Prof. Poulton, F.R.S., and Mr. Verrall took part.—Prof. Franz Klapálek, of Prague, communicated a paper entitled "descriptions of a new species of *Raphidia*, L., and of three new species of Trichoptera from the Balkan Peninsula, with critical remarks on *P[illegible]*, McLach."—Lord Walsingham, ex-President and Vice-President, then took the chair, and a special general meeting convened under chap. xviii. of the bye-laws was held.

Geological Society, June 6.—Dr. Henry Woodward, F.R.S., President, in the chair.—On the banded structure of some tertiary gabbros in the Isle of Skye, by Sir Archibald Geikie, F.R.S., and J. J. H. Teall, F.R.S. After calling attention to the previous references to the pseudo-bedding and banding of the gabbro masses of the Inner Hebrides, the authors described the rocks which form the rugged ridge of Druim-an-Eidhne, near the head of Glen Sligachan. This ridge is made up of parallel beds, sheets, or sills disposed in a general N.N.W. direction with a prevalent easterly dip. Four distinct types of gabbro occur: (1) dark, fine-grained, granulitic gabbros; (2) well-banded gabbros; (3) coarse grained massive gabbros; and (4) pale veins of a highly felspathic gabbro. The relative ages of the banded and granulitic gabbros have not been definitely settled; but the coarse, massive gabbros are certainly intrusive in the banded series, and the pale veins cut all the other varieties. The authors dealt mainly with the banded gabbros. These occur in successive sheets or sills which vary from a few feet to many yards in thickness, and consist of parallel layers of lighter and darker material which correspond in direction with the trend of the sheets, and are usually inclined to the east or south-east at angles ranging from 20 to [illegible]. In some cases the bands can be seen to have been [illegible] folded. The minerals entering into the composition of the banded, as also of the other varieties, are labradorite, pyroxene, olivine, and titaniferous magnetite. The banding is due to a variation in the relative proportions of the different constituents, and especially in the amount of magnetite. Some narrow bands and lenticles are composed entirely of [illegible] and magnetite. The variations in chemical composition were illustrated by three analyses by Mr. Player. The [illegible] characters of the rocks were described, and it was [illegible] the minerals of the banded gabbros have not [illegible] broken since they were formed. The authors [illegible] the banding is the result of the intrusion of a [illegible] magma, and that similar banding in certain portions [illegible] gneiss may have been produced in the [illegible]. Dr. [illegible]-Lavis, Prof. Blake, Dr. Hicks, Mr. [illegible] Herbert Player spoke upon the subject of [illegible] Archibald Geikie briefly replied.—On the [illegible] of the Derbyshire carboniferous dolerites [illegible], by H. H. Arnold-Bemrose. This paper dealt with [illegible] the toadstones or igneous rocks of Derbyshire. [illegible] was made to the work of previous petro[illegible] the rocks, and the question as to the [illegible]. The [illegible] mapped by the geological survey, [illegible] have been examined, and the results [illegible] given in a [illegible] for the purpose of the paper and for future [illegible]. The [illegible] was divided into massive rocks or [illegible] tuffs. The former consist of [illegible], either granular or with ophitic augite, and [illegible] is often very fresh, but in some places [illegible]. The principal constituent minerals were [illegible], optically like biotite [illegible] differing from it chemically, [illegible]. A discussion followed, in which Sir Archibald [illegible], Dr. W. W. Watts, and Dr. Johnston Lavis took part. [illegible] of the Permian breccias of the Midlands, [illegible] of them with the upper carboniferous glacial deposits of India and Australia, by R. D. Oldham. The author first described the Permian breccias of the Midland counties of England, which he had the opportunity of examining at Eastertide of the present year. He described the characters of the breccias, and concluded that they were formed subaerially as gravel-fans by rivers charged with a maximum load of sediment, and therefore incapable of performing any appreciable amount of erosion. An examination of many of the fragments at Abberley and some at Church Hill revealed the presence of scratches, which occur in such a manner that the author believed they existed on the fragments before they were transported, and discussed the evidence for their production by ice or soil-cap movement, deciding in favour of the former. A short description of the upper carboniferous deposits of India followed, and it was pointed out that they differ markedly from the deposits of Britain. Amongst other things the separation of different pebbles by considerable interspace of matrix, and the bending of stratification-planes round a pebble as though the pebble had dropped from above, was noted, and it was maintained that floating ice alone will account for these pebbles being dropped into the Indian deposits. Finally, it was remarked that the so-called upper carboniferous deposits of India and the Permian deposits of the Midlands of Britain may be practically contemporaneous, as maintained by the late Mr. H. F. Blanford, indicating a possible simultaneous existence of glaciers in England, India, and Australia. Prof. Lapworth made some remarks upon the paper, and the author replied.

Linnean Society, June 7.—Mr. C. B. Clarke, F.R.S., President, in the chair.—The President nominated as Vice-Presidents for the year Messrs. J. G. Baker, W. Carruthers, F. Crisp and Prof. C. Stewart.—Dr. John Lowe communicated the results of observations made by him in Madeira and Teneriffe on the habit in certain insectivorous small birds belonging to the genera *Sylvia*, *Phylloscopus* and *Parus* (of which specimens were exhibited) of puncturing the calyces of flowers for the purpose of attracting insects on which they feed. An interesting discussion followed, in which the President, the Rev. G. Henslow, and others took part.—Mr. Carruthers exhibited a series of photographs of the celebrated Cowthorpe Oak in Yorkshire, taken at long intervals, commencing with a reproduction of Dr. Hunter's engraving of 1776, and made remarks upon the rate of growth and decay, and probable duration of life in this tree.—Mr. Raymund Dowling exhibited and made remarks upon a dwarf glaucous pine, and some curiously shaped *Trapa* fruits from Japan.—Mr. Thomas Christy exhibited specimens of two species of *Polygonum* (*P. sachalinense* and *P. cuspidatum*), of value for forage, and pointed out that the roots of the mature plants, when cut, are, in the former species, of a whitish colour, and in the latter of a bright yellow, enabling the two to be readily distinguished apart from the leaves.—A paper was then read by the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., on stipules and the protection of buds. A discussion followed, in which the Rev. G. Henslow, Mr. A. W. Bennett, Prof. Marshall Ward, and Mr. John Fraser took part.—Before the meeting adjourned, the President announced that a bust of Charles Waterton, the Yorkshire naturalist, and author of "Wanderings in South America," had been presented to the Society by the trustees of the late Mrs. Pitt Byrne *née* Busk. This bust was executed in 1865 (the year in which he died, at the age of eighty-three) by the late Mr. Waterhouse Hawkins; it is an excellent likeness, and the only bust of him in existence. The only accessible portrait of him is a small engraving by Adlard, which forms a frontispiece to the third volume of the "Essays on Natural History," from an original oil painting by Charles W. Peale, made in Philadelphia in 1824, when Waterton was in his forty-second year.

CAMBRIDGE.

Philosophical Society, May 28.—Prof. T. McKenny Hughes, President, in the chair.—The announcement was made that the adjudicators of the Hopkins prize for the period 1889–91 have awarded the prize to Prof. J. J. Thomson, F.R.S., for his researches on electrical oscillations and other important contributions to electrical theory.—Mr. Warburton exhibited specimens of the nest of *Trochosa picta*, a Lycosid spider found in abundance on the sand-hills of Southport. The nest is not so simple as was supposed, as it possesses a pouch or off shoot from the main burrow directed upwards and forwards. In this the spider takes refuge when disturbed.

There are two well-marked varieties of this species, the one being pale and light-coloured, and inhabiting the sandhills of Poole in Dorsetshire and Southport in Lancashire, while the dark variety occurs in various localities on dark peaty soil.—Mr. S. Skinner exhibited specimens of magnetic rock. The fragments of rock shown were from the Riffelhorn, near Zermatt, a mass of rock which appears to be permanently magnetised in a direction E.—W. with north polar magnetism towards the west. They are composed of serpentine with small veins of magnetic oxide of iron. The magnetic fields of these fragments have been mapped with a small compass needle and show both regular poles and consequent poles. It is suggested that the magnetism preserved in these fragments was due to magnetic forces acting at the time of the formation of the veins of magnetic ore. With certain assumptions, it follows that these forces acted almost at right angles to the present direction of the magnetic meridian, a conclusion possibly consistent with our present knowledge of the secular variation.—Mr. A. C. Dixon read a paper on a "Geometrical proof of a Theorem of Convergency."

Dublin.

Royal Dublin Society, April 18.—The Earl of Rosse in the chair.—Dr. G. Johnstone Stoney, F.R.S., communicated a paper on a mounting for the specula of reflecting telescopes, designed to remove the impediment to their being used for celestial photography. The author observed that reflecting telescopes are much cheaper than refractors; moreover, their uniting rays of all refrangibilities in one focus would give them an immense advantage over refractors for photographing the heavens and in celestial spectroscopy, were it not for the difficulty of keeping their line of collimation sufficiently fixed. This difficulty arises from the necessity of supporting the speculum by a very equable pressure applied over its whole back. The mechanical appliances for securing this must be so delicate that they yield a little when the telescope is moved from one altitude to another. The author of the present communication proposes to get rid of this imperfection by substituting compressed air for the "bed of levers" or layers of flannel which have hitherto been employed, and he describes a regulator through the intervention of which the pressure will vary automatically according to the requisite law when the telescope is moved from one altitude to another. With this contrivance the speculum is made the front of a closed chamber, and rigidly maintains its position with reference to it, and therefore with reference to the tube of the telescope, however the latter may be moved about. — Sir Howard Grubb, F.R.S., read (*a*) a note on the effect of tarnish on the transmission of light through telescopic objectives; (*b*) a note on the construction of an equatorial with complete circumpolar motion.—Prof. W. Noel Hartley, F.R.S., exhibited photographic enlargements of band spectra of metals, and Bessemer flame spectra, and gave a description of these phenomena.—At the meeting held May 16, Mr. Albert Taylor read a paper (communicated by Sir Howard Grubb, F.R.S.) on the photographing of the solar corona during total solar eclipses (with special reference to the author's experiences at the Brazilian station at Para Curu, during the total solar eclipse of April 1893), and on the selection of suitable instruments. The author commented upon the results obtained at the various stations at which the eclipse of 1893 was observed, and suggested that the organisation of expeditions to observe the next total solar eclipse (August 8, 1896) should at once be begun.—Mr. A. F. Dixon exhibited models constructed from microscopic sections by a method first used by Prof. His. The sections are drawn by means of a camera lucida, on glass plates covered with negative varnish, and the model is completed by simply placing the plates in order one over the other. This method is found especially useful in tracing the courses and connections of fine nerves in the embryo.

Paris.

Academy of Sciences, June 11.—M. Lœwy in the chair.—Note on the great coudé equatorial of the Paris observatory, by M. Lœwy.—The green substance of Phyllum Orthoptera of the family of the Phasmidæ, by MM. Henri Becquerel and Charles Brongniart. A spectroscopic examination has determined the identity of this substance with chlorophyll.—On the homologues of quinine; their physiological and therapeutic action, by MM. E. Grimaux, Laborde, and Bourru. The substances cupreine, methyl cupreine (quinine), ethyl cupreine, propyl cupreine, and amyl cupreine have been studied. As the molecular weight increases the toxic dose becomes rapidly smaller, and the therapeutic action becomes more vigorous. The ethyl derivative should be used as an antiperiodic when quinine has failed, and the propyl derivative might perhaps be employed as a powerful antithermic in cases of continued fevers.—Observations of the planets AY (Courty, February 11, 1894), AZ (Courty, March 5, 1894), and of Denning's comet (March 26, 1894), made at Bordeaux by MM. G. Rayet, L. Picart, and F. Courty: note by M. G. Rayet. Discovery of Champsosaurians in beds of phosphorite in the Algerian suessonian, by M. A. Pomel.—On the chromosphere of the sun. A reply to the last note of M. Hale, by M. H. Deslandres.—A new application for bichromated gelatine, by M. Izarn. The material is proposed to be used for the protection of silver surfaces on instruments, backs of mirrors, and so forth. It has given good results in trial cases.—On an application of continued fractions, by M. Stieltjes.—On the algebraical integrals of linear differential equations of the second order, by M. P. Vernier.—On equations of derived partials of the second order, by M. X. Stouff.—On magnetisation produced by Hertzian currents; a magnetic dielectric, by M. Birkeland.—On the nature of electric conductibility, by M. Vaschy.—Measurement and comparison of coefficients of self-induction by alternating currents of great frequency, by M. H. Abraham.—On the mean geometric distance of the elements of a group of surfaces and its application to the calculation of coefficients of induction, by M. Ch. Eug. Guye.—On the estimation of iodine, by MM. A. Villiers and M. Fayolle. The iodine is liberated by means of ferric chloride, taken up by carbon bisulphide, and titrated in the separated solution by standard sodium thiosulphate.—On the acid sulphates of aniline and ortho- and paratoluidine, by M. Edmond Hitzel.—The synthesis of hexamethylene derivatives; triethylphloroglucinol, by M. A. Combes.—A note on the qualitative composition of officinal creosotes from oak and beech woods, by MM. A. Béhal and E. Choay.—Action of primary aromatic bases on dissymmetrical ketonic compounds, by M. L. Simon. The work was undertaken with the object of discovering in aniline derivatives of the form $\begin{matrix} R.C.R' \\ N.C_6H_5 \end{matrix}$ indications of an isomerism analogous to that obtaining among oximes. The condensations quoted in the communication were effected in the cold and in the absence of every condensing reagent capable of producing migrations. Isomerism has not been observed in any case.—On the stability of aqueous solutions of mercury bichloride, by M. E. Burcker. The author concludes that (1) ordinary waters cause the immediate decomposition of mercury bichloride, and this action continues under the combined influence of air, light, and the substances contained in the water or brought by the air; (2) the decomposition becomes insignificant when the solution is removed from the influence of air and light; (3) solutions made with distilled water undergo very little change, even when exposed to air and light.—On the preparation of tetrachlorethylene and the action of ozonised oxygen on this body, by M. A. Besson.—On a ptomaine extracted from the urine of cancer patients, by M. A. B. Griffiths. This substance has the composition C[illegible]H[illegible]NO[illegible], and is termed *cancrine*. It is a very poisonous base, giving alkaloid reactions and crystallising in microscopic needles. It is alkaline and soluble in water.—Researches on the internal ear of the "Roussette de l'Inde" (*Pteropus medius*), by M. Beauregard.—On the characteristics and the evolution of Lomisinés, a new group of anomurous crustacea by M. E. L. Bouvier.—On the development and formation of excretory canals in *Cer[illegible] echinata*, by M. Joannes Chatin.—Diptera parasitic on Acridians: oviparous Muscidæ (*[illegible] ophage*). Burrowing Diptera. By M. J. Kunckel d'Herculais.—Intercellular communications in lichens, by M. Georges Poirault.—On the geological lines in the neighbourhood of the observatory of Abbadia (Basses-Pyrénées), by M. P. W. Stuart-Menteath.—Defence against Phylloxera, by M. Kaourdin.

Berlin.

Meteorological Society, May 1.—Prof. Hellmann, President, in the chair.—Dr. Süring gave an account of a winter sojourn, from December to March, on the Brocken. During the three months he experienced several anticyclones, two periods of storm, and several of complete envelopment in clouds, all of which he described in detail, and then dealt briefly with a whole series of isolated observations made at a height of 1140 m., that is, at the level of the lower clouds. The phenomena touched upon were the formation of rime, force of the wind, sequence of depressions, and maxima of pressure, &c. The outcome of his remarks showed the necessity for a properly equipped station on the Brocken, under expert management. One point of interest may be mentioned, namely that on the Brocken, during an anticyclone the lowest temperature was always observed at the beginning, followed by a rise of temperature in the second half of the period, whereas, as is well known, on the plains the temperature continues to fall right to the very end of the anticyclone.

Physical Society, May 4.—Prof. du Bois Reymond, President, in the chair.—Dr. Pringsheim alluded in appropriate terms to the death in Brooklyn of their foreign member Dr. F. Schulze-Berge.—Prof. König spoke on the number of distinct differences of colour and brightness which can be discriminated in the spectrum. He had made experiments in conjunction with Prof. Dieterici, subsequently verified by Prof. Uhthof, on the mean error existing when matching two tints, and from this he had been able to deduce the total number of differences in tint which a normal trichromatic eye can discriminate from the red to the blue end of the spectrum. Sensitiveness to difference of tint showed two maxima, one in the yellow and one in the greenish-blue, and the total number of distinct differences discriminated was 165. A dichromatic eye, on the other hand, can only discriminate 140 differences. Experiments of the speaker and of Dr. Brodhun formed the basis for determining the number of differences of brightness which can be discriminated, starting with liminal light and increasing it up to a blinding intensity. For both the tri- and di-chromatic eye the number was found to be 650. If it be desired to deduce from the above data the total number of possible visual differences which can be discriminated in a spectrum, it must be remembered that as the intensity of light diminishes, so also does the number of discriminated tints, so that the result is in round numbers $80 \times 700 = 56,000$. In connection with the above, Prof. von Bezold suggested that by using complementary colours it may be possible to discriminate a much larger number of tints, since, as is well known, two colours which are indistinguishable when compared directly often give quite different complementary colours, and can thus be distinguished.

Physiological Society, May 11.—Prof. du Bois Reymond, President, in the chair.—Dr. Max Verworn spoke on the polar excitation of cells by galvanic currents. Unicellular freshwater infusoria (Paramœcium) were experimented on, and showed always, on making a constant current, cathodic galvanotropism; by this is meant that all the infusoria in a drop of water placed themselves with their anterior end towards the cathode. They then moved towards and congregated at the cathode. When the direction of the current is reversed the infusoria turn round and move away towards the new cathode. When strong currents are employed it is found that the hinder end of the organism is contracted, and if the stimulation is prolonged the protoplasm is disintegrated. From this the speaker drew the conclusion that the infusoria are anodically excitable, and that the cathodic galvanotropism is due to anodic stimulation. The exact reverse holds good for Opalina, since they are cathodically excitable and anodically galvanotropic. A third group of infusoria (Spirostomum) is transversely galvanotropic.—Dr. Lilienfeld gave an account of his researches on the clotting of blood. He had succeeded in separating Al. Schmidt's fibrinogen into two substances, "thrombosin" and an albumose. The former unites with calcium and forms fibrin, while the albumose retards clotting. The separation of fibrinogen into these two constituents may be brought about by means of acetic acid, nuclein, nucleic acid, and other substances. Blood-clotting accordingly consists in a disintegration of leucocytes setting free nuclein; the latter then decomposes the fibrinogen, and enables the thrombosin to unite with the calcium salts of the blood. While the blood is circulating in the body it contains no free nuclein in solution, and hence clotting is impossible. The speaker further considered that peptones (albumose) and leech-extract prevent clotting by themselves uniting with the calcium of the blood, and thus preventing its union with thrombosin.

Note.—In the report of the meeting of the Meteorological Society for April 3 (NATURE, vol. l. p. 95), for Kassner read Kassner, and for Hasen read Hazen.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—A Pocket Flora of Edinburgh: C. O. Sonntag (Williams and Norgate).—Proof Spirit and Fiscal Hydrometry: Dr. B. Derham (J. Heywood).—A Handbook to the Study of Natural History: edited by Lady I. Margesson (Philip).—Coloured Vade-Mecum to the Alpine Flora: L. and C. Schröter, 4th edition (Nutt).—Grundzüge der Geometrie: Prof. G. Veronese (Leipzig, Teubner).—Catalogue of Scientific Papers (1874–1883) compiled by the Royal Society of London, Vol. x. (C. J. Clay).—Epitome of the Synthetic Philosophy: F. H. Collins, 3rd edition (Williams and Norgate).—Report of the Meteorological Service of Canada for the Year ending December 31, 1889 (Ottawa).—Zur Fossilen Flora der Polarländer: A. G. Nathorst (Stockholm, Norstedt).—Elementi di Fisica: Prof. A. Roiti, Vol. Primo (Firenze, Monnier).—Zeit-und Streitfragender Biologie: Prof. O. Hertwig, Heft 1 (Jena, Fischer).—Synopsis der Hoeheren Mathematik: J. G. Hagen, Zweiter Band (Berlin, Dames).—Les Oscillations Électriques: H. Poincaré (Paris, Carré).—Geological Sketch Map of Western Australia: H. P. Woodward (Philip).—A Dictionary of Medicine: edited by Sir R. Quain, &c., 2 Vols., new edition (Longmans).—The Physiology of the Carbohydrates: Dr. F. W. Pavy (Churchill).

Pamphlets.—Protection from Lightning: A. McAdie (Washington).—The Yellowstone Park: A. Hague (Washington).—Leitneria Floridana: W. Trelease (St. Louis).—Weitere Lichtelectrische Versuche: J. Elster and H. Geitel (Leipzig, Barth).—Report of Mr. Tebbutt's Observatory, the Peninsula, Windsor, N.S.W., for the Year 1893: J. Tebbutt (Sydney).

Serials.—Journal of the Chemical Society, June (Gurney and Jackson).—Transactions of the Academy of Science of St. Louis, Vol. vi. No. 15 (St. Louis).—Journal of the Franklin Institute, June (Philadelphia).—Astronomy and Astro-Physics, June (Wesley).—American Naturalist, June (Wesley).—Engineering Magazine, June (Tucker).—Bulletins de la Société d'Anthropologie de Paris, Mars (Paris).—Quarterly Journal of Microscopical Science, June (Churchill).—Intles. Archiv für Ethnographie, Band vii. Heft 3 (Leiden, Brill).—Journal of the Institution of Electrical Engineers, No 112, Vol. xxiii. (Spon).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1894, No. 1 (Moscou).—Royal Natural History, Part 8 (Warne).—Zeitschrift für Physikalische Chemie, xiv. Band, 2 Heft (Leipzig, Engelmann).—L'Anthropologie, tome v. No. 3 (Paris, Masson).—Field and Garden Crops of the North-West Provinces and Oudh: J. F. Duthie Part 3 (Roorkee).

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THURSDAY, JUNE 28, 1894.

STUDIES IN FORESTRY.

Studies in Forestry. A Short Course of Lectures on Silviculture, delivered at the Botanic Garden, Oxford, 1893, by John Nisbet, D.Oec. (Oxford : Clarendon Press, 1894.)

DR. NISBET is an officer of the Indian forest department, specially trained in forestry in Germany, and after spending a number of years in the charge of extensive forests in Burma, he was, a year or two ago, permitted by the Secretary of State for India to make a further study of German forestry in Bavaria. Whilst in Bavaria he wrote six useful essays on forest subjects, which have been published by order of the Secretary of State for India, and they are now being circulated to subscribers to the *Indian Forester*, a monthly magazine published in Dehra Dun, where Dr. Nisbet is now serving as deputy director of the Indian Forest School.

The author states in his preface that he has, with the consent of the Secretary of State, embodied much of the matter in these essays in the "Studies in Forestry," and much of the remainder occurs in Dr. Nisbet's "British Woodlands," or in his translation of a German work on forest protection.

Much of the matter contained in the "Studies" will also be found in Dr. Schlich's "Manual of Forestry," vols. i. and ii., which works are largely founded on the same authorities as those used by Dr. Nisbet, whose work must have been greatly simplified by having ready to hand Dr. Schlich's well-chosen English equivalents of the various German technical forest terms.

As all the books just referred to have been already reviewed in NATURE, a detailed notice of the present work is hardly called for, though it will prove instructive to those who have not seen the former books, if they allow for the author's want of practical experience in the British Isles, where forestry is under different climatic conditions to those prevailing in Germany. The first chapter of the book, however, on "Forestry in Britain," is very forcibly and well written, and contains much suggestive matter to which the attention of everyone interested in forestry should be drawn.

Taking the area of British forests roundly at 3,000,000 acres, and allowing ninety years as their average rotation, their cost of production is estimated as equivalent to :—

(Annual rental of 3,000,000 acres + cost of forming, or regenerating them) × $1{\cdot}0r^{90}$;

where r is the rate of interest at which a forest owner is content to lock up his capital of soil and growing stock.

This rate he, perhaps erroneously, urges should be higher than that used in agriculture, on account of the greater risk incurred by forests from storms, insects, fire, &c. Scotch owners who have suffered from the hurricane last December, which blew down $1\frac{1}{2}$ million trees in Perthshire and Forfarshire, will be disposed to agree with the author here ; but the fact is that all these risks would be very greatly reduced if British forests were properly managed so as to withstand storms and the other dangers referred to. However, owing to the appreciation of *broad acres*, Dr. Nisbet puts the rate of interest at $2\frac{1}{2}$ per cent., that of funded property, which is probably the correct figure after all. Placing therefore the average rental of woodland at 5*s.* an acre, and the cost of formation at £2, that of planting Scotch pine in Perthshire ; he arrives at the following figures :— (3,000,000 × £2 – 5*s.*) $1{\cdot}025$ = £20,500,000 nearly, which is the cost of production of our woodlands, the prospective value of the mature crop being much greater. On comparison with results in Germany, and assuming that our forests are as well managed as German forests, which is at present far from being the case, they should yield an annual revenue of £2,000,000, or at 25 years' purchase be worth £50,000,000. Forty years' purchase and £80,000,000 would, however, be the correct figure at $2\frac{1}{2}$ per cent.

After this estimate comes a reference to the value of our timber imports from Northern Europe, which in 1892 was £9,207,905, and the fact, to which Dr. Schlich in 1890 first drew public attention, that all this material might be produced on waste land in the British Isles, and employment thus provided for several hundred thousand people.

The rapidly approaching exhaustion of the North American forests is also referred to ; and considering that the United States is now importing annually enormous quantities of timber from the Dominion of Canada, and that the Canadian forests are being worked in the same destructive manner as in the United States, it is surely time for Canadian legislators to attend to the formation of large State timber reserves, and provide for the education of a trained forest staff to look after them. *Quis custodiet ipsos custodes?* the negligence shown by the Canadian Executive in this respect looks as if the lumber trade was more attractive than attention to the future welfare of the country. A reference to the latest number of the *Garden and Forest* shows that the United States Government has done nothing yet to protect and manage the vast tracts of forest which there, at any rate, have been for the present saved from alienation as State property. One of the strongest reasons in favour of our establishing national instruction in forestry on a proper scale, and bringing our own Crown forests into a high state of production, is the example it would set to our colonists, and the chances that more of them might come here to study forestry, as they do at present to study engineering, law, and the arts.

Dr. Nisbet refers in hard but not undeserved terms to the results of the Parliamentary Committees on Forestry, remarking that the solemn farce of appointing a Committee, and then letting the question slide, has twice been played with regard to forestry in Britain. The only results from the Committee of 1887 have been that the Treasury pays £100 a year to a lecturer on forestry at Edinburgh University, and £250 (half the salary of the professor of agriculture and forestry) at Newcastle, also £150 each to the Royal Botanic Gardens, Edinburgh and the Glasgow Technical Institute for free classes to foresters and gardeners.

The second Committee of 1889, to inquire into the administration of the Crown forests, came to the conclusion that they were being carefully administered, which does not tally with the previous finding of the 1887 Committee. "*In respect of the Crown forests, the difference between skilful and unskilled management would itself more than repay the cost of a forest school.*"

Certainly it would be for the national benefit, if purely pleasure-grounds, such as Windsor Park, were excluded from the Crown forests, and handed over to the Board of Works, and that the 57,300 acres of the Crown forests actually under timber crops, and worth at least £1,500,000, should be brought up to the highest degree of productiveness, and serve as models of economic forestry to all the private forest-owners in Britain.

Dr. Nisbet states that the salaries and allowances of the officers in charge of the Crown forests average £900 a year, and urges that in all future appointments to these posts a high degree of qualification in forestry should be required, and also from one of the Commissioners of Woods and Forests.

A most amusing account, taken from the Report of the Forestry Committee of 1887, is given by Dr. Nisbet of the examination of a lecturer in forestry of the Cirencester Agricultural College, who stated that he taught forestry in six or seven lectures, but admitted that he had himself learned forestry there, though he did not consider the course sufficient *even for land-agents.* Other quotations from the evidence of Mr. Britton, a leading timber merchant of Wolverhampton, and the late Mr. MacGregor, then in charge of 20,000 acres of the Athole forests in Perthshire, testify to the utter ignorance of forestry possessed by land-agents and factors in both England and Scotland.

In the present state of agriculture, where economic forestry alone will pay on the poorer lands, it is essential that land-agents should possess a fair knowledge of forestry. Broillard, the French silviculturist, goes even further and advises land-owners to learn how to manage their forests for themselves.

Dr. Nisbet refers to the well-equipped forestry staff at Cooper's Hill College, where the three years' course costs £183 a year, including the cost of a fourteen days' tour in the Norman forests, and five months' practical forestry instruction in Germany. He states, however, that the Forestry Branch was added to Cooper's Hill, to prop up an Engineering College which had ceased to pay its expenses, and that there is nothing in the situation of the college to have induced the Government to have located the Forestry Branch there. As a matter of fact, Cooper's Hill is admirably situated from a forest point of view; the 9,000 acres of the Windsor Forest, exclusive of the park, and stocked with every species of tree which will grow in Central Europe, is close to the college, and in it the college has leased 800 acres, chiefly of Scotch pine forest, for practical work for the forest students. There are excellent forest nurseries, osier beds on the Thames, a good Crown coppice with standards of 800 acres at Esher, and large areas of beech selection forests on the Chiltern Hills, all of which are regularly visited by the students, whilst the magnificent oak and beech forests of Normandy are only a night's journey distant, and in them the students spend fourteen days every year. One reads nothing but praise of the old Indian College at Haileybury; and *esprit de corps* among the scientific branches of the Government of India is certainly fostered by training engineers, telegraphists, and foresters at the same college in the loveliest and most wooded part of England. There are more distractions at Oxford, and longer vacations; and after allowing for the cost of all the necessary excursions and practical work in continental forests, it is doubtful whether living at Oxford would be cheaper than at Cooper's Hill, if it had been selected instead of the latter place for the training of future Indian forest officers.

There can, however, be no question that independently of the training of Indian forest officers, in which already men from the colonies have joined, and there is plenty of room for more, there should be available at our principal universities regular instruction in forestry for the benefit of land-agents and land-owners. Dr. Nisbet suggests that two chairs of forestry, each at £700, should be established by the State at Oxford, Edinburgh, and Dublin, and four instructorships in forestry, at £150 each, at Dunkeld, Grantown, Coleford, and Lyndhurst. This would cost in round numbers £5000 a year, which is a slight insurance to pay for the better management of woodlands which have already cost £20,000,000, and will most likely be considerably added to in the immediate future, being less than ¾*d.* an acre on land actually under timber.

Forestry is, however, eminently a practical profession, and the best teaching will not suffice unless extensive well-managed tracts of our Crown forests are also made available for practical illustration of the matter taught by professors.

Sir J. Lubbock quite recently stated at a public meeting that good forestry could only be initiated by the State, and it must be satisfactory to all lovers of forestry that he is again disposed to take interest in the matter, although when member of the Committee on Forestry his attention was unfortunately distracted by other pressing business, and no satisfactory results followed.

W. R. Fisher.

THE COMPARATIVE PATHOLOGY OF INFLAMMATION.

Lectures on the Comparative Pathology of Inflammation, delivered at the Pasteur Institute in 1891 *by Elias Metchnikoff, Chef de Service à l'Institut Pasteur.* Translated from the French by F. A. Starling and E. H. Starling, M.D. With sixty-five figures in the text, and three coloured plates. (London: Kegan Paul, Trench, Trübner and Co., 1893.)

THE work before us is a translation of Prof. Metchnikoff's well-known book on the comparative pathology of inflammation. This work has been so well reviewed by Prof. Ray Lankester in Nature (vol. xlv. p. 505), that it is almost superfluous to give a fresh account of it.

Readers of Nature will remember that the book is really an attempt at establishing a biological theory of inflammation, which is summed up by the author as follows:—"Inflammation generally must be regarded as a phagocytic reaction on the part of the organism against irritants. This reaction is carried out by the mobile phagocytes, sometimes alone, sometimes with the aid of the vascular phagocytes or the nervous system." This definition of inflammation of course differs essentially from that adopted in pathological text-books, for Metchnikoff places the vascular phenomena in the second rank, and reduces to a minimum the part played by the nervous system. It must be acknowledged, however, that the author brings forward a formidable array of facts observed in the various branches of the animal kingdom in order to place his theory on a sure footing; and he clearly establishes one point, namely, that inflammation may take place without the blood-vessels or nervous system playing any part in it. On the other hand, a critic might object that, in the higher animals at least, there are many forms of inflammation in which the amœboid cells take little, if any, part at all. The proposition is, nevertheless, for the most part true, and it has undoubtedly given us a key to the understanding of many obscure points connected with the problem of immunity against microbes.

To a large extent the process of resistance of the animal body against the invasion of micro-parasites is due to the action of cells derived from the mesoblast. This, Metchnikoff has demonstrated by a number of extremely interesting experiments, and has shown that, in vertebrate and invertebrate alike, this function is at all times carried on. He and his pupils have proved that it is a normal physiological function taking place in certain parts of the body, such as the tonsils and the Peyer's patches of the intestine.

The theory of Prof. Metchnikoff has not been accepted by the majority of pathologists, and has been treated with scant respect by many bacteriologists, more especially in Germany. In this country it has, however, been received with greater favour, and it is well that such a book should have been translated by Dr. and Mrs. Starling. Indeed, for the translation we have nothing but praise; it is worded in excellent English, and, what is more, the meaning of the author is, with very few exceptions, exactly reproduced.

It is interesting, however, to see how much of the work is controversial in character, and one might almost wish that Prof. Metchnikoff had not wasted so much time in disputing the many rival theories which have since been shown to be erroneous, and are no longer held even by their promoters. The theory, for instance, that the defence of the organism was due to the so-called bactericidal power of the serum, a theory which was defended by so well known an observer as Dr. Klein, has now been almost universally given up. Metchnikoff and his pupils hit the right nail on the head when they proved that the bactericidal action of the serum in a test-tube was a very different thing from the action of the serum in the living body. Indeed, it is difficult to understand how such a notion should have received any favour, when not a single fact could be produced to show that this bactericidal action ever takes place in the human or animal body. The experiments of Sanarelli, which seemed at one time to support it, have now received another interpretation from their author. When, later on, it was shown that the bactericidal action of the serum in immune animals was very much more marked than in non-immune animals, it was thought that a strong point had been scored against the phagocytic theory; but the discoverers of this fact, Messrs. Behring and Nissen, had to confess that this stronger bactericidal action was not always present in immune animals, and that it occurred in some diseases only. Lastly, the theory was finally buried when Metchnikoff showed that this bactericidal action of the serum had no power to check the reproduction of micro-organisms, and that the immunity was produced by the action of the despised amœboid cells. Indeed, to thinking pathologists, it was apparent from the first that a theory based on the action of the serum was an impossible one, for all the facts relating to serous effusion in the human and animal body pointed to an opposite conclusion. In the majority of cases, serous effusion produces no immunity, and, in many cases, the fact that a large quantity of fluid is exuded from the vessels shows that the disease must end fatally.

Of the anti-toxic theory, which was promoted at one time by Behring and his school, Prof. Metchnikoff speaks with great respect; but in a series of interesting pages he shows how it does not apply to all cases, and that even when the blood contains a large amount of anti-toxine the patient nevertheless dies of the disease; and conversely, that an animal may be immune against a disease without its blood having any anti-toxic power whatever on the toxines secreted by the bacillus which is the cause of the disease.

Prof. Behring himself has now been obliged to give up this theory, and it has been lately shown by Buchner and others that, as a matter of fact, the serum of an immune animal has no anti-toxic power at all, and that in such cases the animal recovers owing to the rapidity with which the immunity is produced.

Of the other rival theories it is unnecessary to speak, as Prof. Metchnikoff has himself shown that a great many facts which have been brought forward to support them cannot be maintained. Of all the theories, therefore, which have been thought to explain the natural and acquired immunity of animals and man against infectious disease, the phagocytic theory is the only one which still holds the field, and, although it will not explain all the phenomena of immunity, it is the only one which is based on accurately observed facts, and which will explain how microbes are destroyed in the body. Moreover, those who will read the present book, will see that Metchnikoff himself has always allowed that probably there are other factors in the production of resistance against infectious disease, but that the chief factor was the part played by cells derived from the mesoderms, and especially by the wandering amœboid cells.

OUR BOOK SHELF.

The Camel, its Uses and Management. By Major A. G. Leonard. (London: Longmans, Green, and Co., 1894.)

THE author treats in this work of the management of the camel in connection with military operations, the result of his experience in India, Afghanistan, Egypt, and the Sudan. He does not claim to have produced a scientific essay on the animal, but rather to furnish officers and others in charge of camel transport with a practical description of the camel, his treatment and management, so as to enable them to avoid the causes to which the enormous mortality of baggage camels in recent expeditions has been mainly due. After describing the anatomy and temperament, the author considers it to be essentially a stupid animal, and incapable of looking after itself, though a model of patience under most trying conditions.

In mentioning the principal breeds of African camels, the Maazee tribe north of Kena is omitted, also the Howetat, who, though now poor and few in numbers near Cairo since the railway has robbed them of the carrying trade between Cairo and Suez, are still a large and important tribe in the Sinai peninsula. The Kabbabish tribe from the neighbourhood of Dongola, mentioned as a powerful and wealthy tribe, has, since the beginning of the Mahdist movement, been practically wiped out.

The author strongly advocates the establishment of stud farms to improve the breeds, as has been done by the French in Algeria, and then goes on to the important subject of watering, strongly combating the common belief that a camel does best on a small supply of water, and that before a desert march they should be watered at intervals, so as to train them, and to make them drink the more before starting. Doubtless many errors on this subject and that of feeding have sprung from information obtained from Arabs, who, though skilled in management, cannot always be depended on for their explanations, as in the case of a Sheikh whom we heard say that "a camel required less food on a hard desert march than when in camp, because the stomach shrunk when in work." Without doubt they should always start on such marches in the best possible condition, and not weakened by previous fasting, while, as the author points out, a main reason of the Arabs' success with their camels on long and arduous marches is that they do not hurry them, and afterwards graze them for days and even weeks to recruit, a thing impracticable on service, where work is at high pressure, and a large reserve of baggage camels is rarely available.

The importance of careful loading and suitable saddlery is strongly insisted on, and this latter point might with advantage have been gone into more fully with figures of the various riding and baggage saddles in use, since we have not yet got a satisfactory service pattern saddle. A diagram of the camel's skeleton might also have been added to the chapter on loading and marching. Chapter iii., setting forth the author's views on the instinct and intelligence of various animals, might have been omitted or greatly curtailed, seeing how little of it relates to the camel.

The subject is of great importance, and, as a practical work, the result of much experience, this book meets a want, though reference would have been greatly facilitated by an index.

Modern Plane Geometry. By G. Richardson, M.A., and A. S. Ramsey, M.A. (London: Macmillan and Co., 1894.)

A close examination of this small treatise shows at a glance that the usual method of treatment has undergone considerable alteration. The proofs contained therein are of those theorems in the syllabus of modern plane geometry which was issued by the Association for the Improvement of Geometrical Teaching. The range of the subject treated may be gathered to a certain extent from the statement that the work is intended to serve as a sequel to Euclid, or to the "Treatise on Elementary Plane Geometry" issued by the above-mentioned Association, and, as the authors state, as a systematic means of procedure from Euclidean geometry to the higher descriptive geometry of conics and of imaginary points. The chapters treat of the geometry of the triangle, quadrangle and circle, harmonic ratio, geometrical maxima and minima, that relating to the first being fully considered and containing an introduction to more recent work on special points connected with the triangle. Other chapters deal with cross ratios, involution and reciprocal polars, and projection. The authors inform us that there has been practically no departure from the syllabus referred to above, with the exception of a few additions and the interpolated examples and problems. The theorems are for the most part accompanied by clearly drawn figures which considerably facilitate the rendering of the text.

A little familiarity with this treatise will commend it to many of our readers, for the authors are clear and concise in their treatment of the theorems with which they have dealt.

Chemistry Demonstration Sheets. (London: Blackie and Son, 1894.)

In our opinion, the series of diagrammatic sketches of chemical apparatus just published by Messrs. Blackie may be put to extremely harmful use. "The sheets have been designed," say the publishers, "as a lecture-room aid in the teaching of chemistry. They present, drawn in bold outline, the apparatus used in the experiments of a first course, and underneath each diagram is set down the chemical formula of the experiment. The diagrams are drawn in elevation, and are just what a student requires to sketch in the examination room, while the formulæ, being constantly before the eye along with the diagrams, will become indelibly imprinted on the memory." If the sheets are merely used to describe the arrangement of apparatus for experiments actually performed, no one will, of course, object to them. But if (and this is more likely) the sheets are employed to impress upon the student's memory chemical reactions and apparatus never seen in reality, they could not be condemned too strongly. Teachers are often too glad to avoid experimentation and to refer their classes to text-books for descriptions of chemical changes brought about by various means. Messrs. Blackie's wall sheets will facilitate such a shirking of responsibility.

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.*]

Panmixia and Natural Selection.

Mr. Weldon's letter on this subject, in Nature of May 3, calls, I think, for a few further observations. He first criticises the statement that "the survival-mean must, on cessation of selection, fall to the birth-mean," by showing that there are probably cases in nature in which the survival and birth-means may coincide, owing to the removal by selection of all individuals above and below the mean, they being approximately equal in number. This is, no doubt, the case with certain characters of a species, but probably never with all or even with most characters. Darwin states that in France and Germany white pigeons are killed off by kites, and that on the coast of Ireland black fowls are also killed off by sea-eagles. These and other analogous facts render it probable that in many species of animals colour is kept to the inconspicuous and protective mean tint by the elimination of all individuals which vary much on either side of it, and thus, as regards colour, the birth-mean and the survival-mean may be almost identical. But with many other characters this is not the case. In sheep, cattle, and horses it has been observed that when the larger lowland breeds are taken to bleak mountain regions they gradually dwindle in size, only the smaller and hardier of each generation surviving the severe winter and spring climate and the comparatively innutritious food. Here the elimination is clearly in one main direction; and the absence of this selection due to the transference of the whole body of such reduced individuals to a milder climate and better pastures, would no doubt lead to a slight increase of average size, indicating that the birth-mean had been above the survival-mean. So also in the case of the half-wild horses of Circassia, which are greatly exposed to attacks of wolves and to extreme vicissitudes of climate, swiftness, strength, wariness, and a hardy constitution must be kept at a high level of efficiency by the elimination of the less gifted in these qualities; so that here again the birth-mean must be below the survival-mean. In such cases as these there seems no difficulty in the fact that the mean characters do not change for many generations; for this is in accordance with Darwin's principle that natural selection "cannot produce absolute perfection, but only relative perfection." When the average characters of a species have reached a point such that it can permanently maintain itself in a given area, then no further change will occur; but, the less efficient being constantly weeded out, the survival-mean will be necessarily a little above the birth-mean. Both means will, however, be sensibly permanent as long as the environment remains unchanged.

Mr. Weldon says that it has not been shown that, in some given case, Panmixia does in fact occur; and further, that in the only case which has been experimentally investigated—that of the stature of civilised Englishmen—the consequences said to result from it do not, in fact, occur. To obtain absolute evidence of Panmixia, or of the action of Natural Selection, is extremely difficult, because we cannot first compare and measure minutely a large number of individuals in a state of nature, and then follow those same individuals throughout their lives and see how nature deals with them. We can, however, observe what happens in the case of semi-wild animals, and the examples already cited show that natural selection must, and actually does, act on the character of colour, weeding out those which diverge on both sides towards whiteness or blackness, and in the case of physical and mental activities destroying those which fall below the standard of excellence requisite for the preservation and continuance of life.

In our domesticated animals, on the other hand, we find what are probably examples of the effects of Panmixia. The wing-bones of our pigeons, fowls, and ducks, as compared with wild individuals, were found by Darwin to be decidedly reduced in size in proportion to the leg-bones; but a part of this may be due to disuse in the individual, and to determine the share of the two causes seems impossible. There are, however, a few characters in which we see Panmixia alone at work in our domesticated animals. Such are, for example, the constant appearance and increase among them of prominent *unsymmetrical* markings, as in dogs, cats, cattle, and horses. Such markings never occur in wild races, or if they occur in individual cases they never increase; and I have given reasons for thinking that symmetrical colour and marking is kept up in nature for facility of recognition, a factor essential to preservation, and to the formation of new species. In this case, there can be no question of disuse, while as we know that white and unsymmetrical individuals do occasionally occur in wild species, but never increase, the fact of their increase under domestication must be due to the absence of whatever form of natural selection eliminates them in nature; that is, to Panmixia. Another illustration may perhaps be found in the fact of curled tails appearing in domestic pigs and some races of dogs, while no wild animal is known which has a curled tail. We can hardly doubt that the special form of tail in each animal is of use to it, and that any abnormality, like a curled tail, would be eliminated under nature. Its appearance and perpetuation under domestication is therefore a fair example of Panmixia.

The slow increase of the stature of civilised Englishmen, which Mr. Galton is said to have proved, may, it seems to me, be partly a result of Panmixia, and partly due to more healthy conditions of life acting on the individual. It is, I presume, a fact, as generally stated, that old armour shows that the knights of the middle ages were rather short men. This may have been a result of natural selection, because, as a rule, the strongest and most active men are rather under than over middle height; while tall men would certainly be more exposed to danger, would have to carry a greater weight of armour, and by thus overloading their horses would be under a disadvantage in battle. Tall men would thus be killed off rather faster than short men; and the same might be the case even after the disuse of armour, so long as rapine and civil war prevailed over a large part of the country. But during the last two centuries of comparative peace tall men have been under no such disadvantage, and their survival may have aided in bringing about the slight increase of average stature which has been observed.

One other point in Mr. Weldon's communication requires notice. He considers that the frequent occurrence of abnormalities and the wide range of variation in many species, show that "natural selection is in most cases an imperfect agent in the adjustment of organisms." This conclusion does not appear to me to be a logical one, since it ignores the admitted fact of the exceedingly intermittent character of selection and its constantly varied *locus* of action. Each species of animal is subject to a number of quite distinct dangers—hunger, cold, wet, disease, and varied enemies—and all these are separately intermittent in their action. Some affect the species at one time of the year only, some at another; but most of them only reach their maximum of intensity at long intervals—once or twice, perhaps, in a century. Whether cold winters or hot summers, excessive drought or excessive wet, deep snow or phenomenal hail or wind-storms, all are intermittent and occur with extreme severity only at long intervals. These intermittent waves of meteorological phenomena have their corresponding "waves of life," as Mr. Hudson well terms them, such as phenomenal swarms of locusts or of wasps, of caterpillars, mice, or lemmings, and to a less conspicuous degree of almost every living thing. It follows, that during a succession of favourable seasons variation can go on almost unchecked, and even hurtful abnormalities and imperfections may survive for a few years, but soon there comes a check to the increase, and the most abnormal forms die out; while after a greater or less interval either adverse seasons or an increase of living enemies weed out all the extreme disadvantageous variations, leaving only the pick of the typical form to continue the race. This may occur again and again, each special period of stress affecting different organs or faculties—now abnormal colour, now deficient agility, now again incaution or a weak digestion—till in turn every departure from the best adapted mean form is eliminated, to again arise and again be extinguished as favourable or unfavourable conditions prevail. Thus, I am fully in agreement with Mr. Thiselton Dyer when he said: "I feel more and more that natural selection is a very hard taskmaster, and that it is down very sharply on structural details that cannot give an account of themselves." (NATURE, vol. xxxix. p. 9.) The appearance of imperfect adjustment is thus only a temporary phenomenon, while that there is an underlying permanent adjustment is indicated by the long-continued identity of specific characters to which Mr. Weldon refers.

As it is very important to obtain some direct evidence of the action of natural selection, I wish to suggest a mode of doing so which might probably be successful. There is much evidence to show that the migrating birds which visit us in early summer are very largely old birds which have lived through two or more migrations; and, consequently, that of the large number of young birds which migrate in autumn for the first time a very small proportion return to our shores. If this is so, then the extreme severity of the selection during migration would afford us the opportunity of determining some of the physical characters which influence it, combined no doubt with mental characteristics which we have no means of gauging. I would suggest, therefore, that two or three common species of migrants should be chosen, of which the young birds of the year can be distinguished with certainty. Of these birds a number of observers should collect specimens just before their autumnal migration, and should carefully record the characters fixed upon in the case of the young and old birds separately. Probably the weight, the total length, and the length of the wing, would be sufficient, since heavy birds with comparatively short wings would hardly be adapted for long-continued flight. By laying down the dimensions of some hundreds of specimens in curves of variation, whatever difference existed between the young and old birds would be easily detected; and this difference would presumably be the difference between the birth-mean and the survival-mean, so far as the selective influence of migration is concerned. In the following spring another set of specimens of the same species should be collected and measured; and we should then perhaps be able to determine the characters which had led to the selection of the young birds which had survived the double migration.

ALFRED R. WALLACE.

Discontinuous Colour-Variation.

I HAVE just received a copy of Mr. Bateson's most valuable work on the "Study of Variation"; and although it will take many weeks to read it as it deserves to be read, a few remarks are now ventured as the result of perusing pp. 42–48, which relate to the discontinuity of certain colour-variations.

Without attempting to discuss Mr. Bateson's general propositions, I desire to point out that the facts related in the portion of the work cited, and the "many similar cases" which might be added, do not altogether support the idea of *discontinuous progressive colour-variation*, as distinguished from *atavism*.

Various writers, including myself, have on sundry occasions endeavoured to demonstrate that both in plants and animals a definite succession of colours may be observed. In flowers, for instance, from pink to purple, and from yellow to red; in birds and insects, and many molluscs, the yellow to red succession is commonly observed. In such instances as these, it has been held that one colour represents a lower stage of evolution or a less degree of metabolism than the other; and it has been many times pointed out, that *discontinuous atavistic variation*, *e.g.* from red to yellow, is commonly to be seen.

Now I take it that Mr. Bateson considers the evidence which he adduces, to illustrate the frequency of *discontinuous progressive variation* in colour, not merely *reversion*. Let us examine this evidence a little more closely.

According to the views held by the writers above mentioned, red is "higher" than yellow, and red varying to yellow is reversion. Such reversion is well known to be often discontinuous, as in the yellow-fruited yew, the yellow tomato, the yellow-fruited raspberry, the yellow varieties of various red moths, and so forth.

But is the yellow to red variation, which is supposed to be the progressive one, discontinuous? Let Mr. Bateson himself tell us. On p. 45 he cites the variations of the yellow *Gonepteryx rhamni* towards orange. Are these discontinuous? Do we find among the yellow *rhamni* some that are entirely orange? Not so, "there are records of specimens . . . more or less flushed with orange."

Exactly: whereas among the red species of *Callimorpha*, *Arctia*, *Zygæna*, &c., we find varieties not flushed with yellow but entirely yellow in place of red (the dark markings being of course as usual), in the yellow *G. rhamni* we find continuous variation towards orange, none yet having attained actual red.

In birds red species may vary to yellow; green also to yellow, and such variation may be sudden. But yellow to green? or yellow to red? We have got our canary yellow easily enough, but all the art of the breeder cannot get him redder than orange, and the variations thereto are fairly continuous.

We cannot get a blue rose; but the blue *Delphinium*, the blue *Pentstemon*, these readily vary to pink. We may have a yellow rose, but it is pretty well agreed that if we ever do see a blue one, it will be by a process of continuous variation and selection. Will not Mr. Bateson admit that he would be immensely astonished to see a blue rose arise from seed of a red one, or a scarlet canary from eggs laid by a yellow one? Yet red from blue, or yellow from red, would seem scarcely worth comment in any group of animals or plants, so numerous are the recorded instances of this kind of variation.

On p. 44, Mr. Bateson cites instances of blue in place of red, which should be progressive variation. This occurs in *[illegible]*, for instance, but *very rarely*, and instances which seem rather intermediate are on record. Another sample cited is the blue-flowered *Anagallis arvensis*. Here the case is different, for the blue and red varieties are entirely distinct, and come true by seed. I have myself lived in districts where the blue and red varieties respectively abounded, and in neither locality did I ever see intermediates. They had all the appearance of true species, which they have often, I think with justice, been considered. The locality for the blue variety was Funchal, Madeira, and there the red pimpernel also occurs. But in England, where the red variety is so common, I never saw the blue one truly wild.

In *Primula* we have yellow species and red species, and, as everyone knows, our common primrose may vary to red. But also, as everyone knows, the variation is continuous. How well I remember as a child looking for those that were tinged with red, always hoping to get one redder than that last found!

The subject admits of much greater amplification than is now possible; and it is by no means denied that many instances may be selected, out of the thousands available which appear to indicate discontinuous progressive colour-variation. But nevertheless, taking the evidence as a whole, I will venture to urge the validity of the following statements:—

(1) Colour-variation occurs in a definite order, the colours forming one or more series.

(2) Variation from those lower to those higher in the scale of evolution, or from those representing less to those representing greater metabolism, is usually continuous.

(3) Reversion from a higher to a lower colour is usually discontinuous.

T. D. A. COCKERELL.

Las Cruces, New Mexico, U.S.A., June 1.

Niagara River since the Ice Age.

MUCH new light on the Quaternary history of the great lakes tributary to the St. Lawrence river has been contributed in three recent papers by Mr. F. B. Taylor, all published within the short time since Mr. G. K. Gilbert's writing on "The Niagara River as a Geologic Chronometer," which appeared in NATURE for May 17 (page 53). These papers are in the *Bulletin of the Geological Society of America* (vol. v. pp. 620–626, April 30, 1894), and in the *American Geologist* (vol. xiii. pp. 316–327 and 365–383, May and June, 1894). Supplementing the earlier observations and studies of Whittlesey, Newberry, Gilbert, Spencer, Lawson, Leverett, Wright, Baldwin, and the present writer, among others, these latest explorations and discussions by Mr. Taylor enable us to form a very definite and closely connected historical statement of the relationships of the ice-dammed lakes which preceded the present Laurentian lakes, and of their dependence on the gradual departure of the ice-sheet and on the accompanying northward uplift of that region.

The largest element of uncertainty in the estimate of 7000 years for the Post-glacial period, from the retreat of the ice-sheet to the present time, drawn from the rate of recession of the Falls of Niagara, consists, as Mr. Gilbert has shown, in the probability or possibility that for some considerable time, next following the melting away of the ice upon the area crossed by the Niagara river, the outlet of lakes Superior, Michigan, and Huron may have passed to the St. Lawrence by a more northern course, flowing across the present watershed east of lake Nipissing to the Mattawa and Ottawa rivers. Mr. Taylor's observations now indicate, however, if interpreted on the hypothesis of glacial lakes (which is believed by Mr. Gilbert and by the majority of other geologists of America to be the true view), that the glacial lake Warren, filling the basins of Superior, Michigan, Huron, and Erie, continued with its outlet flowing past Chicago to the Des Plaines, Illinois, and Mississippi rivers, while the country including lake Superior, the northern part of lake Huron, and lake Nipissing, that is, the whole northern side of lake Warren, was uplifted about 350 to 450 feet along its extent of 600 miles from east to west. The existence of lake Warren was terminated by the recession of the ice-sheet from the area between lakes Erie and Ontario, when the Niagara river began to flow and to channel the gorge six miles long below its receding falls, from which the computation for the time since the Ice Age is derived. The Niagara gorge measures the time after the outflow past Chicago ceased, lake Warren being then succeeded in the basins of the upper lakes, above Erie, by the glacial lake Algonquin, while in the Ontario basin the ice-bound lake Iroquois outflowed past Rome, N.Y., by way of the Mohawk and Hudson to the sea.

Seven-eighths of the differential uplifting which carried the watershed east of lake Nipissing above the level of lake Algonquin had taken place before the north-eastward retreat of the ice-sheet uncovered the Niagara area. For some later time the ice-barrier must have remained upon the Mattawa and Ottawa areas, forbidding any outflow there from lake Algonquin; and it seems very probable that within that time the continuation of the uplift had raised the watershed so high that no discharge from the upper lakes ever passed over it. During the ensuing existence of lake Iroquois the Ontario basin was undergoing a rapid northward uplift, which doubtless was shared by the Nipissing area, so that if any outflow occurred there it must have been very brief, being ended when the land east of lake Nipissing rose higher than the present course of outflow by the St. Clair and Detroit rivers to the Erie basin and Niagara river. The duration of the outlet to the Mattawa could probably have been only a few hundred years, at the longest, if it ever existed. With this possible exception, the present volume of the Niagara river has been maintained during all the time of its gorge erosion. Only an insignificant addition to the estimate of 7000 years can therefore be required by the diversion of the waters of the upper lakes.

The view held by Taylor, Spencer, and Lawson, that the high shore lines around the great Laurentian lakes are of marine formation, seems to be inconsistent with the total absence of marine fossiliferous beds overlying the glacial drift in all that region. So far as the sea did extend, after the further recession of the ice-sheet permitted it to come into the St. Lawrence and Ottawa valleys and into the basin of lake Champlain, marine fossils abound; but none are found above the Thousand Islands at the mouth of lake Ontario. We may therefore confidently accept the Niagara gorge as a measure of all the time since the departure of the ice-sheet from the northern United States.

In a recent paper in the *Journal of Geology* (vol. ii. p. 142, February–March, 1894) Mr. Andrew M. Hansen, of Norway, notes the approximate concurrence of about thirty independent measurements and estimates of the duration of the Post-glacial period, which have been made in North America and in Europe, all coming within the limits of 5000 and 12,000 years. He accordingly says: "With full regard to a legitimate calculation of probabilities, it may be predicated that the number of 7000 to 10,000 years is as nearly an exact estimate of the duration of Post-glacial time as can ever be expected."

Minneapolis, Minn., June 9. WARREN UPHAM.

The Teeth and Civilisation.

NONE of the writers of the interesting letters which have appeared upon this subject seem to have kept before them a distinction which is of the utmost importance in its investigation, and which I should like to state, in order that the attention of those who, like Mr. Wenyon, have opportunities of observation of any segregated community, may be drawn to it.

Dental caries is very prevalent, and its increase seems to be very rapid, so that the last few generations show a marked increase; at least so it is generally believed.

But its victims may be divided into two groups, namely, those whose teeth are apparently perfect in their construction, but nevertheless fall a prey to caries, and those whose teeth show, to the trained eye, clear evidence of structural weakness.

As the latter class present a problem in heredity, and for various reasons are likely to be more interesting to the readers of NATURE than the former, I will dismiss these with a very few words.

There is good reason for supposing that the proximate cause is to be found in vitiation of the oral secretions, as caries often occurs in an extreme degree after diseases of the digestive tract, and examples such as those quoted by Mr. Wenyon are probably to be explained as due to dyspepsia induced by the unhealthy way of feeding.

To the explanation that the enamel may be cracked by alternations of temperature which could be borne in the mouth, I am not inclined to attach importance. In the first place, as a matter of experiment, I have failed to crack enamel by plunging teeth alternately into boiling and ice-cold water, and, as a matter of clinical experience, teeth do not decay along the cracks which from some cause are common in the enamel, but in natural pits of larger size, or on surfaces of contact; the cause is to be sought either in decreased power of resistance, or in the intensification of deleterious influences.

Abnormal conditions of life are known to deleteriously affect the teeth of animals; for example, stall-fed beasts are more liable to diseased conditions in the mouth than those which are fed up in rich pastures; and it has been pointed out by Mr. Bland Sutton, that some animals in the Zoological Gardens suffer in this way, notably the Lemurs, whose teeth frequently loosen and fall out.

It is rare to meet with good teeth in children whose parents have had bad teeth, and peculiarities of form in the teeth and jaws are often inherited with curious exactitude. But it is quite common to meet with instances of healthy parents with good teeth bearing a family of children, also apparently healthy and well-grown, whose teeth, although to the casual observer normal in shape, size, and general aspect, are to the eye of the dentist doomed to early destruction, and speedily undergo it.

These teeth have an appearance somewhat difficult to describe; they have a glassy look, are more translucent than they should be, are softer, and are believed, though the proof is not complete, to be somewhat deficient in their proper proportion of lime salts. This kind of tooth is very apt to run through a whole family, and its causes must be sought either in some condition of inheritance, or if it be due to anything acting upon the individual, it must be something which commences to act immediately after birth. Comparative anatomy teaches us that the teeth are less variable than the jaws. In long-muzzled dogs the teeth are spaced; in short-muzzled dogs they are crowded, reduction in size having gone on faster in the bones than in the teeth; and the same thing is observed in the human subject.

Moreover in animals, whilst some variability is often observable in the teeth, that variability does not take the form of structural difference, but only of differences of size and shape.

Again, in rickets, where the bones are starved of lime salts, the teeth contrive to get more than their share; it is therefore not a little remarkable that we should find the teeth, and apparently the teeth alone, to have deteriorated in one generation.

On the other hand, it is equally difficult to find any cause which shall have operated alike upon all the children of a family if we reject inheritance as being at the bottom of it; it does not appear to be determined by the greater frequency of hand-feeding, as I know of instances in the same family where some children were nursed and others were not, and yet their teeth were alike of the poor structure to which I have alluded.

Upon the whole, I am rather inclined to attribute it to some causes operating shortly after birth, rather than before it, for the milk teeth, which are well started in utero, are far less liable to structural variation than are the permanent teeth, whose calcification is mainly effected after birth; but I need hardly say that the period of occurrence does not by any means exclude inheritance.

However the question, interesting and important as it is, is not so simple as some of your correspondents imagine, and there is a considerable amount of literature upon the subject which seems to have escaped them, some of it accurate and valuable, some of it quite the reverse.

CHARLES S. TOMES.

Electrical Theory of Vision.

IN my letter to Prof. Lodge, published in your last issue, I notice a printer's error, which I think should be corrected, as it gives an entirely wrong meaning to the sentence in which it occurs. As it stands it reads as follows: "The energy thus lost by the tissues was then *suppressed* from without by the vibrating fingers," whereas I said the energy was *supplied* from without by the fingers, the idea being that the shaking back of the eyes to their normal state of rest, evinced by the sensation of darkness, is perfectly analogous to the tapping back of Prof. Lodge's "Coherer" to its normal position, evinced by the return of the galvanometer needle to zero.

E. OBACH.

Old Charlton, Kent, June 23.

CLIMBING AND EXPLORATION IN THE KARAKORAM-HIMALAYAS.[1]

THE mountain district explored by Mr. Conway lies on the southern side of the watershed of the Karakoram chain, and is drained by tributaries of the Upper Indus. For most of the time he was in Baltistan, but ended his journey by a visit to Leh. Here, at about 11,500 feet above sea-level, is a small meteorological observatory, which enabled Mr. Conway to check his observations by a comparison of barometers. Besides himself, the party consisted of the Hon. C. G. Bruce, Mr. McCormick, the artist, Messrs. Eckenstein and Roudebush, Matthias Zurbriggen, the well-known guide from Macugna, four Gurkas, who took readily to ice work, and one or two two other native attendants, with, of course, a considerable but variable party of coolies.

As the author states, the party spent in all eighty-four days on snow or glacier. They were often encamped at

[1] "Climbing and Exploration in the Karakoram-Himalayas." By William Martin Conway, M.A., F.S.A., &c. With 300 Illustrations by A. P. McCormick, and a Map. (London: T. Fisher Unwin, 1894.)

elevations ranging from 12,000 to 15,000 feet above the sea, occasionally even up to 20,000 feet, and some of them accomplished the ascent of a peak approximately 23,000 feet—the highest summit which man has reached. But mountain climbing was far from the only purpose of the expedition. Mr. Conway surveyed the district, and has made many important additions to and corrections in the map which was constructed, about thirty years ago, by Colonel Godwin-Austen, after a journey—for that time—hardly less adventurous. He got together considerable collections, and noted, with the eye of an expert, the archæology and other peculiarities of this remote region. A supplementary volume, to be issued in the course of a few months, will contain reports on the zoology, botany, and geology, and on the other scientific results of the expedition. The separation of the two parts is to be regretted, but was probably almost inevitable.

FIG. 1.—The Ogre's Fingers, Biafo Glacier.

Incidentally, however, Mr. Conway tells us something of the natural history and geology of the mountain regions, and a note on the latter subject has been communicated recently to the Royal Society. This part of the Karakoram-Himalayas evidently consists of strips of sedimentary rocks infolded in crystalline masses, and often resembles the Alps of Europe not only in structure but also in mineral characters. Many of its glaciers are enormous; for instance, one proved to be forty miles in length; others are hardly less; their ice-falls sometimes are even more formidable than those in the Alps. This Mr. Conway attributes not so much to their greater steepness of slope as to the irregular form of their beds. They lie among peaks which often range from about 22,000 to 26,000 feet above sea-level, and in one case—the nameless K2—reach 28,278 feet. The snow-line, however, is much higher than in Central Europe. In the middle of April, at the beginning of his journey, Mr. Conway found the snow lying thickly below 13,000 feet, but later in the season an elevation of 15,500 feet in his district seems to correspond roughly with that of 8000 feet in the Alps. But in this respect, evidently, there is considerable variation; for the "col" between the vast Hispar and Biafo glaciers is only 17,600 feet above the sea, while further to the east, passes on the route from Yarkand to Leh rise to this height, or even more, and are almost free from permanent snow.

The first-named pass entailed the longest march over glacier and snow, for it occupied the explorers from July 11 to July 26; but the greatest height above sea-level was reached at the head of the Baltoro glacier. Here, on the flank of a huge mountain, called the Golden Throne, the party encamped for five nights at stations from 18,200 to 20,000 feet above sea-level, Mr. Conway sleeping two nights at the latter elevation, and he ascended, in company with Mr. Bruce, one of its peaks (Fig. 2). This, according to a barometric observation, is 22,600 feet in height, but by its level compared with K2 it should be not less than 23,000. On several occasions they reached elevations ranging from 17,000 to over 19,000 feet, and frequently camped out above the level of Mont Blanc. Thus they had exceptionally good opportunities of observing the effects of diminished atmospheric pressure. Their experience fully bears out that of Mr. Whymper in the Andes, though it affords some interesting differences in detail, while the effect produced, as usual, depended much upon the individual; it also seemed to vary with the environment. Occasionally the attendants suffered at from 13,000 to 14,000 ft., but, as a rule, the Europeans and stronger members of the party were not materially affected till about 15,000 feet, and then but slightly, unless they spent the night on the spot. This, it will be remembered, accords with Prof. Tyndall's experience on Mount Blanc.

FIG. 2.—Pioneer Peak (Golden Throne) from about 20,700 feet

The usual symptoms were felt: panting for breath, and quick, irregular action of the heart after the slightest exertion, with headache, more or less nausea, and a general sense of extreme lassitude and exhaustion. The travellers were most severely affected at the highest camp on Golden Throne, though even here, when completely at rest, the inconvenience was comparatively slight. The ascent from this camp—probably about 3000 feet, without any exceptional difficulties—took $8\frac{3}{4}$ hours. In such a district as the Pennine Alps this distance would probably have been accomplished in half the time. It is therefore obvious that the difficulties in reaching such a point as K2 will be extremely great, though possibly not insuperable. Among these the weather will be one of the most serious. This, in the Alps, is frequently not good; in Baltistan, unless Mr. Conway's experience was exceptional, it is habitually abominable.

Much interesting information in regard to physical geology can be gleaned from this volume. The beautiful illustrations enable us to form a good idea of the magnificent snow peaks; the lower mountains, as a rule, seem to be more precipitous and shattered, more weird and desolate than in the Alps (Fig. 1). The climatal conditions are probably favourable to rapid denudation; mud avalanches are frequent, sometimes on a gigantic scale; the fans of débris also are enormous. Mr. Conway's account of the alluvial deposits in the beds of the valleys, especially on the route to Leh, are most interesting (Fig. 3). These often make it difficult to discover the limits to what glaciers have extended. At the present day the larger ice-streams seem to end at 10,000 to 11,000 feet above sea-level, but here, as in other mountain regions, they were once much greater. Mr. Conway mentions the occurrence of old moraines at various elevations down to about 6000 feet, and we cannot be certain that this is the lowest limit.

Fig. 3.—Remains of Alluvium, Lama-yuru Valley

The volume contains, in addition to a map, three hundred illustrations, process-block reproductions of drawings by Mr. McCormick, some from photographs, and some from original sketches. They represent not only the scenery, but also incidents of travel, and greatly enhance the value of the book. It is worthy to take a place, for literary and artistic excellence, with Mr. Whymper's "Travels amongst the Great Andes of Ecuador," for it is a record of an adventurous journey, carefully planned and bravely effected, as well as a real contribution to knowledge. Clearly and pleasantly written, full of interesting information, not only on the geography, geology, and natural history, but also on the people, buildings, and customs of a rarely visited region, the book does honour to its genial and able author and to his companions in travel.

A NEW FORM OF OBJECT-GLASS MOUNTING.

AMONG the numerous details in telescopic construction that have become of greater importance in consequence of the increase in size of refractors, may be mentioned that relating to the form of mounting of the object-glass, which plays a leading *rôle* in the good working of a telescope.

The chief difficulty which has to be overcome is the great dearth of substances which have the same coefficient of expansion as glass. For small objectives brass fastenings are used, but for larger discs these have been replaced by the adoption of steel, the coefficient of expansion of which more nearly approaches that of glass. In the latter case allowances have to be made for the [d]ifference of expansions of the two substances (glass an[d] steel), and this is done by breaking the metallic band which encircles the objective, and connecting the two ends thus freed by means of one or more screws. In this way the pressure of the band on the circumference of the discs can be regulated by tightening or slackening the screws as the case may be, and the inequality of expansion or contraction can thus be counterbalanced.

If only one disc of glass were in question, the problem would be somewhat simple, but since an objective consists of two discs, and these of different kinds, each possessing its own special coefficient of expansion, the matter is distinctly complicated. With two discs it will be seen at once that the metallic ring may be made fast for one, while the other can be free to move, and therefore quite loose; this naturally raises numerous disturbances in the centering of the lenses.

The functions of a perfect cell are then, firstly, it must be capable of holding the lens firmly and without change of form; while, secondly, it must be so arranged as to allow for the different changes brought about by temperature without disturbing the centering of the lenses.

To produce such a cell as this has been the object of Dr. R. Steinheil's investigations [1] and the following summary contains his suggestions. The principle consists in leaving a space between the inside of the cell and the circumference of the two lenses, and placing rigidly between them blocks of particular substances and sizes, such that they compensate for the different expansions at work.

The amount a substance expands or contracts depends not only on its increase or decrease in temperature, but on its length; thus, for instance, a long rod when heated expands more than a short rod of the same substance. Making use of this fact, we may either assume the *length* of the blocks referred to above, and calculate of what substances it must be composed to give the exact coefficient of expansion required, or we may take any substance with a *known* coefficient of expansion, such as zinc, and determine the length it is required to be. The latter method, of course, by its simplicity commends itself, and if the length of the block be denoted by l we have the formula

$$l = \frac{\phi - \gamma}{\sigma - \phi},$$

[1] See "Ueber eine neue Art von Objektivfassungen" in *Zeitschr[ift für] Instrumentenkunde*, Heft 5, p. 170, 1894.

which gives l in terms of the coefficient of expansion of (ϕ) the cell material, (γ) the glass, and (σ) the material for the blocks. It will be seen from the formula that the shorter the blocks the more equal must be the coefficients of expansion of the glass and cell material, and also the greater the relative distance between the coefficients of expansion of the blocks and cell material.

Dr. Steinheil, as an example, determines the length of these blocks for an objective of 50 cm. aperture, the lenses being composed of common flint silicate marked O.544 in the Jena glass factory, and common crown silicate marked O.1022.

If the material for the blocks used be of zinc (coefficient of expansion $\sigma = 0{\cdot}00002918$), then their length, adopting for the flint glass (544) the value $\gamma = 0{\cdot}00000788$ and for the cell material the value $\phi = 0{\cdot}00001061$ for their coefficients of expansion, is given by the equation

$$l = \frac{1061 - 788}{2918 - 1061} = \frac{273}{1857} = 0{\cdot}147.$$

Similarly for the crown glass, the coefficient of which is 0·00000954, we obtain the length of its blocks

$$l = 0{\cdot}0576.$$

As the radii of the glass discs are the same and equal to 25 cm., the lengths of the blocks for each of the lenses must be $0{\cdot}147 \times 25$ cm. and $0{\cdot}0576 \times 25$ cm. or 3·675 cm. and 1·44 cm.

Dr. Steinheil proposes that for each lens three blocks should be used and placed at intervals of 120° round the circumference of the discs, the blocks fitting tightly between the discs and the sides of the cell. It might at first be thought that such tight-fitting as seems necessary could not be exactly enough done, but it is stated that accuracy in the length of the zinc block to 1 mm can be safely depended on, and the danger of strain by eliminating the disturbances of centering thereby reduced to a minimum.

That this new mounting for object-glasses has many points in its favour cannot be denied, but it is in such questions as these that we must look to the results after the method has been practically applied. Thus, practice would better settle the proper number of blocks for each lens; three seem at first sight somewhat too few, and might lead to local strains due to the weight of the lenses, whereas such strains must be avoided in any sort of cell.

W. J. S. LOCKYER.

NOTES.

WE are requested to state that a volume containing a memoir of the late Dr. Geo. J. Romanes, F.R.S., will be published. Those who possess letters of general interest written by him are requested to forward them to Mrs. Romanes, St. Aldate's, Oxford. The letters will be returned directly their contents have been noted and copies made.

A GRACE of the Senate of the University of Dublin has been passed, conferring the degree of Doctor of Science upon Mr. Daniel Morris, C.M.G., Assistant-Director of the Royal Gardens at Kew.

PROF. KARL GUSSENBAUER, of Prague University, has been appointed to the chair of Surgery at Vienna, in succession to the late Prof. Billroth.

A REUTER telegram states that at a meeting of leading citizens held at Toronto on June 23, it was unanimously decided to invite the British Association to hold the meeting there next year.

THE Council of University College, Liverpool, have appointed Dr. A. M. Paterson to the "Derby" Professorship of Anatomy, and Prof. R. W. Boyce to the chair of Pathology recently endowed by Mr. George Holt.

DR. AUGUSTUS SCHLOESSER, assistant to Prof. Henderson in the chemical department of the Glasgow and West of Scotland Technical College, has been appointed to the Principalship of the Storey Institute, Lancaster, rendered vacant by the resignation of Dr. G. S. Turpin.

A KINDLY and appreciative letter, by Prof. Poulton, F.R.S., on some incidents in the life of the late Prof. Romanes, appeared in the *Times* of June 19. The July number of *Science Gossip* contains an obituary notice of the lamented investigator, together with his portrait.

THE Cracow Academy of Sciences have awarded the Copernicus Prize of five hundred florins, founded by the town of Cracow, to Prof. Louis Birkenmajer, for his work "Sur la temperature des lacs des Tatres." A prize of one thousand francs (Priz Majer) is offered for the best work on "La Climatologie des pays Polonais"; papers to be sent in before December 31, 1896.

A SEVERE earthquake disturbance was experienced at Oran, Algeria, at about one o'clock on the morning of the 19th inst. The duration of the shock is said to have been four seconds.

A SPECIAL meeting of the Chemical Society will be held this evening, at nine o'clock, at the Royal Institution, when Prof. Dewar will lecture on "Phosphorescence at very low temperatures."

THE meeting of the Museums Association, now being held in Dublin, was opened on Tuesday with an address by the President, Dr. Valentine Ball, C.B., F.R.S., on "The Museums of Dublin."

IN the House of Commons on Tuesday, Colonel Howard Vincent asked the Home Secretary whether he had decided to adopt in the Metropolitan and City Police districts, and in the provinces, the recommendations of the committee appointed to inquire into the system of identifying criminals by measurement, invented by M. Bertillon, of Paris, and the finger-print test of Mr. Francis Galton; and, in such case, if, in order to facilitate research into the judicial antecedents of international criminals, the registers of measurements would be kept on the same plan as that adopted with such success in France, as also in other continental countries. In reply, Mr. Asquith said that the recommendations of the committee had been adopted, including the recommendations as to the mode of keeping the register.

IN connection with the Antwerp Exposition, a Congress has been arranged, under the auspices of the Société Royale de Geographie d'Anvers, having for its object the discussion of matters relating to the atmosphere. The Congress will be held on August 16, 17, and 18. The papers will be classified into two sections, one dealing with atmospheric movements, while the other is concerned with aerodynamics. The former section is divided into four parts as follows:—(1) General theory of atmospheric currents and the causes which affect them. (2) Methods of observation at different altitudes. (3) Instruments of observation and for automatic registration. (4) Maps of permanent and of variable atmospheric currents, and a comparison of them with ocean currents. In the aerodynamic section the subjects dealt with will be:—(1) The measurement of the velocity of wind. The action of wind on a plane normal surface and on an inclined surface will be considered, and the friction of air. Experimental apparatus is also included in this division, and the effects of wind on buildings, bridges, towers, &c. Aeroplanes, windmills, and turbines are classified under the motive power of wind, while transport by land, sea, and air are arranged in a sub-group of questions relating to the resisting power of air. The subjects of the second part of the second section are the special application to aerial navigation of data on the resistance of air, and the development of the motors required to render such means of transport an accomplished fact. From this summary it will be seen that the Congress has been organised not only with the idea of bringing together those who are working at the problem of aerial navigation, but also meteorologists, naval architects, and all whose experiences may help to elucidate the matter. The President of the Congress is Lieut.-General Wauwermans, and the General Secretary, Chevalier Le Clement de Saint Marcq, Rue du petit Chien, 16, Antwerp. M. Lancaster, of the Brussels Observatory, is the President of Section I., and Captain M. van den Borren, the President of Section II.

Everyone will agree that the Marine Biological Association of the United Kingdom has, since the opening of the Laboratory, six years ago, carried out the intentions of its original supporters, which were "to promote researches leading to the improvement of zoological and botanical science, and to an increase of our knowledge as regards the food, life, conditions, and habits of British food-fishes and molluscs." Scientific research, however, is not often generously endowed, hence the Association, like many similar institutions for investigation, has its activity greatly restricted by the need for further financial support. With the idea of showing the truly national importance of the work carried on in the Laboratory at Plymouth, the Association has issued a pamphlet, in which its aims are briefly stated, and a few of the many practical and purely scientific investigations carried out under its auspices are described. It is hoped that this statement will quicken interest in marine biology, and induce benefactors to science to give their support to its representative Association, not only because their assistance will help to extend scientific knowledge, but also because they will be assisting in the development of our sea-fisheries. The following extract from the pamphlet referred to shows how small are the funds of the Association in comparison with those of other establishments having similar objects:—"The income of the Association is derived partly from a grant by the Treasury, partly from the voluntary generosity of public companies and private individuals. The Fishmongers' Company contribute £400 a year to the Association, whilst Her Majesty's Government have given £500 a year in the years 1888-9, 1889-90, 1890-91, and £1000 a year in the years 1891-2, 1892-3, and 1893-4. The total income unfortunately falls considerably short of the amount necessary to place the Laboratory on a properly efficient footing. The purchase and maintenance of a sea-going steam-vessel, by means of which fishery investigations can be extended to other parts of the coast than the immediate neighbourhood of Plymouth, is a most pressing need. The admirable Marine Biological Laboratory at Naples, founded and directed by Dr. Dohrn, and devoted purely to zoology and botany, has cost about £20,000, including steam-launches, &c., whilst it has an annual budget of £7000. The United States Fish Commission receives from its Government more than £70,000 a year, and possesses a perfect fleet of vessels. Its work almost exclusively relates to fisheries. The Scottish Fishery Board is credited in the estimates for 1893-4 with £21,858, which (with the exception of £3000 for pier and harbour works) is granted for fresh and salt water fishery work. The Marine Biological Association, with the twofold aim of promoting pure zoology and scientific fishery investigation, received in 1892-3 only £2199 in all." We trust that the appeal of the Association will result in a large extension of the list of subscribers, so that biological science and the fishing industry may both be benefited.

A recent number of the *Comptes Rendus* contains a note, by M. Birkeland, on some recent work done in the late Prof. Hertz's laboratory. It is well known that Hertzian waves when they travel along an iron wire magnetise it transversely, although they only penetrate a very short distance below the surface of the wire. This being so, it was an interesting problem to investigate whether it would be possible to observe in such a wire nodes and loops in the magnetisation. Experimenting in this direction M. Birkeland was led to a negative result, which he attributed to the electrical conductivity of the wire, and hence he was led to experiment, not on cylinders of iron, but on mixtures of finely divided iron and paraffin. He uses a square resonator having each side 60 c.m. long, the opposite side to the spark micrometer being formed into a coil of twelve turns, well insulated from each other. If a cylinder of soft iron is introduced into this coil, the spark length is not changed; a fact which previous experimenters have shown to be due to the screening effect of the induced currents in the superficial layer of the mass of metal. When, however, a cylinder of the mixture of iron and paraffin is introduced into the coil, the spark length may be reduced from 9 m.m. to 0·05 m.m. or to 1/180th of its original value. The effects observed increase as the electrical conductivity of the cylinders diminish, so that the magnetic action of the iron becomes less masked by the conductivity effects. This is well shown by surrounding the cylinder with tin-foil, when the spark regains its original length. When a hollow cylinder of the mixture of iron and paraffin is introduced into the coil, the spark length is much shortened, but the effect is much enhanced when the hollow cylinder is filled by a solid rod. Thus the author finds that the magnetic action is felt through a thickness of 5 m.m. when the mixture contains 25 per cent. of iron, and through 7 m.m. when it contains 10 per cent of iron.

The Central Meteorological Office of France has just published its *Annales* for the year 1892, consisting of three large quarto volumes. Vol. i. contains a number of memoirs on special subjects, among which, as usual, there is one by M. Fron, on thunderstorms in France during the year. These summaries have been continued for thirty years, and furnish useful data for determining the laws which underlie the formation and propagation of those phenomena. M. Moureaux discusses the observations on terrestrial magnetism at the Parc Saint Maur, and gives curves from the self-recording instruments of the most remarkable disturbances, which were considerable during that year. He also contributes a paper on the magnetic conditions at 100 stations; there are altogether 428 such stations in France; those not yet dealt with will be discussed in subsequent years. The results of phenological observations and the migrations of birds during the years 1881-90 are discussed by M. Angot; this is one of the most comprehensive and complete papers of the kind hitherto published. He also contributes a valuable paper on the results of M. Vallot's first series of observations on the summit of Mont Blanc, made in 1887, and a comparison of the simultaneous observations made at the central office in Paris and on the Eiffel Tower, which confirm the principal results obtained in previous years. Finally, M. Durand-Gréville gives a detailed investigation of the connection between squalls and thunderstorms, and has determined some of the phenomena which regularly accompany the formation and propagation of the latter. Vols. ii. and iii. deal respectively with the ordinary observations and with rainfall values at a large number of stations. An important addition to this branch of the work has been made by the publication of the observations made in Senegal, among those referring to stations for various foreign places.

At the joint meeting of Cornish scientific societies, held at Penzance on June 15, Mr. Howard Fox, the president of the Royal Geological Society of Cornwall, read a paper on "Some Fossils from the Coast Sections in the Parishes of Padstow and St. Mervyn," in which he showed that a hitherto unexamined portion of the North Cornish Coast is Upper Devonian. Mr. G. L. Crick, of the British Museum, recognised amongst the fossils found, Orthoceras, Bactrites, and Goniatites, and determined two species, *Bactrites Budesheimensis* and *Goniatites Simplex*. Both these species occur in Germany in Lower Beds of the Upper Devonian, and both forms are likewise present at a corresponding horizon in the red shales of Saltern Cove, near Torquay. In the same horizon at Trevone several specimens were found of the small bivalve shell *Cardiola retrostriata (Cardium palmatum)*, also found at Saltern Cove and in the Upper Devonian beds of Budesheim. The occurrence of these characteristic fossils in the Trevone rocks leads to the conclusion that the beds are on the same geological horizon of the lower portion of the Upper Devonian as the Budesheim strata. A portion of a plate of a ganoid fish imbedded in the blue shale of Trevone was recognised by Mr. Smith Woodward as undoubtedly Devonian and belonging to a genus not yet described, distinct from the *Steganodictyum* of Ray Lankester. Remains of Trilobites, apparently species of Phacops, with several corals, viz. Favosites, Amplexus, and Pachypora, were found in the friable cliffs, which also yielded two bivalves not determinable, and a small brachipod, with a minute punctate structure, closely similar to that of the Devonian genera *Centronella* and *Cryptonella*. In the foreshores of the northern part of Constantine Bay a palmate form of coral was found, from which a section was made, and determined by Dr. Hinde to belong to the genus *Pachypora*, but the particular species could not be identified. The fossil which most distinctly characterises this foreshore is a species of Conularia. In surface markings this form, according to Dr. Hinde, differs from all other known species from the Devonian rocks of America and Germany, principally in the marked fineness of the transverse lines, and it probably belongs to a new species.

NEW bread and the hot morning roll, though difficult of digestion, may have some advantages. According to the *British Medical Journal*, Dr. Troitzki, writing in the Russian medical periodical *Vratch*, states that he has found that new and uncut bread contains no micro-organisms, as the heat necessary to bake the bread is sufficient to kill them all. As soon, however, as the bread is cut and is allowed to lie about uncovered, not only harmless but also pathogenic microbes find in it an excellent nutrient medium. White or wheatmeal bread is a better medium than black or rye bread, as the latter contains a greater percentage of acidity. Dr. Troitzki's experiments with pathogenic bacteria gave the following results:—*Streptococcus pyogenes aureus* retains its vitality on the crumb of wheatmeal bread for twenty-eight to thirty-one days, on the crust for twenty to twenty-three days; the bacillus of anthrax (without spores) remains alive on the crumb for thirty to thirty-seven days, and on the crust for thirty-one to thirty-three days; the typhoid bacillus remains active twenty-five to thirty days on the crumb, and twenty-six to twenty-eight on the crust; whilst the bacillus of cholera lives twenty-three to twenty-five or twenty-seven days on both.

A RECENT number of the *Arbeiten a.d. Kaiserlichen Gesundheitsamte* contains an interesting paper, by Dr. Dunbar, on the detection of cholera vibrios in river-water. As many as 1100 samples in all were examined, 855 being abstracted from the river Elbe alone, whilst samples from the Rhine, Weser, Oder, and other rivers were also submitted to the special tests necessary for the isolation of cholera vibrios. The investigations were begun at the beginning of last August, and were continued until the middle of December. Only those vibrios which gave the cholera red reaction were submitted to further cultivation and examination. Dr. Dunbar exercises great caution in the classification of the numerous vibrios he has isolated, and although in all important respects it was impossible to distinguish them from undoubted cholera vibrios, yet he prefers to describe those obtained from the river Elbe as Elbevibrios, those from the river Rhine as Rhinevibrios, those from the river Oder as Odervibrios and those from the river Amstel as Amstelvibrios. Some of these vibrios when cultivated in ordinary peptone broth in the presence of air and at a suitable temperature, gave rise to phosphorescence, a phenomenon which was never obtained with the cholera vibrio; but even this failed to serve as a mark of distinction, for out of 68 cultures in which this characteristic appearance was exhibited, 38 only gave it occasionally, losing this power in some instances and exhibiting it in others. Elbevibrios were detected in the vicinity of Hamburg from July 19 down to November 4; after that date, although samples were daily examined, none were found. But whereas these cholera-like vibrios were not found after November 4 in the running water, they were found more than a month later, on December 19, in the mud at the bottom of the river; the latter, remarks Dr. Dunbar, probably offering them an opportunity of remaining in a dormant condition for considerable periods of time until chance and suitable circumstance enable them to become again redistributed in the stream itself. These Elbevibrios were found on 21 occasions in the tap-water as delivered to the city, and once in this water after passing through a Berkefeld cylinder, which was investigated on 50 successive days.

WE have received part iii. of the *Proceedings* of the Academy of Natural Science of Philadelphia, extending from October to December 1893.

MESSRS. J. WHELDON AND CO., Great Queen Street, W.C., have issued a catalogue of books and papers on microscopic zoology and botany they offer for sale.

THE June number of the *Journal* of the Royal Microscopical Society, just issued, contains the sixth part of Mr. A. D. Michael's "Notes on the Uropodinæ," in addition to the useful summary of current researches relating to zoology, botany, microscopy, &c.

THE "Beginner's Guide to Photography" (Perken, Son and Rayment) is in its fortieth thousand. Evidently the purchasers (and their name is legion) of the cheap cameras with which the market is glutted, appreciate this guide to the methods of the "black art."

To the third edition of his "Epitome of the Synthetic Philosophy" (Williams and Norgate), Mr. F. Howard Collins has added an abridgement of the "Principles of Ethics." The volume thus presents, in a condensed form, the whole of Mr. Spencer's philosophical principles, so far as they have been published.

THE volume of *Proceedings* of the Liverpool Naturalists' Field Club for the year 1893 has been issued. It contains an interesting address by the President, Mr. G. H. Morton, on museums of the past, the present, and the future, accounts of the excursions and evening meetings of the Society, and summaries of the botanical and entomological work done. We regret to note that this Society, like many others in the provinces, is not flourishing, the number of members this year being forty less than last year.

THE Alembic Club Reprints, published by Mr. W. F. Clay, Edinburgh, are handy little volumes enabling a retrospective view to be obtained of scientific researches that have become classical. In No. 6, a copy of which is before us, we have the Bakerian Lecture delivered by Davy before the Royal Society in 1807, and a part of a paper communicated by him to the

Society in the following year. The papers, as is well known, deal with "The Decomposition of the Fixed Alkalies and Alkaline Earths." Priestley's experiments in 1775, which led to the discovery of oxygen, will be reprinted in No. 7, and Scheele's work of 1777 in the same direction will form the contents of No. 8. No. 9 will be made up of reprints of Davy's papers on the elementary nature of chlorine. These three volumes of the series are in the press.

THERE is a certain amount of satisfaction in identifying wild flowers gathered during country rambles. To assist amateur botanists in and near Edinburgh to carry out this kind of determination, Mr. C. O. Sonntag has prepared a little book of handy size, viz. "A Pocket Flora of Edinburgh and the Surrounding Country," and Messrs. Williams and Norgate have published it. Therein will be found, to quote the sub-title, "a collection and full description of all Phanerogamic and the principal Cryptogamic plants, classified after the natural system, with an artificial key and a glossary of botanical terms." It may be doubted whether a student derives any great advantage from the dictionary method of classifying specimens, nevertheless he may be led through such work to higher studies. Another local flora of which we have received a copy is a "Vade-mecum to the Alpine Flora," by L. Schröter and Prof. C. Schröter (London: David Nutt). This book is in its fourth edition. It contains one hundred and seventy coloured representations of Alpine flowers, so that every bit of bloom which beautifies the Swiss mountainside can be easily identified by tourists without any botanical knowledge whatever. No attempt is made to describe or classify the plants in a systematic manner. Unlike Mr. Sonntag's book, that by Prof. Schröter appeals to the curious tourist rather than the investigating student. The text is in English, French, and German.

THE first edition of Quain's renowned "Dictionary of Medicine" was published in 1882; the second edition was issued by Messrs. Longmans, Green, and Co. last week. For twelve years Sir Richard Quain's comprehensive work has been the standard dictionary of medical knowledge, and the practitioner, teacher, and student alike have put their trust in it. The fact that more than 33,000 copies of this work of reference have been issued in this country and America suffices to show the manner in which the labours of the editor and his eminent staff are appreciated. To bring the book up to the present state of knowledge was a laborious task, for, since the first edition was published, the science and practice of medicine have made enormous progress, and many new developments have occurred. The work had, in fact, to be completely revised, and a large number of new articles had to be prepared. The result of these expansions is that the Dictionary now consists of two volumes, entirely reprinted, while the number of pages have been increased from 1834 to 2518. The editor, and his assistants, Drs. F. T. Roberts and J. Mitchell Bruce, are to be congratulated upon the accomplishment of their task. With the co-operation of numerous members of the medical profession, they have launched their treatise for a second time. We do not doubt that its future career will be as successful as its past.

UNDER the title "Proof Spirit and Fiscal Hydrometry," Mr. John Heywood has published a small book by Dr. B. Derham. The author arraigns the legal definition of proof-spirit, because it depends upon the indications of a certain Sykes' hydrometer. This instrument, and the tables for use with it, are shown to be open to objection. According to Dr. Derham, the proper allowances for variations of the temperature of the hydrometer, and of the spirit stored in bonded warehouses, are not made. Accepting this, it is shown that the Revenue suffers a considerable loss of duty on proof-spirits. In fact, it is asserted that the Revenue estimate, for the year 1892-93, of the total quantity of proof-spirit, fell short of the true estimate by 186,542 proof-gallons; and that, consequently, the loss sustained was £93,271. And, it may be added, since the funds for technical education came from the wine and spirit duties, Dr. Derham's book would seem to show that the moneys available are less than they ought to be. Thus it appears that the progress of technical instruction is dependent upon the graduations of Sykes' hydrometer, a connection that reminds us of Darwin's story of the relation between cats and clover. Having pointed out the seeming defects in Sykes' system, Dr. Derham develops a new system of hydrometry, and describes a new form of hydrometer for carrying it into effect. His suggestions may be worth the consideration of those responsible for the proof standard.

THE hitherto unknown dimethyl arsine, $(CH_3)_2AsH$, has been isolated by Dr. Palmer in the laboratory of the University of Illinois, and is described by him in the current *Berichte*. It was obtained by the reduction of cacodyl chloride. The most advantageous mode of preparing it is as follows:—Granulated zinc is first slightly platinised, then covered with absolute alcohol, and sufficient hydrochloric acid added to produce a rapid current of hydrogen. A mixture of cacodyl chloride, hydrochloric acid, and alcohol is then allowed to fall into the flask from a dropping funnel; a reaction immediately commences, and copious vapours of the reduction product are carried away by the escaping excess of hydrogen. The vapours are conducted first through water contained in a couple of U-tubes, then dried by passage through a calcium chloride tube, and eventually led into a suitable receiver immersed in a freezing mixture of ice and salt. The dimethyl arsine rapidly condenses in the receiver to a colourless mobile liquid which boils at 36°. It is endowed with the characteristic cacodylic odour, and spontaneously inflames with some violence in contact with the air. When air is admitted to the mixture of its vapour with hydrogen a dense white cloud is produced, which rapidly settles upon the walls of the vessel in the form of a crystalline deposit, which is very soluble in water. Dimethyl arsine is completely absorbed by silver nitrate from the mixture of its vapour with hydrogen, with formation of a precipitate of metallic silver and an acid substance which appears to be cacodylic acid. The reaction which occurs in its preparation may be represented by the equation:

$$(CH_3)_2AsCl + H_2 = (CH_3)_2AsH + HCl.$$

If the cacodyl chloride is allowed to enter the reaction vessel too rapidly, or if there is an insufficient supply of acid present, the chief product of the reaction is cacodyl itself, $(CH_3)_4As_2$. Owing to the high boiling point of cacodyl, however, it is either retained entirely in the reaction vessel or in the washing tubes, so that the purity of the escaping dimethyl arsine is not appreciably affected, although its amount is considerably diminished. Dr. Palmer expects shortly to have a further communication to make concerning the remaining unknown organo-arsenic compound, monomethyl arsine, CH_3AsH_2, experiments being now in progress with a view to its isolation.

THE additions to the Zoological Society's Gardens during the past week include a Black-headed Lemur (*Lemur brunneus*, ♂) from Madagascar, presented by the Hon. Mrs. Fellowes; a Green Monkey (*Cercopithecus callitrichus*, ♀) from West Africa, presented by Mrs. Flowers; a Leonine Monkey (*Macacus leoninus*, ♂) from Burmah, presented by Mr. J. W. Hunter; a Brown Capuchin (*Cebus fatuellus*, ♀) from Guiana, presented by Mrs. J. L. Johnson; a —— Mangabey (*Cercocebus*, sp. inc. ♂) from Ujiji, Lake Tanganyika, a Yellow Baboon (*Cynocephalus babouin*, ♀), a Duyker-bok (*Cephalophus mergens*,

♀), an Æthiopian Wart Hog (*Phacochærus æthiopicus*, ♂), a Banded Ichneumon (*Herpestes fasciatus*), a Milky Eagle Owl (*Bubo lacteus*), a Black-crested Eagle (*Lophoaëtus occipitalis*), a Marabou Stork, (*Leptoptilus crumeniferus*), two Green-necked Touracous (*Corythaix chlorochlamys*), two White-crested Touracous (*Corythaix albo-cristatus*), a Bell's Cinixys (*Cinixys belliana*) from British Central Africa, presented by Mr. H. H. Johnston; a Black faced Kangaroo (*Macropus melanops*, ♂) from Australia, presented by Dr. G. Lindsay Johnson; a Black-headed Conure (*Conurus nanday*) from Paraguay, presented by Mr. A. Harrison; a Golden Eagle (*Aquila chrysaëtos*) from Scotland, presented by the Maclaine of Lochbine; a Stump-tailed Lizard (*Trachydosaurus rugosus*) from Australia, presented by Capt. Jamieson; a Maholi Galago (*Galago maholi*) from South Africa, an Arabian Gazelle (*Gazella arabica*, ♂) from Arabia, an Indian Gazelle (*Gazella bennetti*, ♀) from Persia, a Lioness (*Felis leo*) from East Africa, a Military Macaw (*Ara militaris*) from South America, deposited; a White-tailed Gnu (*Connochetes gnu*), three Ypecaha Rails (*Aramides ypecaha*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE NATIVE CALENDAR OF CENTRAL AMERICA AND MEXICO.—The native races of Mexico and Central America used a calendar differing completely from those employed by the ancient nations of the Old World to reckon time. Many explanations of the origin of the calendar have been suggested, some referring it to series of recurring events in nature, others to astronomical phenomena, while a third section of inquirers regard it as purely mythical and terrestrial. Dr. D. G. Brinton has lately studied the peculiar calendar from the point of view of linguistics and symbolism, and his results are given in the *Proceedings* of the American Philosophical Society, vol. xxxi. p. 258, 1893. As the calendar system investigated is not widely known on this side of the Atlantic, it may be well to give an outline of it. "The basis is a so called 'month' of twenty days. Each day is designated by a name of some object, animate or inanimate, and besides its name, each day is numbered, but not from one to twenty, but only from one to thirteen, when the numbering begins again at the unit. The result of this combination evidently is, that a day bearing both the same name and the same number will not recur until thirteen of the 'months' have elapsed. This gives a period or cycle of 260 days, and this anomalous period is at the foundation of the native calendar." Dr. Brinton's linguistic analysis of the names of the twenty days in the Maya, Tzental, and Quiche-Cakchiquel dialects, and in the Zapotec and Nahuatl languages, shows that they are all identical in signification, and therefore must have had one and the same origin. By arranging the symbols represented by the day-names in order from one to twenty, it is found that they exhibit a sequence covering the career of human life, from the time of birth until death at an old age. Thus, in all the five languages and dialects, the name of the first day signified birth or beginning, that of the tenth day, success (through hardship and suffering); of the eleventh, difficulties surmounted; of the thirteenth, advancing years; of the eighteenth, war and death; of the twentieth, the sun, or house of the soul. It appears, therefore, that the calendar conveyed a philosophical conception of life; which may or may not, however, have originated contemporaneously with it. The period of twenty days was doubtless derived from the vigesimal system of counting in use among the tribes employing the calendar. The number 20 is based on finger-and-toe counting, and Dr Brinton points out that in the languages investigated its name has the signification "completed" or "filled up." "In this way," he thinks, "the number came to represent symbolically the whole of man, his complete nature and destiny, and mystically to shadow forth and embody all the unseen potenesis which make or mar his fortunes and his life." Each of the twenty signs in the primitive calendar had 13 numbers, and also 13 names, or rather 13 varieties of the same name. Apparently the ancient seers of Mexico and Central America believed that by assigning thirteen modes of activity to each of the twenty headings under which the agencies that influence human life were arranged, they had taken into account the thirteen possible relations of each to both the material and immaterial worlds; and the fact that the result of 20 × 13 days is 260 days or approximately nine months, that is, the period from conception to birth, would, according to Dr. Brinton, have appeared to confirm the mystic potenesis of these cardinal numbers. But whatever theory is accepted to account for the adoption of the factor 13, there is little doubt that this period was posterior and secondary to the 20 day period.

THE APPEARANCE OF THE HELIUM LINE.—M. A. Bélopolsky contributes to the *Memorie delle Società degli Spettroscopisti Italiani* for May an account of some observations made by him on the apparent reversal of the Helium line, D_3. He noticed, while observing solar prominences, that this bright line frequently appeared double and contained a dark line, not running down its middle, but nearer to one edge than the other. A close investigation on several occasions showed that the one-sided appearance was not produced by instrumental defects. And since it was found that the line was sometimes visible, while at other times it could not be detected, M. Bélopolsky concluded that it was produced by absorption in the earth's atmosphere. The fact that the line did not split D_3 in halves, and that a second similar line could sometimes be seen, indicated that the appearance was not merely one of reversal. To locate the positions of these dark lines, the third order of a spectrum produced by a Rowland grating having 14,438 lines to the inch was employed. It was then found that the bright badge of Helium was almost exactly in the middle of two fine lines, of which the one near the redward side was double. Their telluric origin was evidenced by their absence on one occasion when the air was very dry and the temperature 4° C. At other times, when the atmosphere was full of moisture, and the temperature comparatively high, the lines were perfectly seen. With a spectroscope of small dispersive power, the double line on the red edge of D_3 appears as a single line stronger than the really single line on the violet side, which can only be seen under good observing conditions. M. Bélopolsky gives the following wave-lengths of the lines, on the Potsdam scale: 587·65 (double), 587·60 (D_3), 587·58.

EPHEMERIS FOR TEMPEL'S COMET.—In continuation of the ephemeris for Tempel's periodic comet, given in these columns on May 31, the following ephemeris for Paris Midnight (from *Astr. Nach.* 3229) shows the positions of the comet until the middle of August:—

1894.		R.A. h. m. s.		Decl. ° ′
July 1	..	2 16 48	..	3 15
5	...	2 26 5	...	3 34
9	...	2 35 2	...	3 50
13	...	2 43 39	...	4 3
17	...	2 51 55	...	4 14
29	...	3 14 34	...	4 30
Aug. 2	...	3 21 20	...	4 29
6	...	3 27 41	...	4 26
10	...	3 33 36	...	4 21
14	...	3 39 4	...	4 13

The comet is in Cetus, and is moving towards Taurus. It will pass about a degree to the north of α Ceti in the middle of July.

THE RECENT DISCOVERY OF FOSSIL REMAINS AT LAKE CALLABONNA, SOUTH AUSTRALIA.[1]

II.

GEOLOGY.

FOR what I have to say under this head I must express my obligations to my colleague, Prof. Tate, whose observations in Australia have now extended over many years. He has recently summarised the whole history of its geological progress in a very able presidential address to the Australasian Association for the Advancement of Science, and I have had no hesitation in quoting freely from this and from other writings of so competent an observer.

There appears to be no doubt, both from geological and

[1] By Dr. E. C. Stirling, F.R.S., C.M.G., Hon. Director, South Australian Museum. (Continued from page 1[illegible])

biological reasoning, that in the Lower Cretaceous period a great part of Central Australia was covered by a sea which extended from the Gulf of Carpentaria to the Great Bight, and so divided the continent into an eastern and western moiety. Following this, an upheaval of the sea-covered area took place, succeeded by a denudation of the cretaceous deposits. Unequal movements of depression then brought about lacustrine conditions on portions of the now uplifted bottom of the old sea strait and, in other portions, permitted of the admission of the waters of the ocean. Finally a general upheaval, followed by utter desiccation, placed the deposits of the period just concluded in nearly the condition as that in which we now find them.

The systems of existing lakes, which have been mentioned in an earlier part of this paper, are evidently the shrunken remnants of the much larger lacustrine area of Pliocene times —a condition which demanded for its existence a much greater rainfall than now exists, and was contemporaneous with that which gave rise to the glacial phenomena at places in more southern latitudes in Australia. The region of Lake Eyre was then, as now, the centre of the inland continental drainage. Towards this depression are directed many dry water-courses, of which those of the Macumba, Finke, Cooper, and Diamantina are the chief. For miles around extends an area of sand-hills, separated by loamy interspaces, which are littoral sand-banks marking the successive changes in the contraction of the waters. Within its basin the Pliocene sands and loams have yielded further proof of its lacustrine origin in the remains of Diprotodon, Turtle, Crocodile, and Ceratodus.

In Prof. Tate's opinion, Lake Torrens may have belonged to a lacustrine area distinct from that of Lake Eyre, as with the existing contour of the country a submergence of at least four hundred feet would be necessary before the two systems could be connected.

Such a submergence would also unite in a vast inland sea the whole of the lake region around Lake Eyre and to the westward of Lake Torrens. A very much less considerable submergence would connect Lake Eyre with Lake Frome and the lakes to the north of it. Much of the Murray Desert to the eastward of Overland Corner, and perhaps the whole Riverine region, was at this time a lacustrine area, though probably disconnected from those of Lakes Eyre and Torrens.

The following table, based on Mr. Hurst's report, and revised by Prof. Tate, represents approximately the classification of the formations of the district :—

Recent.—Loose sand generally forming low ridges, sand-hills, or dunes overlying in places the Pliocene beds.

Pliocene.—Lake Callabonna ; fossiliferous formation.

Bands of unctuous blue clay containing abundant quantities of saline minerals and concretions of carbonate of lime ; thin seams of sand ; inflorescent deposit of salts upon the surface. Fossils : Extinct Mammals, Birds, a fresh-water Mollusk (*Potamopyrgus*, sp.), Entomostracans, and a few plants of living species (*Charæ* and *Callitris robusta*).

Mesozoic.—(*A*) "Desert Sandstone" or Upper Cretaceous (hard quartzites or porcellanized sandstone, gritty sandstones, and conglomerates). Fossils : Dicotyledonous leaves. (*B*) "Rolling Downs" formation or Lower Cretaceous ; shales with fossiliferous limestone bands.

Azoic.—Metamorphic schists.

Clay slates, mica, talc, and hornblende slates, metamorphic and intrusive granite and greenstone.

The Pliocene formation in which the extinct Marsupials occur does not appear to be restricted to the present boundaries of the lake, since wells, sunk a considerable distance from the present shore, have yielded fragments of bone in exactly the same formation, thereby showing that the lacustrine area, in Pliocene times, occupied a larger area than at present.

The Mesozoic formation is limited upon the surface to a line of outcrops along the eastern slope of the Flinders Range. At Parabana, Pepegoona, Hamilton and Paralana Creeks, these beds occur as the edges of an immense mesozoic basin which underlies Lakes Frome and Callabonna. The detritus of this formation forms the stony table-lands and plains of the country, and the, so-called, stony deserts of the early explorers have their origin in the same formation.

The Azoic rocks are restricted to the Flinders Range, and are of doubtful age. These rocks were pierced by the Government boring party at Lake Frome several years ago, while boring through the Post-tertiary and Mesozoic formations in search of artesian water.

FOSSILIFEROUS AREA.

The area that has been more or less well explored, is not more than a mile long by about half to three-quarters of a mile wide, but this forms but a small portion of the fossiliferous ground. Bones were dug up at the springs lying in the lake bed eight miles to the north of the camp, and were observed on the surface in a very weathered condition all along the track thither. In fact Mr. Zietz informs me that traces of bones and teeth exist on the surface in almost every part of the lake he examined. Nor, as has been said, are they restricted to the present boundaries of the lake.

SURFACE SKELETONS.

One very remarkable feature is the existence of surface skeletons, indicated by the presence of concretionary limestone, or travertine, which has formed for the bones a sort of cast, elevated a few inches above the surrounding level. In some cases the relative position of the bones has been preserved to such an extent that the limestone mass presents a striking outline of the form of the skeleton. Usually in such cases the animal is lying on its side with the head and limbs plainly visible and more or less extended. The actual osseous substance has, in many of the bones of these surface skeletons, completely disappeared, but not however, in all cases, some of them, usually the limb-bones, are more or less imperfectly preserved and devoid of concretion. Several of these surface skeletons existed near the camp at the time of my visit, but Mr. Zietz informs me that after the drying up of the rain which then fell they were no longer visible, having been covered up by the general saline encrustation which has previously been spoken of.

CONDITION OF THE BONES.

The condition of the bones varied very much ; some were so friable that they crumbled into powder and could not be removed ; others, usually in moist places, were wet, soft, and of the consistency of putty. Curiously enough, for reasons which are not clear, some bones from wet places were firm and hard, while others from ground that was comparatively dry were soft. As a rule, those in best condition came from localities which, without being too wet, were moderately damp. The bones, thus varying in condition and consistency, required very different methods of treatment. The greatest difficulty was undoubtedly due to the circumstance that the bones were saturated with what was practically a concentrated saline solution. In fact, all their cavities were so filled with this fluid that it was necessary to allow a considerable time for it to drain away. In other cases the bones were encrusted and impregnated with gypsum crystals. From such causes the bones became in dry weather brittle and liable to break or crack, and in damp weather difficult to dry. Very careful and patient methods of treatment had consequently to be adopted, and will still be necessary until the salt is removed.

When dry, the fractured surfaces adhere strongly to the tongue, and an approximate chemical examination, by Mr. Turner, of a clean piece of Diprotodon bone gave the following composition :—

Substance dissolves almost entirely in dilute hydrochloric or nitric acids. Contains—

Moisture	3·76 per cent.
Organic matter	7·4 ,,
Inorganic matter, mainly phosphate of lime with some carbonate	88·84 ,,
Total	100

POSITION AND ATTITUDE OF SKELETONS.

The heads were pointed towards all directions, and the remains of different animals frequently much mixed. Where, however, the bones of an individual were lying in juxtaposition they preserved fairly constant relations to one another. The vertebræ, for instance, often formed a more or less continuous series or were broken up into segments, of which the constituents were in such close apposition that they could be removed entire. These bones and the head, which was often much flattened laterally, as if by pressure, were usually lying either in their proper position with the dorsal surfaces uppermost, or were turned over on their sides. The pelvis was usually horizontal ; of the ribs, some were *in situ*, others either widely separated from their fellows, or several firmly welded together. The limbs, almost invariably at a greater depth than the rest of the skeleton, had their various segments greatly flexed. The feet were deepest of all. This attitude, together with the frequent approximation of the bones of individual skeletons, is, as has been observed, strongly suggestive of death *in situ* after being bogged. A very similar attitude was assumed by the camels on the occasions when they got bogged in crossing from the sand islets to the main land.

The four Birds whose remains were found close to the camp had their heads all pointing to the south-west, that is towards the part of the lake-bed considered to be the deepest, but their bones, especially the ribs and short bones, were much broken and mixed together. The larger bones, however, were well preserved, and in one skeleton the cervical and dorsal vertebræ formed a continuous series. It was, unfortunately, only possible to secure two heads, and these, though apparently entire, were so soft and fragile that they had to be set immediately in a half-mould of plaster of Paris.

determined by Prof. Tate to be *C. robusta*, a species now living, were found embedded in the same blue clay, and some fructifications of *Charæ* were washed out of it.

Food Remains.

Associated with the skeletons of Diprotodon, in a relative position which corresponded with that of the abdominal cavity, were occasionally found loosely aggregated globular masses of what I judge to be the leaves, stalks, and smaller twigs of some herbaceous or arboreal plants. The fragments are very uniform in length, thickness and character, rarely exceeding an inch in length or a line in thickness. They are solid, often irregularly branched, frequently retaining portions of the bark, and have their ends often frayed or crushed as if by the action of teeth. Microscopic examination showed the structure of the sclerenchyma tissue to be well preserved, and gave clear indication of the existence of dotted ducts, but I could find no trace of leaves that might have indicated a diagnosis. Judging from this entire

Fig. 2.—Head of Diprotodon (Lying in clay matrix which has been partially removed.)

The position of the Bird-remains were here, as elsewhere, indicated by the presence of circular surface patches of "gizzard-stones," consisting of fine and coarse sand and small siliceous pebbles not exceeding three-quarters of an inch in diameter, the surfaces of which were smooth and worn as if by attrition.

The stones comprised in one entire patch weigh fourteen ounces, and include examples of siliceous sandstone, jasper, claystone, blackened on the outside, black quartz, clear quartz, chalcedony, together with a few fragments of blue brittle clay with worn edges. Such stones are not now found on the Flinders Range, but are characteristic of the great Central Australian plain formation, which extends from the Lake Eyre basin across the continent to the Gulf of Carpentaria.

Such pebbles occurred either scattered or in groups at various places in the lake, and were the only stones of any kind to be found anywhere on its surface. The only shell found in the clay matrix of the bones was a minute fresh-water Mollusk (*Planorbis* sp.). Three fruits, however, of a *Callitris*

absence of leaves and from the degree of maceration, or entire absence of the bark, these masses probably represent the contents of the intestines. No traces of coprolites were anywhere met with.

I have submitted a sample of these food remains to Baron von Mueller, who recommends that it should be sent to Prof. Radlkofer, of Munich, whose special investigations in xylography may enable a more accurate determination to be made.

Material obtained.

At the present time it is impossible to give more than a very bare outline of the extent of material obtained. In the first place, more than a third (and that the best) of it has not yet reached Adelaide, nor can do so for another month, and the unpacking of what has already arrived has only just been completed. On the field itself there was no time or means for careful examination and comparison, Mr. Zietz very rightly understanding his duty to be that of gathering in and of preserving as much material as possible while conditions, which might at any time alter, were favourable for work. In this and in the all-important work of careful labelling and packing, his time was fully occupied as long as daylight lasted, and as soon as the bones were sufficiently hardened they were packed up so as to be out of harm's way; consequently, the opportunity has never yet occurred of examining the collection in the aggregate.

Mr. Zietz is, however, confident that he has one fine skeleton of the large *Diprotodon australis* complete, and a second nearly so. The indications afforded by differences in the shape of the skull and other bones, together with the great variation in size, shape and section of the great upper incisors, render it probable that, even among the moiety of specimens already unpacked, there are at least three or four species of large Diprotodontoids represented.

We have nearly a dozen heads in good or fair condition, either intact or in pieces which can be put together; a very extensive series of limb bones, including some perfect feet removed entire with their envelope of clay, which, in some cases, will be found to show the impressions of the soles.

Of the feet, in which from our previous ignorance of their constitution much interest is centred, I prefer not saying much at present. Among the first consignment of bones brought down by Mr. Hurst, were the supposed bones of a fore and hind foot, but a careful examination of them satisfied me that they were not only incomplete, but that the assigned constituent bones did not all belong to the same individual, or possibly even to the same species. When at Lake Callabonna I made a further attempt to ascertain their structure from apparently untouched and entire specimens, but the wet weather had made the bones so exceedingly soft and fragile, that they collapsed under the gentlest handling, and I was consequently unwilling to risk further damage. Several of those we have were removed without disturbance of the enveloping clay, and are presumably complete, but the clay has now, with exposure, become so hard that they require for development more time than we have been able to devote to them under our present great pressure of work. Besides, there are many other bones the condition of which demands more immediate attention, so that I fear the feet must wait. There are hundreds of separate carpal, tarsal, metacarpal and phalangeal bones, many ribs, several more or less perfect pelves, and a very few marsupial bones. The vertebræ are the weakest point in the collection, as these are usually in bad condition or broken, and, in all cases, they were very difficult to remove and to prepare without further damage. Several small bones, which are almost certainly those of a very young Diprotodon, were found by Mr. George Hurst in such a position relative to the pelvis of an adult animal as to suggest that the parent had died with a young one in its pouch. Other such bones were found by one of Mr. Zietz's party. Of an apparently smaller species of Diprotodon, possibly *D. minor*, we have several heads and many other bones.

How many separate individuals of Diprotodon have been met with it is difficult to say with accuracy, on account of the way in which they were often scattered and mixed, and the fact that the work of Mr. Zietz overlapped that of his successor, but it would probably be safe to say that there was some indication or other of the existence of at least 100 distinct animals.

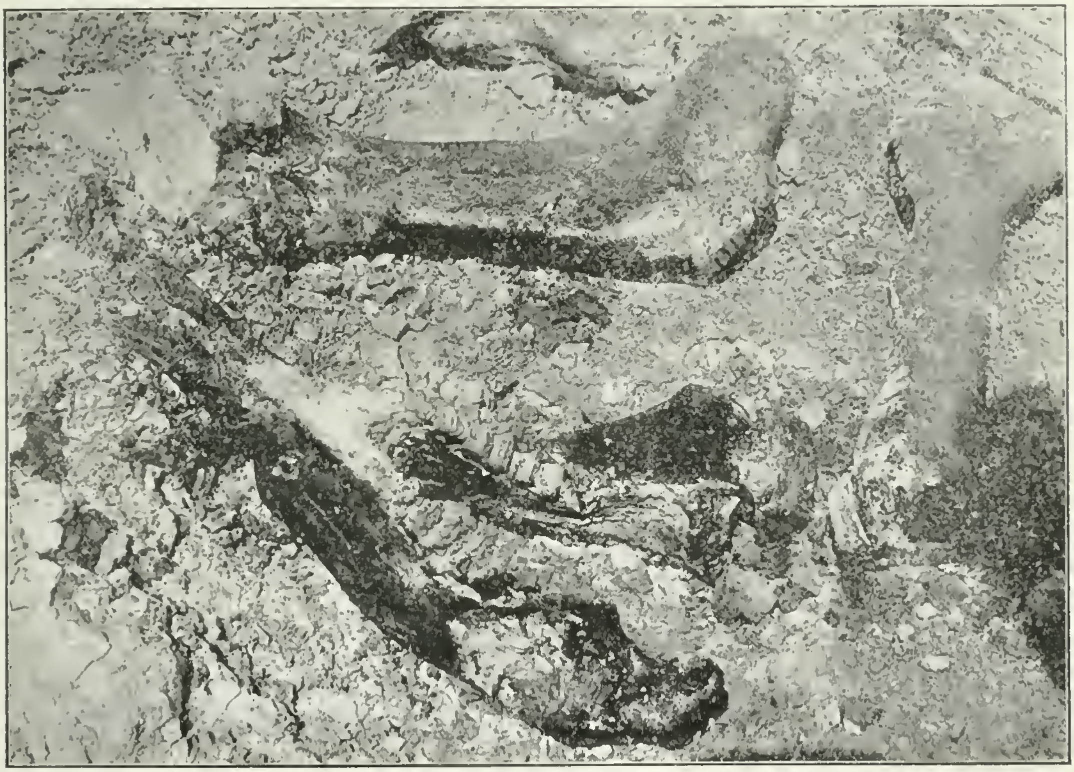

FIG. 3.—Diprotodon bones partially excavated.

Remains of a large Wombat, which appears without doubt to be *Phascolomys gigas*, were very scarce; most of the bones of the appendages, however, are represented more or less perfectly, as are also the marsupial bones. Unfortunately we have only fragments of two skulls, of which one can be made fairly complete when the pieces are put together. There appears no doubt but that the adze-like teeth, described by Sir R. Owen as those of *Sceparnodon*, belong really to this animal, as anticipated by Mr. Lydekker ("British Museum Catalogue of Fossil Mammalia," part v.). The name, however, is a misleading one, as the animal could not have exceeded three feet in height, though the bones are very massive.

Of fossil Kangaroos we have one small but very complete skeleton, and a large series of separate bones of several larger kinds, including a fairly complete skull, which has a length of 33·5 cm.

Of *Nototherium*, so far as we are aware, no remains have been met with, unless, perhaps, some teeth which differ from the ordinary type of those of Diprotodon may prove to be referable to this animal.

Besides the above, which constitute the bulk of the mammalian specimens, there are odd bones and fragments of bones belonging to some, as yet, undetermined small animals.

Of the great Birds which appear to be all of one species, and of nearly one size, we have, as stated, two skulls of extraordinary size, in passable condition; but as these have not yet been developed, it is not possible to give their characters or exact measurements. They, however, certainly exceed eleven inches, and possibly reach twelve inches, in length. There are besides three pelves, one sternum, a whole vertebral series, including the tail, several ribs, two partially complete sets of wing bones, and a dozen or more legs complete, so that the collection probably comprises nearly all the bones of the skeleton. The femur is of the same massive build as that of *Dromornis australis*, and even exceeds it in size. Moreover, so far as can be judged from description and plates, it differs from it in contour and section, which is greatly compressed antero-posteriorly, and in some other particulars. The differences between the two tibiæ are also considerable, especially in respect of the existence in the new fossil of a bony ridge across the precondylar groove. The proximal end of the femur differs also from the fragment assigned by Mr. De Vis to *Dinornis queenslandiæ*, but not accepted as such by Captain Hutton. Apart from the vast differences of proportion, the leg-bones of the new fossil have many points of resemblance to those of *Dromæus* in the disposition of salient anatomical features, a similarity which has been noted by Sir R. Owen in the case of *Dromornis*. The foot, relatively small, when compared to that of *Dinornis elephantopus*, is tridactyl, the outer toe appearing to possess only four phalangeal segments.

The following measurements present, roughly, a comparison between the dimensions (reduced to the metric system) of the femur of Owen's *Dromornis*, as stated by him (*Trans. Zool. Soc.* vol. viii. p. 381), and one of the largest of the femora of the Lake Callabonna fossil.

—	Extreme length.	Lat. diameter at middle-third.	Antero-posterior diameter.
	cm.	cm.	cm.
Dromornis australis	[illegible]2	6·4	4·0
Lake Callabonna bird	35·1	7·9	[illegible]

A further idea, also, of the comparative proportions of the various segments of the leg may be gained by reference to the subjoined table, in which the comparison is made between the leg of a *Dinornis elephantopus* in the South Australian Museum, the Lake Callabonna fossil, and a large Emeu (*Dromæus novæ-hollandiæ*):—

	Femur.		Tibio-Tarsus.		Tarso-Metatarsus.		Middle toe.
	Extreme Length.	Girth at middle.	Length.	Girth.	Length.	Girth.	Total length.
	[illegible]	[illegible]	[illegible]	cm.	cm.	cm.	cm.
Dinornis elephantopus	[illegible]	[illegible]	[illegible]2	14·[illegible]	22·2	14·[illegible]	1[illegible]
Lake Callabonna Fossil	[illegible]	[illegible]3	[illegible]	1[illegible]	7[illegible]	14·[illegible]	[illegible]3
Dromæus novæ-hollandiæ	21[illegible]	[illegible]	[illegible]6	[illegible]	[illegible]·4	7·[illegible]	14·[illegible]

The combined lengths of the three principal segments in the Callabonna fossil thus exceed those of the Emeu by more than a foot, and those of *D. elephantopus* by about the same amount.

Of the wing we fortunately possess two examples, one wanting only in the phalangeal portion, the other more imperfect. Comparing it with the appendage of the same Emeu, whose humeral and radio-ulnar segments are respectively 10 cm. and 7·5 cm. in length, I find that the corresponding segments of the fossil bird are 8·9 cm. and 10 cm. and considerably thicker.

The remaining bird-bones are in the collection which has yet to reach Adelaide, and I can therefore give no particulars of them from personal observation. There can, however, I think, be no doubt, even from the above limited observations, that these bird-remains indicate the former existence of a large extinct struthious bird distinct from either *Dromornis* or the *Dinornis queenslandiæ* of De Vis.

It is estimated that altogether about three to four tons net weight of bones have been, so far, obtained.

Although the most careful search was constantly made, no traces whatever of *Thylacoleo* were discovered, which, under the circumstances, is rather remarkable if the habits of this beast were as predatory as is believed by some. Its remains have, however, been found in other parts of South Australia, associated with those of Diprotodon. Nor were there any signs of the contemporaneous presence of man.

Meteorological.

Arriving at the camp on August 16, the party experienced fine weather, but very cold nights for about a week. Strong winds, mostly south-easterly but veering in all directions and increasing in strength for about twenty four hours and eventually subsiding, then became of frequent occurrence. Later on, towards the end of October, these gales, now usually from northerly quarters, increased in force and frequency, beginning at any time in the day and lasting twelve to eighteen hours, carried dense clouds of fine sand from the dunes, and pulverised saline matter from the lake, and were most irritating to the eyes.

In November these gales blew almost continuously and with still greater force, raising sand-storms so dense that it was impossible to see more than a few yards, and work was consequently impossible. Empty cases, and even the bones laid out to dry, were blown about the camp, sometimes to a distance of a hundred yards. The nights were intensely dark. Heavy clouds to the northwards seemed to threaten rain, but none came for some days. These clouds appeared to separate at the northern end of the lake, to travel southwards on each side of it, and then to unite again. Mr. Ragless, at Callabonna, was convinced that in some way or another the lake bed was an obstacle which the rain clouds from the west did not readily pass. During the day the heat was often intense, the thermometer in the tent rising frequently to 110° F. or not unfrequently even to 120°, but the nights were still comparatively cool. Innumerable flies were, in the day-time, a constant and maddening source of annoyance to man and beast, and so tortured the camels that the margin of their eyelids became quite raw. About the middle of November there was heavy rain for eighteen hours, and a week later a severe sand-storm from the west, bringing a sharp thunder-shower, in which an inch fell in a quarter of an hour, and its impact on the surface of the lake was so heavy that it could be heard at Callabonna Station six miles distant. A fortnight later a second severe sand-storm from the west was followed by another heavy shower. Just previous to the latter rain large flocks of the Australian Swift, *Cypselus australis*, locally called rain-birds, and considered to be a sure sign of heavy rain, passed over the lake. On one night only was there a fog, which was of such peculiar denseness that the candle in the tent threw hardly any light, and its flame appeared surrounded by a yellow halo.

Previous to heavy weather immense numbers of nocturnal insects came round the camp fire at night, and a large collection of them was made.

Rabbits.

During November the camp became almost unbearable from the stench produced by the dead carcases of rabbits which came to drink of the waters of a very brackish, in fact salt, spring at the base of the sand-hill, about a hundred yards from camp. Round this they died after drinking, or else perished after crawling for shelter into the tents and empty boxes. It became part of the routine of the camp to bury upwards of fifty bodies every night, but still the nuisance was hardly lessened. The rabbits also caused many bones to be broken by crawling under them in search of little pools of salt water which dripped from them as they were laid out to dry. In their frantic search for water they gnawed holes in the water-bags in camp, and on the mainland bit through the stems and roots of the "needle-bush," a species of *Hakea*. In one night at Callabonna Mr. Ragless killed 1400 with poisoned water, and what with drought and the ravages of these pests, which stripped the scanty bushes of every green leaf till they were nothing more than bundles of bare sticks, the surrounding country presented an appearance of desolation that defies description.

Under such circumstances of heat, sand and effluvia, it is not surprising that the health of the party suffered eventually from ophthalmia and gastro-intestinal complants, and, indeed, it was chiefly this which led to the breaking up of the camp at the end of November for the time being.

It would be an unworthy omission if I were not finally to acknowlege the cheerfulness and skill with which Mr. Zietz performed his duties under somewhat arduous and depressing circumstances; indeed, whatever satisfactory results may have been achieved by this expedition they are most chiefly due to his indefatigable zeal in the interests of palæontology and of his museum. To the Messrs. Ragless our best thanks are due for their kindness and hospitality to members of the party at various times, and for many necessary articles supplied, sometimes, I fear, at their own inconvenience. Our great obligation to the Government of South Australia for the loan of camels, granted through the mediation of Mr. Goyder, the Surveyor General, I have already acknowledged.

For the preceding notes I can only claim that they comprise but a rough and imperfect epitome of the physical features of the fossiliferous area, and of the conduct of the Museum party's operations up to the present time. As has been already stated, until the whole of the specimens have been unpacked, cleaned, mended, examined and compared, no accurate summary of the palæontological results can be given. It must further be remembered, that the South Australian Museum has recently shared in a general retrenchment imposed upon all Government institutions by the financial exigencies of the day, and that at this very time when the limited museum staff is called upon to deal with, for it, an unprecedented mass of material, it is also called upon to remove and re-arrange, with expedition, the whole of its collection in a new and more commodious building. I mention these facts as a plea for some indulgence for the delay that must inevitably take place, even with such collaboration as we may hope to secure, before the full scientific results can be made known.

Recognising the extreme promise of this discovery at Lake Callabonna, no hesitation was felt by the Museum Committee in subordinating all other work for a time to its vigorous prosecution. But for reasons, to which I have just alluded, excavations could only have been continued for a very limited time, had it not been for the very timely, generous, and unconditional assistance afforded by Sir Thomas Elder, G.C.M.G., a gentleman who stands conspicuous amongst Australian colonists for the liberal support he has so frequently and so munificently displayed in the interests of education and exploration in South Australia. This latest benefaction has enabled much to be done under undoubted difficulties, but much yet remains to be done, and it is hoped that, at a more favourable season, the work now for a time suspended may be resumed, to yield results still more favourable than those hitherto achieved. In the meantime the area comprising the lake has been reserved by the Government for the purposes of further exploration to be carried on under the authority and direction of the South Australian Museum.

KAFIRISTAN.

THE concluding meeting of the Royal Geographical Society for the present session was held on June 25, when a paper on Kafiristan was read by Surgeon-Major G. S. Robertson. Kafiristan is the least known part of Asia, and Dr. Robertson is the first European who has succeeded in penetrating its remote valleys, and making the acquaintance of the primitive tribes who dwell there.

Kafiristan is a geographical expression used to designate the country of those non-Mahomedan tribes who inhabit that space left blank in our maps, which is bounded on the east by Chitral and the Kunar valley, on the south-east by the Kunar valley, on the west by Afghanistan, and on the north by the Hindu Kush and by Badakhshan. Politically speaking, the whole region is bounded on the east by Chitral and the debatable land of the Kunar valley, and on all other sides by Afghan territory. All the rivers of Kafiristan drain into the Kabul river. The parts of this country explored during a year's stay included the Bashgul valley and many of its subsidiary valleys, from the head of which a passage was made to the Minjan valley of Badakhshan. The Kunar valley was also visited, and the valley known as Viron by the Mahomedans, and Presun by the Kafirs, was finally reached and found to be the most sacred part of this well-secluded country and the most interesting. Tribal jealousy made progress very difficult, but Dr. Robertson's journey and sojourn did not cost a single life, a very remarkable fact in a country where homicide is not regarded as criminal. All the passes leading into Kafiristan from Badakhshan are more than 15,000 feet in elevation, and internal communication between valley and valley is completely cut off in winter, when the various tribes live in absolute seclusion, each in its own district. The tracks which take the place of roads are narrow and difficult, running along the river valleys in many parts; they can only be traversed by experienced men; dogs cannot pass some of the difficult points without assistance.

The origin of the people is unknown. Classifying the tribes according to speech, there are, first, the Siah-Posh; secondly, the Wai, including probably the Ashkun; thirdly, the Presun. The Presun are certainly unlike all other Kafirs; they are possibly an aboriginal race. Dr. Robertson could never learn to repeat nor could remember one single word of their language; indeed, at their religious functions the sounds uttered by the officiating priests seemed more like a soft musical mewing than anything else.

Their customs are very peculiar and extremely primitive. One of the most curious is that a chief on his appointment, or anyone who excels in athletic exercise, does not receive tribute or reward, but is expected to feast all his neighbours as a thanksgiving for his exceptional distinction. The physique of the people was splendid, perfect muscular development being the rule, and fat men were quite unknown amongst them. They are great dancers, and have many ceremonial dances of much complexity. Funeral ceremonials are elaborate, and last a long time; but marriage is performed with the minimum of ceremony, the only essential being the payment of purchase-money to the bride's parents. The people were boastful, and at first it was impossible to get them to speak the truth on any subject: but they are brave to the last degree, and have maintained their independence for centuries against all comers.

A short paper was read at the same meeting by Mr. F. G. Jackson, describing the equipment of the Jackson-Harmsworth polar expedition and its proposed route.

SCIENTIFIC EDUCATION AND RESEARCH.[1]

ENGLISH boys and girls at the present day are the victims of excessive lesson learning, and are also falling a prey, in increasing numbers year by year, to the examination-demon, which threatens to become by far the most ruthless monster the world has ever known either in fact or in fable. Ask any teacher who has to do with students fresh from school his opinion of them: he will say that in the great majority of cases they have little if any power of helping themselves, little desire to learn about things, little if any observing power, little desire to reason on what they see or are called on to witness; that they are destitute of the sense of accuracy, and satisfied with any performance however slovenly; that, in short, they are neither inquisitive nor acquisitive, and as they too often are idle as well, the opportunities offered to them are blindly sacrificed. A considerable proportion undoubtedly are by nature mentally very feeble; but the larger number are by no means without ability, and are, in fact, victims of an acquired disease. We *must* find a remedy for this state of things, or perish in the face of the terrific competition now setting in. Boys and girls at school must be taught from the very earliest moment to *do* and to *appreciate*. It is of no use our teaching them merely *about* things, however interesting—no facts must be taught *without their use* being taught simultaneously; and, as far as possible, they must be led to discover the facts for themselves. Instead of our placing condensed summaries in their hands, we must lead them to use works of reference and acquire the habit of finding out; they must always be at work applying their knowledge and solving problems. It is a libel on the human race to say, as many do, that children cannot think and reason, and that they can only be taught facts; early childhood is the time at which these faculties are most apparent, and it is probably through failure to

[1] Extracted from the Presidential address delivered by Dr. H. E. Armstrong, F.R.S., at the Chemical Society, on March 22.

exercise them then that they suffer atrophy. The so-called science introduced into a few schools in answer to the persistent demands of its advocates has been in most cases a shallow fraud, of no value whatever educationally. Boys see oxygen made and things burnt in it, which gives them much pleasure; but, after all, this is but the old lesson learning in an interesting shape, and has no superior *educational* effect. I would here repeat what I have recently urged elsewhere, that in the future *all subjects* must be taught *scientifically* at school, in order to inculcate those habits of mind which are termed scientific habits; the teaching of *scientific method*—not the mere shibboleths of some branch of natural science—must be insisted on. No doubt some branch of chemistry, with a due modicum of physics, &c., is the subject by means of which we may best instil the scientific habits associated with experimental studies, but it must be the true chemistry of the discoverer, not the cookery-book receipt pseudo-form which has so long usurped its place. Whatever be taught, let me repeat that mere repetition work and lesson learning *must* give place to a system of allowing children to *do* things themselves. Should we succeed in infusing the research spirit into our teaching generally, then there will be hope that, in the course of a generation or so, we shall cease to be the Philistines we are at the present time; the education given in our schools will be worthy of being named a "*liberal education*," which it never will be so long as we worship the old world classical fetish, and allow our schools to be controlled by those who reverence this alone, having never been instructed in a wider faith.

As regards our college courses, I see no reason to modify the views expressed in my address to the chemical section of the British Association at Aberdeen in 1885; on the contrary, the experience I have since gained as a teacher and examiner has served only to strengthen them and to convince me of the paramount necessity of a very radical change in our system of instruction, and I rejoice at the increasing evidence of a state of unrest both at home and abroad. The "thorough" course of qualitative analysis which it has long been customary to impose at a very early period of the student's career must, I venture to think, be relegated to near its close; this course certainly has not the effect of producing competent analysts, and but too often reduces those who toil through it to the dead level of machines; in hundreds of cases I have seen students, as it were, hang up their intelligence on the clothes-peg outside and enter the examination room masked with a set of analytical tables, through which alone they allow themselves to be actuated, and to which they render the blindest obedience. Qualitative analysis actually requires the fullest exercise of the mental faculties as well as considerable manipulative skill. By introducing this branch of study at too early a period we force our students to act as machines, inasmuch as they do not, and cannot, know enough to work intelligently; we are but trying to make them run before they have learnt to walk. Even when the interactions on which qualitative analysis is based are fully studied, and the equations relating thereto are conscientiously written out, the result is not much better, owing to the slight importance of so many of the interactions apart from their technical application in analysis, and especially on account of our ignorance of the precise nature of many of the interchanges of which we avail ourselves: the persistent misrepresentation of facts which such a course encourages is, in my opinion, one of its worst features.

I believe that in the near future our students will first be set to solve problems, each in its way a little research, and involving much simple quantitative work; they will thus be taught chemical method, or, in other words, *the art of discovery*. They will then be taken through a course of quantitative exercises with the object of making them acquainted, by direct contact with the facts, with the fundamental principles of our science, which are but too rarely appreciated at the present day. After this, they will seek to acquire proficiency in quantitative analysis and in the art of making preparations; and subsequently they will give sufficient attention to the study of physical properties to enable them to appreciate the physico-chemical methods of inquiry which are now of such importance. The study of qualitative analysis in detail will be left to the last, as being an eminently technical subject. Meanwhile, by attendance at lectures, by reading carefully chosen works of a kind altogether different from the soul-destroying text-books we now possess, and especially by the study of classical models in chemical literature, they will have acquired what is commonly spoken of as theoretical knowledge, but too often regarded by us as of secondary importance, and which it is so difficult to make Englishmen realise means a proper understanding of the subject. Students so trained—imbued from the outset, even from early school days, with the research spirit—will at all times be observant and critical, nay, even logical; dogmatic teaching will cease to have any charm for them: they will actually take deep interest in their studies—a result devoutedly to be hoped for, as nothing is more galling to the teacher at the present day than the crass indifference of the average student and his refusal to give attention to anything unless it will pay in an examination. At the close of such a course, the student will be thoroughly prepared to undertake original investigation, distinctly with the object of exhibiting his individuality and originality, and not, as at present, with the object of acquiring for the first time an insight into the methods of the investigator; he will thus be spared the unpleasant discovery which the advanced student now too often makes that his early training has unfitted him, rather than prepared him, for the task of original inquiry.

But to attain to this happy state it will be necessary that school education be "rationalised" and improved, as I have already indicated; that the material placed at our disposal be of far higher average quality than heretofore; and that the period of study be lengthened.

As it offers but few prizes and unfortunately has no sinecures—which, however objectionable from an abstract point of view, are actually of the greatest service to many causes—chemistry has hitherto failed to attract much ability. Very many commence its study because they have an idea that chemists are always making interesting experiments of the firework order such as the conventional lecturer shows to a popular audience, and when the drudgery of actual practice is discovered by the young worker to be something very different from the rosy picture which such displays had excited in his mind, it often turns out that a mistake has been made in the choice of a career; such mistakes will occur less frequently when our schools are so conducted that we shall be able to find out what our boys and girls are fit for. Too often those who take up the study of chemistry are destitute of the mental ability required to comprehend so difficult and wide a subject, even if possessed of considerable manipulative skill; very many of these never can rise to the dignity of chemists, and it is clear that in the future some distinction must be made between cultured chemists and those who are but mere skilled workmen in some special branch of the subject; even "analyst" is too broad a term, in many cases; "tester" might, perhaps, be coined for the purpose. When we teachers are in a position to advise a parent that his son has not the making of a chemist in him, but that he would do well as a food tester, manure tester, or iron tester, for example—and the advice is understood and appreciated—we shall be relieved of much anxiety. We have to bear in mind Huxley's remark—that the future of the country depends, in industries as in everything else, on getting our capacities to the top and, if possible, sending our incapacities to the bottom. Infinite mischief has been done in this country by the intrusion into our industries of large numbers of men dubbed chemists, who have no right whatever to the name—from no fault of their own, but owing to their imperfect training, and more especially the ignorance of employers. Experience has shown only too fully that no one has derived any real advantage from this state of affairs. We may hope for better things in the future, especially if our colleges generally are led to impose an entrance examination. I am satisfied, from the experience that we have had at the City and Guilds of London Central Technical College, that it is of utmost importance that those who are to study chemistry should at least have acquired a sound elementary knowledge of mathematics; that those who prove to be satisfactory students of chemistry are almost invariably those who are fairly proficient in mathematics, and *vice versa*. "It is almost impossible to become a chemist in less than three or four years of constant application." (Author's preface to Lavoisier's "Elements of Chemistry," English translation by Kerr, 5th ed. 1802.) Such being the opinion nigh on a century ago, what must our view now be? And yet there is a strange illusion abroad that a *three years' course* suffices to make a lad who has had no previous training whatever in scientific method a "full blown" chemist, worthy of considerable hire! It is often heart-rending to the teacher to see lads of great promise forced out into the world, largely by this prejudice, just at the most critical period of their career, when they are on the very verge of acquiring real understanding of their subject, and of developing originality, as well as the power of working independently: abandoning their studies in this way, they too often degenerate into mere machines, capable of doing what they are told, but rarely more. And the manufacturer, who is too short-sighted to discriminate, then complains that he gets very little help from his "chemist," and seeks for a superior article abroad.

If we consider what a chemist, to be worthy of the name, must know in these days, it is clear that public opinion as to the duration and nature of his studies needs much emendation. He must be both artificer and artist. By constant practice and persevering application, he must acquire the manual dexterity, manipulative skill and neatness required of the analyst, while, at the same time, he must gradually become imbued with that high sense of accuracy, without which his labours will ever be untrustworthy; he must also acquire manipulative skill of an entirely different order by preparing a variety of typical substances, so that he may understand how to set to work when he subsequently engages in original labours involving the preparation both of materials already known and of new ones; and he must be practised in the more important methods of determining physical constants. While thus engaged in the laboratory, he must also be studying hard, constantly reading and *occasionally* attending lectures. To be a chemist it is necessary, moreover, to know much besides the practice and theory of chemistry proper: no slight amount of mathematical knowledge is also requisite for the proper understanding of the fundamental problems of our science, and no mere acquaintance with the first principles of physics, especially electricity, suffices; some acquaintance with biological science is indispensable, if we are to understand the manifold applications of our science in agriculture and in medicine, or are to assist in unfolding the nature of physiological processes generally; without some knowledge of mechanical drawing it is impossible to deal with machinery or to understand the language in which machinery is described; and it is necessary to read French and German fluently, the latter especially, in order merely to follow with intelligence what is being done by chemists. All this cannot be compressed into three years, and be it remembered I have said no word as to the necessity of every student who aspires to rank as a chemist undertaking some research work in order that he may acquire independence and the ability to solve problems and to progress.

So long as it is commonly supposed that it is but necessary to learn how to "analyse" in order to become a chemist, there will be but little progress; but when it is realised that chemistry is an exceedingly difficult subject to master, requiring a high order of intellect and breadth of mind, combined with extreme patience and perseverance and much mechanical dexterity, other views will prevail, and we may hope that we shall then count as of us very many who will rank high as artists and designers, and statesmen even—instead of being for the most part mere bricklayers, carpenters and joiners, capable only of working to order.

I have great hope that in the near future there will be many inducements held out to capable students to prolong their period of study to a satisfactory extent. At present, scholarships are mostly given to lads on their leaving school and commencing their technical training; the method by which such lads are selected is, in too many cases, an unsatisfactory one, the award being made on the result of an examination for which the candidates have been carefully prepared and crammed beforehand: the result too often affords but a proof of the power of lesson learning, and but little evidence of real ability. Serious injury is done at the Universities, owing to the stilted and artificial character of many of the college examinations, mere lads being required to answer questions of a highly technical character, far beyond the standard of school knowledge of the subject; those who are successful are more often than not overtrained—purely artificial products, whose mental digestion has been impaired, if not altogether ruined, by skilful tutors up to the tricks of the examiners. Such a system is partly responsible, also, for the growing practice of keeping lads at school—and even establishing "technical" sides for their special benefit—far beyond the age at which school should be quitted; such lads usually acquire bad habits during the last year or two of their school career, growing lazy; they are more often than not very poor material when they come to college; and in cases in which they are successfully pushed through public examinations, such as those of the London University, not having enjoyed the advantages of college life and instruction, they are too frequently but provided with a varnish of knowledge. However, it will probably be thought necessary to offer such entrance scholarships in order to attract ability, and they will be regarded with favour by schools as they obviously afford a means of advertising—in fact, they are used as such; it is, therefore, all the more important that the conditions under which they are awarded should be such as to favour rational methods of teaching and which as nearly as may be correspond with the natural conditions of school life; especially should we guard against encouraging the tendency which undoubtedly exists in schools to lavish attention on those of great promise at the expense of those of average ability. Genius will ever take advantage of opportunities, while necessarily it will benefit from careful training; but it may be overtrained and dulled, or made priggish by undue specialisation at too early an age. Yet to make changes is difficult, as there are so many rivals interested; and although the evils of our system are recognised, no one is willing to take the first step, fearing that this may entail individual sacrifice.

It has long been my opinion that scholarships would be of most use if given to those who have gone through a systematic course of training—lasting say about three years—and who are on the verge of learning to become capable independent workers; an additional two years spent in acquiring the power of undertaking investigations will render such students highly competent. But most parents can ill afford the necessary outlay, and it is astonishing how little at this stage lads themselves realise how extraordinarily important it is for them to continue their studies; that, in fact, they are worth very little to anybody. A limited number of such scholarships are available in some of our provincial colleges, and those given by the 1851 Exhibition Commissioners are also of this kind. In London, however, there has long been a strange deficiency in this respect, but I rejoice to say that this is on the eve of being remedied by the enlightened action of the Salters Company, by whom not only has a scholarship of £150 per annum been offered to my Institute for the encouragement of higher research in chemistry, but also one of £100 tenable in the research laboratory of the Pharmaceutical Society, as well as one of like amount to aid in the investigation of the more medical aspects of pharmacology, tenable in the school attached to St. Thomas's Hospital. The influence of the example thus set will, I trust, be widely felt—may our sore needs be met ere it is too late!

In my address at Aberdeen I dwelt much on the necessity of creating *an atmosphere of research in our colleges*, and to-day I am but repeating much that I said then; I regret to say that meanwhile no great progress has been made, although indications are not wanting that the foundation is being laid on which, if conditions become more favourable, we shall be able to build extensively. I venture to think that the time is come when we must appeal to our senior students to help us: hitherto the majority of these have gone to Germany to complete their education, Liebig's magnetic influence being in no wise exhausted—for it was he who gave direction to the stream which ever since has steadily flowed in one direction, and deep beyond description is the debt we owe to his memory in consequence. Time was when it was necessary to take passage on this stream, but this is no longer the case, or need not be if advanced students will but collect around us in sufficient numbers to enable us likewise to form schools of original workers—for we, like the ancient Egyptians, cannot make bricks without straw, and to be condemned always to teach the rudiments, more often than not to unwilling ears, takes the very life and soul out of those among us who by nature have any higher aspirations. There are undoubtedly advantages to be gained from a residence abroad—no one can recognise this more fully than I do; but I believe the case to be one of such gravity that some sacrifice must be made, and that if national interests are not to be put aside as of altogether secondary importance, individual preferences must, for a time at least, be subordinated to higher considerations. It is not accounted necessary in Germany to study abroad, and severance from apron strings is effected when desirable by visiting a university away from home. Why should not English students in like manner pass from college to college in this country, and thus help us to help them?

But we want help also from another quarter—or rather, let me say, that there is another section, and that a very large one, of the community *must help us* far more than they have hitherto done *to help them*; I mean *our manufacturers* generally. Let me remind you that the Chemical Society *was established for the general advancement of chemical science as intimately connected with the prosperity of the manufactures of the United Kingdom*: these very words form part of our charter. Yet to how small an extent is it recognised that chemistry is of service—that many of our manufactures, in the words of our charter, mainly depend upon the application of chemical principles and discoveries for their beneficial development? It is of no use to manufacture goods if you cannot sell them, and that is too often our position. Every teacher of any standing in Germany can count on placing his students so soon as he is in a position to state that they are fully capable and worth a trial; but here there is no such relationship established between the schools and the works; no proper opportunity is given to young men to prove their fitness for an industrial career. It is not even recognised that the discipline afforded by the study of our subject is an admirable preparation for an industrial career. Take the brewing industry, which in this country has availed itself far more than any other of our services—the brewer is called on to conduct operations involving chemical changes of a most complex and delicate character, subject to variation if the slightest departure be made from a very limited range of conditions, and this too with a material subject to constant fluctuation in composition and character, requiring the most vigilant and appreciative watching. Every brewer ought consequently to have received a chemical training: yet those who enter this industry are, with very rare exceptions, pitchforked into it as raw lads from school, without any preliminary training whatsoever, having received their position through the influence of a friend and from no merit of their own. The same might be said of the dyeing industry, of that of gas manufacture, and of many others. Some of you may have seen the list of subscriptions to the proposed Schorlemmer laboratory at the Owens College, Manchester, and may have marked with sorrow, as I have done, how few and small are the contributions from those connected with the local industries, and how large and numerous relatively are those from friends and admirers of the deceased chemist and from members of the college staff. Contrast with this the great number of subscriptions towards the erection of the Hofmann-Haus in Berlin. Although the comparison is not quite a fair one, perhaps, yet it illustrates my meaning, the reception accorded to the Manchester scheme being sufficiently indicative of the absence of appreciation of the real value of chemical science to industry in one of our chief industrial strongholds. . . .

The proposed Teaching University in London and the Commission on Secondary Education may help in an extraordinary degree to improve our position. But it is to be feared that our subject will not attain to its proper condition unless some action be taken which will consolidate the teaching—which will lead to the centralisation of students of chemistry proper, so they may enjoy the inestimable advantage of intercourse, and have at their disposal a complete staff of competent teachers, each one of whom thoroughly represents some special branch of the subject; so long as students are distributed about the town in half-dozens and each chief teacher is called on to cut himself up into any number of small pieces, so as to deal with the subject of chemistry as a whole, true higher teaching is impossible.

Much to be feared, also, is the tendency to over-estimate the value of examinations, and the great work of the future will be so to improve these that they shall have no prejudicial influence on the student's work and in no way check the development of original methods of teaching; we must fix our attention mainly on the influences to which the student is to be subjected during his career; the competent teacher will ever study his students while they are at work, and do the best for them, provided he be not rendered powerless by the trammels of an examination system which heeds "results" only and not individuals.

Finally, let me say that, while sympathising most fully with those who advocate a complete course of study, I feel that it is very easy to demand too much—very easy to make it impossible for students to do justice to their work by imposing too many subjects. Our chief desire must always be that students shall acquire a knowledge of scientific method and the power of working independently. Certain subjects must be insisted on—for example, mathematics and drawing: if a knowledge of these be not acquired early it will never be acquired; but apart from these and a competent knowledge of the main subject, we probably may, as a rule, be satisfied with comparatively little. Those who have once learnt to work and acquired a knowledge of scientific method will of their own accord, in proportion to their intelligence, apply themselves also to the study of other subjects—as many among us have done; those who are not sufficiently intelligent to do this are not, as a rule, improved by being forced to pay attention to unpalatable studies; on the contrary, they are, more often than not, thereby hindered from acquiring a competent knowledge of some one subject which does appeal to them, and are spoilt for life in consequence.

SCIENTIFIC SERIALS.

Bulletin de l'Académie Royale de Belgique, No. 4.—On the hydrates of the alkyl-amines, by Louis Henry. It has been known for some time that ammoniacal bases form compounds with water, a typical example being $2CH_2 . 2NH_2 . H_2O$, ethylenic diamine. Their properties have not yet been fully investigated. The author distinguishes between hydrates whose bases are soluble, and such whose bases are insoluble in water. He deals with methyl, ethyl, propyl, butyl, and amyl compounds, with the aromatic series, and with nitrites and amides. Their density increases with the percentage of water contained in them, even if the molecular weight diminishes. Their power of combining with water increases with their solubility and their richness in hydrogen, whether this be contained in the nitrogen radicle or the hydrocarbon.—On the creation of an International Bureau of Bibliography, by M. Mourlon. M. F. Vander Haeghen had proposed to the literature class of the Academy to initiate a movement for the compilation of a universal catalogue of public libraries. This proposal coincides with that for the establishment of a comprehensive and international catalogue of scientific papers, brought forward by the Royal Society. M. Mourlon proposed the deputation of three delegates to confer with the other two classes of the Academy with a view towards co-operation with the Royal Society.—On the aurora borealis observed at Louvain on March 30, 1894, by F. Terby. The author points out the recurrence of the monthly period previously observed in the appearances of February 28 and March 30.—Vascular hyphæ of the mycelium of the Autobasidiomycetes, by Ch. van Bambeke. The mycelium in question always contains vascular hyphæ, varying in number, distribution, dimensions, and form according to the species of mycelium. They are larger than ordinary hyphæ, and are usually cylindrical, with occasional fusiform or claviform extensions. They consist of a thin, extensible, and elastic envelope containing a substance which is usually homogeneous and highly refracting, but sometimes granular. They may be considered as a conducting apparatus playing an important part in the distribution of nutritive materials

Symons's Monthly Meteorological Magazine, June.—The May frost of 1894. M. Symons publishes minimum temperatures in the shade, obtained from forty-six counties in England and Wales, in which the thermometer fell below the freezing point between the 20th and 22nd May. In six counties minima of 25° or lower were recorded, while on the grass, readings of 18° in Nottingham, and 19 in Stafford were registered. The readings were not excessively low for May, which has always a cold period about the middle or latter part, for during a frost in May 1891 these low temperatures were exceeded by about 1°. Letters from correspondents show that the wide-spread disaster to vegetation was caused not so much by the lowness of the air temperature, as by the radiation, which was facilitated by the clearness of the sky, while owing to the mildness and dampness of the weather previously the vegetation was more forward and fuller of sap than usual, which froze and burst the cells by expansion. The frost was, as usual, most severe in the lowlands, near streams, and except in the north-east, where the temperature just touched 32°, none was recorded on the English sea-coast.

SOCIETIES AND ACADEMIES.

London.

Royal Society, May 31.—"Propagation of Magnetisation of Iron as affected by the Electric Currents in the Iron." By J. Hopkinson and E. Wilson.

Consider a solid, cylindrical electromagnet, it is well known that, in reversing the magnetising current, the induction does not instantly reverse, but a certain time elapses before it again attains its full value, that it reverses at a later time at the centre of the core than near its surface, and that the delay in reversal near the centre is due to the electric currents induced in the iron. The object of the present paper is to investigate these effects.

The magnet experimented upon had a diameter of 4 inches, and formed a closed magnetic circuit. Through a part of its length the cylinder of 4 inches diameter was formed of an iron core surrounded by two concentric, closely fitting tubes. Exploring coils of fine copper wire were bedded in the iron between the surfaces of the tubes. The currents induced in these exploring coils were observed when the current in the main coil of the magnet was reversed. These currents in some cases last for over half a minute.

Inferences can be drawn from these results as to the behaviour of other diameters than 4 inches. Comparing two cylinders of different diameters, similar events occur, but at times proportional to the squares of the diameters of the cylinders. From this consideration and the experiments, a judgment is formed as to the effects of local currents in the cores of transformers and of the armatures of dynamo machines.

June 14.—"The Effect of Mechanical Stress and of Magnetisation on the Physical Properties of Alloys of Iron and Nickel and of Manganese Steel." By Herbert Tomlinson, F.R.S.

Royal Meteorological Society, June 20.—Mr. R. Inwards, President, in the chair.—Mr. R. H. Scott, F.R.S., read a paper on fogs reported with strong winds during the fifteen years 1876–90 in the British isles. Out of a total of 135 fogs, 108 were associated with cyclonic, and twenty-seven with anticyclonic conditions. The majority of the fogs occurred with south-westerly winds and with temperatures very close to the maximum for the day.—Mr. R. H. Curtis read a paper on some characteristic features of gales and strong winds. After calling attention to the unsatisfactory state of anemometry, and after describing the "bridled" anemometer at Holyhead, Mr. Curtis stated that the greatest force of an individual gust which he had met with was registered in December 1891, and amounted to a rate of 111 miles per hour, which with the old factor would be equivalent to a rate of about 160 miles per hour. Gusts at a rate from 90 to 100 miles per hour have many times been recorded, but the usual limit for gusts may be taken to equal about 80 miles per hour, which on the old scale would be equivalent to about 120 miles per hour. Gales and strong winds differ in character very much; and as the result of a prolonged study of their general features, as recorded by the bridled anemometer, the author has been able to group them into three general classes. He then described those gales which are essentially squally in character, in which the gusts constitute the main feature of the gale. In an average gale the ordinary gusts follow each other at intervals of about ten to twenty seconds, while the extreme gusts occur at the rate of about one per minute. Another class of gales are those in which the velocity of the wind is tolerably steady. In the third class are gales which appear to be made up of two series of rapidly succeeding squalls: the one series at a comparatively low rate of velocity, the other at a much higher one, the wind-force shifting rapidly, and very frequently from one series to the other. Mr. Curtis also stated that, on looking carefully over the anemometer records, he had not unfrequently found very distinctly marked a prolonged pulsation in the wind-force, which recurs again and again with more or less regularity, of perhaps twenty minutes or half an hour in some cases, and in others at longer intervals of about an hour, more or less.

Physical Society, June 8.—Prof. A. W. Rücker, F.R.S., President, in the chair. Prof. Ramsay, in opening the discussion on experiments on the relations of pressure, volume, and temperature of rarefied gases, by Mr. E. C. C. Baly and himself, recapitulated the chief points in the paper. Siljeström, in 1873, and Mendeléef, in 1875, he said, had both found that gases become less compressible than Boyle's law would give, as rarefaction proceeds. Amagat, in 1883, examined the subject, and concluded it was impossible to make measurements sufficiently accurate to decide the question one way or the other. In 1886 Bohr investigated the compressibility of oxygen, and found its behaviour abnormal about 0·7 m.m. pressure. Van der Wen's experiments (1889) led him to conclusions opposite to those of Siljeström and Mendeléef, and those of Melander (1892) gave support to Van der Wen's results. To decide the question at issue the authors took up the subject, and their results confirm the conclusions of Siljeström and Mendeléef. They also prove that oxygen behaves abnormally about 0·75 m.m., as found by Bohr. Prof. Perry said some of the terms used in the paper required alteration. The word "elasticity" was employed in several senses; sometimes being used to denote "pv," the product of pressure and volume, whilst at others its ordinary meaning was intended. He did not quite understand the connection between pv and the thermal expansion, to which the authors refer at the end of their paper. Taking Ostwald's equation for gases $(p + a)v = Rt$, he proceeded to show that the coefficient of expansion would be constant whether pv was constant or not. Dr. Burton said he had been accustomed to think as pressure was reduced gases approached the simple or "perfect" state. It was very desirable that similar experiments be made on other gases, to ascertain if any had constant coefficients of expansion. He failed to see why the internal energy should increase as the pressure decreases, unless, under these conditions, energy travels more by radiation than by conduction or convection. The President, speaking of the adhesion of gases to the surface of glass, suggested experiments on the effects produced by varying the ratio of the surface to the volume of the gas. On the subject of distribution of energy he was inclined to agree with Dr. Burton's view, rather than with the author's suggestion. One would not be led by *à priori* reasoning to expect that the internal energy would increase with decrease of pressure. Prof. Ramsay, in reply, said that in the experiments on oxygen at about 0·75 m.m. pressure, the greater part of the gas was sometimes found in one McLeod gauge and sometimes in the other. Only after standing seventy-eight hours did the quantities trapped in the two gauges become equal. The only explanation they could think of was that the temperatures of the gauges might not have been absolutely the same. Speaking of the suggested increase of internal energy with decrease of pressure, he said Prof. Dewar's experiments tend to show that there was little conduction through vacuous spaces. The President thought Dr. Bottomley's researches had shown that radiation also falls off rapidly as the pressures become very small.—Owing to the absence of Captain Abney, the exhibition of photographs of flames, which had been announced, was postponed. A paper on the isothermals of ether was read by Mr. Rose Innes. Taking the important linear law $p = bT - a$ connecting the pressure and temperature of substances (liquid and gaseous) at constant volume, given by Ramsay and Young (*Phil. Mag.* vol. xxiii. p. 436), and subsequently confirmed by Amagat and Tait, the author has endeavoured to express the constants b and a in terms of the volume v. Using the results of Ramsay and Young's experiments on ether, because they extended over a large range of volume (1·9 to 300), the following formulæ were found to give the best approximation, viz.

$$b = \frac{751 \cdot 9}{v - 0 \cdot 9173\, v^{\frac{2}{3}}} \quad \text{and} \quad a = \frac{23{,}300{,}000}{v^2 + 11 \cdot 05\, v^{\frac{5}{3}}}$$

Tables and curves accompany the paper showing that for volumes between 6 and 300 the agreement of calculated and observed values of p do not differ more than can be accounted for by errors of experiment. For volumes less than 5 the formula for p gives numbers quite wrong. In searching for a physical basis for the expressions for b and a the author puts l^3 for v in the above formula, l being the side of a cube whose volume is v. The expression for p then becomes

$$p = \frac{RT}{l^3 - cl^2} - \frac{A}{l^6 + kl^5} \quad \dots \quad (3)$$

Writing the coefficient of T in the form $\frac{R}{l^3} \cdot \frac{l}{l - c}$, the author goes on to show that this form might be expected if the molecules had finite dimensions, for the number of impacts on the faces of a cube would be increased in the ratio $\frac{l}{l - c}$, where c is a quantity depending on the size of the molecules. Ingenious arguments suggested by Van der Waal's remark that his formula must not be pushed beyond the point where the actual volume is less than eight times the volume of the molecules, lead the author to infer that for ether this limiting volume is somewhat above 6. Hence he would not expect his (Mr. Rose Innes) formula to hold below this volume. The formula for a, the "internal pressure," is explained on the supposition that a "skin" effect exists between the matter in the vessel and the boundary layers. By clearing expression (3) of fractions the author shows that the shape of the isothermals are represented by an equation of the seventh degree in l, which cannot have more than three positive roots, and thence infers that isothermals are not necessarily represented by cubic equations, as is sometimes assumed. Prof. Ramsay said Mr. Rose Innes' formula was much more satisfactory than that of Van der Waal's, which was at best only a rough approximation. The President objected to the use made of the word "discontinuity" in the paper, as being quite different to its precise mathematical meaning. He also pointed out that the author's arguments respecting the effect of finite molecular dimensions was much less general than that of Van der Waal's. Although the new formula agreed with experiment over a longer range of volume than that of Van der Waal's, it would not be safe to argue beyond the range of the experiments it represented.

Paris.

Academy of Sciences, June 18.—M. Lœwy in the chair.—On the satellite of Neptune, by M. F. Tisserand.—The principle of maximum work and entropy, by M. Berthelot. A general discussion of the theory of maximum work, treated under the heads—(1) Chemical action and the disengagement of heat; (2) the principle of maximum work; (3) entropy; (4) a comparison of the consequences of the principle of maximum work and those of entropy.—Note on *Phyllium pulchrifolium*, by M. Sappey. The author shows that *Phyllium pulchrifolium* exhibits only a superficial resemblance to leaves, and is a true insect in all essential particulars.—On the *Dyrosaurus thevestensi*, by M. A. Pomel. This fossil reptile is the same as that described by M. Phil. Thomas as *Crocodilus phosphaticus*. It is not a crocodile, and should perhaps be termed *Dyrosaurus phosphaticus*.—On the astronomical observations made at Abastouman by M. de Glasenapp, director of the St. Petersburg Imperial Observatory, by M. Lœwy.—A memoir was presented on a theoretical study of the elasticity of metals, by M. Felix Lucas.—Solar observations made during the first quarter of the year 1894, by M. P. Tacchini. A progressive diminution in spots and faculæ has been recorded.—Researches on continued fractions, by M. Stieltjes.—On four connected solutions of the problem of transformation relative to the elliptic function of the third order, by M. F. de Salvert.—The expression of the number of classes deduced from the transformation of elliptic functions, by P. de Seguier.—On the surfaces capable of forming, by a helicoidal displacement, a *famille de Lamé*, by M. Albert Petot.—On a system of chromato-diatonic gamuts, by M. Edmond de Polignac.—The detection of traces of chlorine, by MM. A. Villiers and M. Fayolle. The chlorine is liberated by permanganate in presence of sulphuric acid, and shows, even in small traces, a blue colouration becoming red violet when treated with the following reagent in excess: saturated aqueous solution of colourless aniline 100 cc., saturated aqueous solution of orthotoluidine 20 cc., and glacial acetic acid 30 cc.—On the emetics, by M. E. Maumené.—Preliminary notice on a meteorite of a type distinct from the ordinary stony meteorites, by M. G. Hinrichs.—On the influence of fluorine compounds on beer ferments, by M. J. Effront. It is shown that ferments which have gradually become inured to the action of fluorine compounds give more alcohol and less glycerine and succinic acid than ordinary yeast from a given quantity of glucose.—Anatomy of the digestive tube of Hymenoptera, by M. Bordas.—On the presence of a thread cell in the spores of Microsporidiæ, by M. P. Thélohan. The author concludes that the Microsporidiæ should belong to the group of the Myxosporidiæ, as their spores present the same characteristics.—On the structure of the plants of Spitzbergen and of the island of Jan Maven, by M. Gaston Bonnier. The following conclusions have been formulated:—(1) Arctic plants as compared with Alpine plants of the same species are thicker and present a differentiated structure, and contain more numerous lacunæ; (2) the greater humidity of the air and the different character of the light play the principal part in this adaptation of Arctic plants.—The *gommose bacillaire* of vines, by MM. Prillieux and Delacroix. On the presence of remains of Foraminifera in pre-Cambrian rocks of Brittany, by M. L. Cayeux.—Impermeability of healthy epithelium to drugs and poisons, by MM. Boyer and L. Guinard.—Regulation of thermogenesis by the cutaneous action of certain alkaloids, by MM. L. Guinard and Geley.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—A Text Book of Ore and Stone-Mining: Dr. C. le Neve Foster (Griffin).—A Hand-book to the Flora of Ceylon: Dr. H. Trimen, Parts 1 and 2 and Plates (Dulau).—Practical Photo-Micrography: A. Pringle (Iliffe).—Travels amongst American Indians: Vice-Admiral L. Brine (S. Low).—Aspects of Modern Study (Macmillan).—Beginner's Guide to Photography, fifth edition (Perken).—Bodenphysikalische und Meteorologische Beobachtungen mit besonderer berücksichtigung des Nachtfrostphänomens: T. Homen (Berlin, Mayer).—Travels in a Tree-top: C. Abbott (Matthews).—The Tidal Streams of the North Sea: F. H. Collins (Potter).—A Monograph of the Bats of North America: Dr. H. Allen (Washington). Bulletin of the U.S. Fish Commission, Vol. xi. (Washington).

Pamphlets.—The Calming of Waves: Dr. M. M. Richter, translated (Hamburg, Porges).—On Blinding of the Retina by Direct Sunlight: Dr. G. Mackay (Churchill).—Johns Hopkins University of Baltimore Register for 1893-4 (Baltimore).—Carolina Pirates and Colonial Commerce, 1670-1740: S. C. Hughson (Baltimore).

Serials.—Sitzungsberichte der Physikalisch-Medicinischen Societät in Erlangen, 25 Heft, 1893 (Erlangen).—*Zeitschrift für Wissenschaftliche Zoologie*, lvii. Band, 4 Heft (Leipzig, Engelmann).—Seances de la Société Française de Physique, July-December, 1893 (Paris).—Proceedings of the Liverpool Naturalists' Field Club, 1893 (Liverpool).—Economic Journal, June (Macmillan).—Good Words, July (Isbister).—Sunday Magazine, July (Isbister).—Longman's Magazine July (Longmans).—Bulletins de la Société d'Anthropologie de Paris, Avril (Paris).—Journal of the Royal Microscopical Society, June (Williams and Norgate).—Transactions of the Royal Irish Academy, Vol. xxx. Part xi.: On the Geology of Torres Straits: Profs. Haddon, Sollas, and Cole (Dublin).—Ditto, Vol. xxx Part xii: On the Volcanic District of Carlingford and Slieve Gullion, Part I.: Prof. Sollas (Dublin).—Proceedings of the American Philosophical Society, January (Philadelphia).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1893, Part 3 (Philadelphia).—Journal of the Academy of Natural Sciences of Philadelphia, 2nd series, Vol. x. Part 1 (Philadelphia).

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THURSDAY, JULY 5, 1894.

A LABORATORY FOR PHYSICAL AND CHEMICAL RESEARCH.

IT is now about twenty years since the Duke of Devonshire's Commission pointed out that the needs of chemical and physical investigators, upon whose work our national industries so largely depend, were entirely neglected by the Government. Money has been freely lavished that artists may have all they require; biology and archæology have been well equipped, and students of literature have been provided with the finest library in the world; but such is the chaos and disorganisation of our scientific system that many industries are languishing, and some have already left the country because those who are able to foster them by making new discoveries find absolutely no help, and have neither places to work in nor instruments to use, although the sum which the Government has not hesitated to give for one picture would have been more than is needed to correct a condition which is really disastrous from the national point of view.

We rejoice to learn that this state of things, so little to the credit of successive ministries, is now to be partially corrected by the munificence of an individual, Dr. Ludwig Mond, one who, though not an Englishman by birth, has already aided English science by large endowments in other directions.

We learn from a communication which we have received from the Royal Institution, that Mr. Mond last year bought the large freehold house, No. 20 Albemarle Street, contiguous to the Royal Institution, and formerly the residence of the Earl of Albemarle, and has resolved to convey it in fee simple to the Royal Institution. He further proposes to defray the whole expense of converting it from its present uses into a laboratory of chemical and physical research, to be called the Davy-Faraday Research Laboratory, and of equipping it with everything needful for the conducting of scientific research upon a large scale. In addition to this, he proposes to endow the new laboratory first with an income sufficient to defray all local expenses; and, secondly, with a further and of course much larger income, sufficient to pay the salaries and incidental expenses of a trained scientific staff.

Mr. Mond thus realises an idea which engaged the attention of Faraday and Brande and the managers of the Royal Institution half a century ago. In the year 1843 a proposal was made to establish at the Royal Institution a school of practical chemistry, which was not only to give practical and systematic instruction to students, *but was also to provide a place where original researches could be conducted by individuals skilled in manipulation, and where the professors could work out their problems by the aid of many qualified hands.*

In a letter addressed to the managers of the Royal Institution, Mr. Mond writes:—

"I have felt that the need for such a laboratory has become greater and greater since the work of the scientific investigator has become more and more subtle and exact, and, in consequence, requires instruments of precision and a variety of facilities which a private laboratory can only very rarely command; and surely this need exists nowhere to a greater extent than in England, and nowhere can such a laboratory be expected to bear more abundant fruit than in this country, which possesses such an unrivalled record of great scientific researches, which have emanated from private laboratories not connected with teaching institutions, and amongst which the laboratory of the Royal Institution stands foremost, and has kept up its reputation for nearly a hundred years.

"It has been my desire for many years to found a public laboratory which is to give to the devotees of pure science, anxious and willing to follow in the footsteps of the illustrious men who have built up the proud edifice of modern science, the facilities necessary for research in chemistry, and more particularly in that branch of the science called physical chemistry.

"I have come to the same conclusion as the promoters of the scheme of 1843, viz. that such laboratory would still have the greatest prospect of success under the ægis of the Royal Institution, that in fact it would be the consummation of the work which this great Institution has been fostering in its own laboratory, with such remarkable results, by the aid of the eminent men whose services it has always been fortunate enough to procure.

"As only want of space prevented the Royal Institution undertaking this task fifty years ago, I took the opportunity which offered itself last year of acquiring the premises, No. 20 Albemarle Street, adjoining the Institution. This property I found very suitable for the purposes of such a laboratory, and large enough to afford, besides, facilities to the Royal Institution for a much needed enlargement of its present laboratory and its libraries and reception rooms, which I should with great pleasure put at the disposal of the Institution.

"Being convinced that the managers of the Royal Institution will give all the encouragement and aid in their power in the foundation and working of such a research laboratory, I hereby offer to convey to the Royal Institution the freehold of No. 20 Albemarle Street, and also the lease I hold from the Institution of premises contiguous thereto, to be held by them for the purpose of a laboratory, to be named 'The Davy-Faraday Research Laboratory of the Royal Institution,' and also for the purpose of providing increased accommodation for the general purposes of the Royal Institution, as far as the available space will allow, after providing for the requirements of the research laboratory.

"I also offer to make, at my own expense, all structural alterations necessary to fit the premises for these purposes, and to equip the Davy-Faraday Research Laboratory with the necessary apparatus, appliances, &c., and to make such further adequate provision as will hold the Royal Institution free from all expense in connection with the premises and the working of the said laboratory. . . . .

"I am aware that my offer will not provide for the third object of the scheme of 1843, viz. to enable the professors to work out their problems by the aid of many qualified hands; but I trust that if the laboratory which I offer to found proves successful, others will come forward who will supply the means for attaining this end, by the foundation of scholarships and bursaries to qualified persons willing to devote themselves to scientific work and not in a position to do so without assistance."

It is almost impossible to overrate the importance of the results which may be expected to naturally follow this noble endowment. The new Institute will not fill the gap to which we have previously referred, but it will emphasize its existence. It will not fill it because we suppose that when it is in full work it will not hold as many workers as are to be found in some of the research laboratories which form an integral part of many industrial establishments on the continent.

Further, here at last we have from one who is both a practical man of affairs and a successful student of science, a distinct endowment of research such as was advocated now many years ago to deaf ears.

We believe that Dr. Mond's noble endowment, for which all true lovers of science must thank him, will have far-reaching effects.

THE HISTOLOGICAL INVESTIGATION OF DISEASE.

Methods of Pathological Histology. By C. von Kahlden. Translated and edited by H. Morley Fletcher, M.D. With an introduction by G. Sims Woodhead, M.D. (London: Macmillan, 1894.)

HISTOLOGICAL methods have become so perfected during recent years that we are apt to forget that there was an age of discovery when microtomes, special dyes, celloidin and paraffin were unknown. In the days of Max Schultze, of Schwann and Virchow, tissues were cut free-hand with an ordinary razor; for the purpose of embedding, pieces of carrot and liver were used, and stains were not dreamt of. Solutions of salt, acetic and mineral acids and iodine were the only reagents employed, and gradually carmine came in use. Yet that age turned out its heroes in such men as von Bäer, Remak, Schwann, Max Schultze, Johannes Muller and Virchow, who with tools and media which we are unable to use now, observed appearances and processes which have remained the corner-stones of normal and morbid histology. We are apt to forget their deeds as being antiquated. Gradually stains were introduced, and these led to fresh discoveries. Dr. Klein's work on histology, begun in Stricker's laboratory, is a permanent testimony of what a practised hand can do without our modern microtomes, embedding methods, and multitude of stains. Hæmatoxyline and carmine were the only dyes used. Since then various kinds of microtomes, simple and complicated, have been designed, and every laboratory possesses apparatus for cutting in paraffin, celloidin or ice, and instead of two simple stains, almost numberless reagents are a necessity for the modern worker.

On reading Dr. Morley Fletcher's edition of von Kahlden's book on "Methods of Pathological Histology," we cannot help being struck with the great strides made in histological *technique*. While fully acknowledging the brilliant work of our predecessors, and even regretting that the simpler methods of examination of unstained tissues have practically been forgotten, we feel that every histologist, however modest, should make himself acquainted with the *ars technica* of microtomy. With simple methods it is possible only to study simple processes, and these often with difficulty. The minute structure of the nervous tissues in health or disease, the pathological changes of the blood or of infective lesions, can only be approached, if the necessary staining methods have been fully mastered. Stains are chemical reagents, and their action must be properly appreciated. There exists in our midst a large number of "histologists" who have accustomed themselves to one stain, and whatever comes into their hands is treated in the same manner, and they even acknowledge their inability of recognising tissues or lesions stained in any other way. Carmine specimens often trouble those who have become the slaves of hæmatoxyline. We cannot sympathise with them; their methods are at fault, and they have not appreciated the value and *raison d'être* of staining. Many great and important discoveries have been made by morbid histologists such as Weigert, Ehrlich, and others, by methods which at first sight appear to be empirical, but are based on sound chemical principles, discoveries which have proved as useful to the physiologist and anatomist as to the pathologist. It is von Kahlden's merit to have collected the most important histological methods, previously scattered and hidden away in archives and journals, and thus to have made them more accessible; and we are indebted to Dr. Morley Fletcher for having given us a readable English translation of a work which rightly enjoys great popularity abroad.

The few critical remarks which we shall make apply chiefly to the German original. The methods of embedding in paraffin and celloidin, and of preparing sections by means of freezing, are well described, and if to some the hints given appear incomplete, it should be remembered that as the work is meant to be a guide for the pathologist, some knowledge of histological methods may reasonably be assumed to exist. The Cambridge rocking microtome was deserving of more than a short reference, at least in an English edition, for with us paraffin is much more *en vogue* for delicate work than celloidin. A few notes might have been added stating for what tissues and stains each embedding method should be used, for the inexperienced have generally difficulties in deciding how to proceed with tissues supplied to them for examination. For the staining of bacteria in tissues, for instance, the paraffin method is the only satisfactory one. The "metal lifter" is a piece of rough apparatus we object to, and recommend a strip of cigarette paper as being the most delicate carrier for transferring sections from water or clearing medium to the slide. Under "double staining" no allusion is made to acid fuchsine, a most selective and beautiful stain. We have little to add to the section on bacterial staining, but venture to offer an important suggestion. When examining for bacteria in albuminous or gelatinous media, it is advisable to remove the ground substance by means of acetic acid. From personal experience we do not agree that Gabbet's method is the best for the detection of tubercle bacilli in sputum. Ziehl's and Van Ketel's methods are far more certain. In the latter the bacteria are previously treated with carbolic acid, which destroys them, so that there is no danger of disseminating infective matter, while at the same time the staining power of the micro-organisms is greatly increased. Carbolic acid should be added to all microbic material, so as to avoid all possible risk of infection. Moreover, treated in this manner any material may be kept indefinitely for histological examination.

The chapter on blood examination is excellent, and must prove extremely useful also to the physician. The systematic study of the blood at the bedside is still too much neglected in this country, though in cases of anæmia it is of the utmost importance, and without a complete knowledge of the same, a certain diagnosis is often impossible. For this reason we should have liked to see a fuller account of the methods of examining blood for the *plasmodium malariæ*, for we feel certain that the inexperienced would not succeed with the meagre instructions given on page 109. The foot-note on page 115 is not clear, if correct. For purposes of simple diagnosis cover-glass preparations of blood should be stained "with a solution of alcohol-soluble eosine (·5 gramme in 100 cc. of 50 per cent. alcohol)," and not "with a 50 per cent. alcoholic solution of eosine," which would overstain everything. The summary of the methods used for the histological examination of the nervous system is perhaps the best part of the book.

So far our remarks apply to the work of von Kahlden. Dr. Morley Fletcher as translator and editor has done his share creditably. The editorial notes on the whole will be found useful, and in future editions we would suggest to raise them from their position at the foot of the page, and incorporate them with the text, at the same time adding others, so as to render the book entirely in keeping with English histological teaching. The idea of a book for the pathologist is so good that it should stimulate the editor to perfect it, all the more as there is no other work in the English language which serves the same purpose. Dr. Sims Woodhead's well-known manual will always remain a favourite book with the ordinary student, but as a compendium of descriptive morbid histology rather than a laboratory guide.

A. A. KANTHACK.

NATAL ASTROLOGY.

A Treatise of Natal Astrology. By G. Wilde and J. Dodson. To which is appended "The Soul and the Stars." By A. G. Trench. (Halifax, Yorks: The Occult Book Company, 1892.)

THREE authors have therefore combined to produce this work; and to accept a brief, either on behalf of, or in opposition to, a work exhibiting so much erudition, is to undertake a heavy responsibility. The peculiarity of your astrologer is that he is so heartily in earnest. He, with a faith that no disaster can overturn or contradiction disturb, believes his results are as certain and as unquestionable as the astronomy on which he relies for his calculations and configurations. He, worthy man, asks to be taken seriously, and society as a rule declines to accept his deductions and explanations otherwise than as literary curiosities. But his day of triumph and reward may be approaching, for in the preface it is distinctly asserted that the production (and presumably the sale) of this kind of literature is on the increase. This is curious, if it be true. What have the promoters of primary education and the machinery of the School Board to say to the assertion that "the literature of astrology is to-day more perused than that of any other natural science"? The authors cannot be angry with anyone for saying that such an assertion is as true as that the positions of the planets and luminaries decide the health of a person (p. 86).

It is only honest to confess our inability to do justice to the aims and ambitions of those who read the future in the skies. We need an exponent on whom the mantle of the late Prof. De Morgan has fallen. Of men who have enjoyed a reputation for sound mathematical knowledge, he is the only one, that occurs to us at the present moment, who has found leisure or inducement to make a serious study of the peculiar tenets of the astrologer. And after an examination, which was no doubt thorough and exhaustive, it is believed that he decided that there was no ground for the conclusions drawn by the students of horoscopes, a decision to the truth of which many will subscribe, who have not the same means and the same knowledge to guide them. But we have been told, and let us hasten to add the fact for the satisfaction of the votaries to this "science," that he did not pronounce this sentence till after three months' study. If three months were necessary to convince a De Morgan of the uselessness of further prosecution of this occult inquiry, it need be no wonder that a much longer period, embracing possibly a whole life-time, is in some cases necessary before a less cultivated and less gifted man can escape from the ensnaring meshes of a fascinating delusion. The authors of this book have not yet issued from the realms of darkness and recognised the inquiry as a curious, it may be an absorbing, but certainly a misleading study. Nor are they likely to gain enlightenment, for their methods of inquiry and examination are imperfect and deceptive. Their process seems to consist in the examination of many cases, and the exhibition of those which favour, or seem to favour, the conclusions drawn from the horoscope. The story of Dryden's sons is served up for our edification, and a tale is told of a gentleman who married at the age of fifty and went to Italy, which it is thought by the authors ought to carry conviction to the unconverted. How many men in a year do marry at fifty and go to Italy for a honeymoon? But averages or coincidences are alike disregarded by the student of horoscopes. "The successes of a science," say they, "establish it, while the failures cannot disprove it. The practice of medicine is recognised because of its successes, and not rejected because of its failures." This is a very curious remark, and apparently an oversight by the authors. What success or what failure can there be for medical science when men's health and condition are regulated by the position of the stars and planets?

But apart from the question of the usefulness or the worth of astrology, about which the authors wax eloquent, and with whom of course it is absolutely useless to argue, they have produced a book not without interest. Astrology is a study which has occupied men's minds for many ages, much time and ingenuity have been devoted to it, and the student of science or of human nature might very well like to know what were the methods by which these men worked, what was the character or the measure of the success that supported them in their labours, and urged them on, in days when planetary ephemerides did not exist and astronomical calculation must have been difficult. Kepler is perfectly frank about his horoscopes—he worked them for his daily bread, and despised himself for doing it; but others certainly looked for success, undaunted by disappointment and failure. "Horoscopes," and "cusps," and "houses," and "malefics," and what not, constitute a jargon that many an one might like to have explained and to know something about, without pledging himself to the accuracy of the conclusions which the experts draw. In this book he will find the definitions and the grammar of the subject lucidly explained, and if he be at all familiar with the use of planetary tables and understand that much ridiculed but nevertheless valuable science "the use of the globes," he will be able to construct, or rather to erect, a horoscope with certainty, and perhaps edification. Naturally, I have experimented in my own case, but I cannot say that the result has thrown a great deal of light, either on my character, my circumstances, or my future condition, on all points of which I expected information. But I have learnt one caution, that it is not desirable to operate on anyone, in whom we may be interested, indiscriminately, because the result may not be flattering, but is apt to be even disagreeable. A cynic might suggest that since there are more failures than successes in the world, it is necessary to connect a preponderance of gloom and disappointment with planetary configuration. It seems especially that Uranus is responsible for much that could easily be dispensed with, and one cannot help congratulating those who lived before his presence and influence were discovered. But if this is our flippant view, the authors, on the other hand, regret that the older astrologers were without the guidance that a knowledge of the motions of Uranus and Neptune could have afforded, and recognise the possible existence of yet unknown planets, that not only shape our destinies but also disturb the accuracy of astrological prediction. There is, however, no hint that the theoretical determination of horoscopes compared with the observed facts of individual life will in time lead to the assignment of the position of a hypothetical planet, as the perturbations of Uranus revealed Neptune.

Not a small portion of the book is taken up with the description of the horoscopes of distinguished men. How far they support the contention of the authors, and can be quoted as successes in astrological inquiry, must be left to a closer student of them and of history than I can claim to be. Mr. Gladstone, it seems, was so indiscreet as to admit that he was born about breakfast time. That might seem a sufficiently vague indication in these days, but, nevertheless, his horoscope appears in this gallery; but whether his admirers or his opponents will best agree with the estimate of character drawn, is a matter of doubt. We are sure only a few will see that the fact that the tail of Capricorn, said to bring danger from beasts, conjoined with Mars, affords an explanation of the "historic attack upon Mr. Gladstone by a cow." The incident of the ginger-bread-nut is apparently still unexplained.

The book concludes with a reprint from the *University Magazine* of 1880, of Mr. Trent's paper on "The Soul and the Stars." We are told in the introduction that the original grew out of a controversy on the topic of reincarnation, forsooth, and further that it is commended to the reader's indulgence as an honest attempt to elucidate a subject which ninety-nine out of a hundred understand just sufficiently to misunderstand. Having no claims to be the hundredth man, we must leave this honest attempt with a simple reference for the benefit of those who are interested in the subject.

W. E. P.

NAVAL ENGINEERING.

Elementary Lessons in Steam Machinery and the Marine Steam Engine. By Staff-Engineer J. Langmaid, R.N., and Engineer H. Gaisford, R.N. (London: Macmillan and Co., 1893.)

THIS work consists of a series of elementary lessons in steam machinery, and a short description of the construction of a battle-ship, intended for the use of junior students, and especially for the naval cadets in H.M.S. *Britannia.* The syllabus of subjects is based on the plan adopted by the Science and Art Department.

The first lesson relates to exact measurements, by the use of standard rules and gauges; the meaning of strain, stress and strength, factor of safety, &c.; the second and third upon the metals used in machinery and ship construction; the fourth and fifth upon rivets and rivetted joints, and various kinds of screws; the sixth, seventh, and eighth upon shafting, shaft-bearings, and toothed gearing; the ninth upon friction; the tenth, eleventh, and twelfth upon stuffing-boxes, packing, pipe-joints, valves, cocks, and pumps; the thirteenth to the eighteenth upon boilers and boiler mountings; and the nineteenth to the twenty-fourth upon the principal component parts of the marine engine, the indicator and indicator diagrams, and screw propellers. The last one contains a short description of the construction of a battle-ship.

These lessons appear well adapted for imparting to junior students a simple course of instruction, as a preliminary to a thorough study of marine engineering, which is the object the authors had in view. They are illustrated by well-executed and instructive sectional drawings of boilers and marine engines, and with sketches of many of the principal details of boiler and engine work. These include a very useful sketch, for a young student, of a section of cylinder, with movable piston and slide valve. There are also two very clear views of the triple-expansion engines fitted to H.M.S. *Sappho* and *Scylla*, which are representative of a large number of engines in the Navy, these ships being two out of a class of twenty-nine that have been recently built under the Naval Defence Act of 1889.

The terms strain and stress might be dealt with more accurately than is done on pages 8 and 9. Strain is defined as change of form due to load, and stress as the force or forces producing the strain. Tensile strain is then described as "a *stress* that tends to stretch the body acted upon"; and we find the various kinds of stress described as follows: Tensile *strain*, compressive *stress*, torsional or twisting *force*, bending *force*, and shearing *force*. The want of exactness in the use of these terms might easily be corrected. We observe that the thicknesses of the shell-plates of large marine boilers are stated to be 1 in. to 1¼ ins. In the largest marine boilers, however, the shell-plating exceeds 1½ ins.

The description of the construction of a battle-ship is very brief and general, but it serves at least to call attention to a very useful "Text-book of Naval Architecture" by Mr. J. J. Welch, formerly instructor at the Royal Naval College. In speaking of the division of a battle-ship into water-tight compartments, it is stated that "the total number of water-tight compartments is considerably over one hundred; several of them might fill without affecting the safety of the ship, provided they were not so situated as to cause the ends to be submerged, or the ship to capsize." It is surely, however, the object of the naval constructor to obtain such a relation between water-tight subdivision and the stability of a ship, both transverse and longitudinal, as would prevent capsizing, or going down head or stern first, if a few small compartments were filled wherever these might be situated. With regard to bilge keels, also, it is stated that they are generally fitted for about two-thirds of the length of a ship. The usual length is, however, from one-third to one-half.

It might appear hypercritical to call attention to such points as the above when dealing with a work that is so well adapted for the elementary purposes which the authors designed it to serve; especially as these do not affect the principal lessons that deal with those mechanical details and elements of construction that junior students require to be instructed upon. We can recommend the book to the diligent attention of those for whom it has been prepared.

OUR BOOK SHELF.

The Yoruba-speaking Peoples of the Slave Coast of West Africa; their Religion, Manners, Customs, Laws, Language, &c. With an appendix containing a comparison of the Tshi, Ga, Ewe, and Yoruba Languages. By A. B. Ellis. (London: Chapman and Hall, 1894.)

THE late Colonel Ellis, whose death was almost simultaneous with the publication of this book, had devoted long and earnest attention to the study of the West African tribes, amongst which his military duties led him. This volume completes and brings into focus his life-work. Like the previous volumes on the Tshi- and the Ewe-speaking peoples, it is a contribution to anthropology of the very highest order, combining the enthusiasm of a student and the literary power of a cultured scholar with the simple and unobtrusive directness of the soldier. Colonel Ellis touches no controversy, and records, with no more commentary than is necessary to do justice to the narrative, the facts of his own observation. The book begins with an excellent geographical and historical summary of the Yoruba country and people, goes on to consider their deities, priests and superstitions, and the laws and customs which prevail, and concludes with the citation of 250 Yoruba proverbs, many of them worthy mates of those of Solomon, and a series of folk-lore tales, in which we see the origin of many of "Uncle Remus's" best stories.

As the Tshi tribes represented the lowest stage of primitive culture, the Yoruba represent the highest, having fairly emerged from animism into polytheism. The similarities in their mythology to that of the Greeks, and in their customs to those of the early Hebrews, are in many instances remarkably close. In municipal government they show considerable enlightenment, having a female functionary, the "Mistress of the Streets," to deal with all disputes between women, only those which she is unable to settle being passed on to the *Bale* or civil governor. They are observant of the phenomena of nature, calling Sirius the canoe star, as it is believed to be a guide to canoe-men. The Milky Way is called "the group of chickens," the clearer stars being the hens; while Venus, according to the position in which it appears, is known as the morning or evening star, or when near the moon as "the moon's dog." The Yoruba calendar is based on the lunar month, and it is interesting to note that while the Tshi- and Ga-speaking people divide this period into four weeks of seven days with some odd hours, the Yorubas count six weeks of five days minus a few hours. All the tribes commence the reckoning of the day with the evening, the first day of each month being reckoned from the appearance of the new moon. The first day of each group of five is held as a day of rest, and looked upon as generally unlucky; but the follower of each of the recognised gods must observe another day of rest also, on which those not worshipping the same deity are at liberty to work.

The appendix to the book is an elaborate philological treatise in the form of a comparison of the grammar and vocabularies of all those West African languages which Colonel Ellis had minutely studied.

A Handbook to the Study of Natural History, for the use of Beginners. By various authors. (London: George Philip and Son, 1894.)

STUDENTS of science are usually inspired with the desire to create in others an enthusiasm for the pursuit of natural knowledge. This fact probably explains why so many books of mediocre quality are foisted upon the public. Lady Isabel Margesson, who has edited the book under review, had the laudable ambition of "putting before the Beginner a clue to the many paths of the somewhat bewildering labyrinth called Natural Science." To carry out her idea, she procured persons to write short descriptions which could be used as finger-posts pointing the way to the acquisition of knowledge concerning all manner of living things, of minerals, &c., and, to the whole, Sir Mountstuart Grant Duff has contributed an introduction, in which he expatiates upon the book's inception and the qualifications of the authors of the various parts. Lady Isabel's plan may appear excellent in the abstract, but its realisation is not deserving of much praise. We venture to say that there is scarcely a section in the book exactly meeting the requirements of beginners. Scientific names are frequently given without any explanation, and the beginner is led into the maze of botanical nomenclature before he is told how to disguish the parts of plants. One or two of the authors have confined themselves to describing the spirit in which their branches of natural science should be wooed in order to be won; others give descriptive lists of books suitable for sequential reading; while a third section devote their space to methods of work. When fourteen writers assist in making a book, inequality may be confidently expected. Thus it is that Lady Isabel's idea has not crystallised into a very symmetrical form.

Surveying and Surveying Instruments. (The Specialists Series). By G. A. T. Middleton. (London: Whittaker and Co., 1894).

THE contents of this book have already appeared in a series of articles in the *Building News*, but there is no doubt that in book form they will be found more serviceable to readers in general. The articles in question deal in a practical way with the methods of procedure adopted in surveying, and with the descriptions of the different instruments employed. The first chapter treats of surveys with chains only; here the author gives some very sound advice, and concludes it with a description of a worked-out survey, showing also the method of entering measurements in the field-book. In case of obstructions such as rivers, sheets of water, bog land, &c., modifications in the chain line methods have to be adopted, and these are discussed in chapter ii.; the reader is also brought in contact with right-angle instruments, such as the now comparatively little used cross-staff, the optical square, and Weldon's right-angle prism. Next is described the uses of that very important instrument the level, and the different methods of "levelling" are each dealt with. The numerous worked-out "levellings" with figures, should bring the subject home to the reader. The numerous forms of levels require the author to devote chapter iv. to a discussion of their qualities and of their different means of adjustment. This latter point is of the greatest importance to the surveyor, for on this depends to a great extent the accuracy and rapidity with which observations may be made. The chief levels discussed are the so-called "dumpy" and "Y" types, but other hand-levels are referred to, such as Stanley's builder's level, Watson's clinometer level, and Stanley's Abney and Stanley's improved Abney level. Short reference is made to the barometer as a measurer of differences of level.

Chapter v. is devoted to the uses of angle-measuring instruments, such as are employed in the determination of either the main points upon an extensive survey or of inaccessible points. By means of extracts from the field-book and illustrative diagrams, the method of procedure is carefully explained, and many practical hints are in addition interpolated. The following two and last chapters contain detailed accounts of the theodolite, other angle-measuring instruments, and instruments for ascertaining distances; among the last-mentioned being Stanley's tacheometric theodolite, Steward's omni-telemeter, and the Labbez Telemeter.

As a handbook for those employed in the practical work of surveying, the volume should be of great use; its value is greatly enhanced by the very excellent drawings of the numerous instruments which are inserted in the text.

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 Photography of the Splash of a Drop.

Prof. Worthington tells me that in his lecture on the splash of a drop, at the Royal Institution, on May 18, he was not able, through want of time, to explain how the photographs were taken, and has suggested to me that a short account of them, which was our joint work, may be of interest.

In our first attempts we employed the spark used by Prof. Worthington many years ago for viewing and making drawings of the phenomenon (*see Proc. Roy. Soc.* No. 222, 1882). This spark was produced by breaking at the surface of mercury a current of high self-induction; but we found that when this was made powerful enough for photographic purposes, it became of too great duration (from 4 to 6 thousandths of a second), so that the drop had time to move appreciably while under illumination. We therefore had recourse to the Leyden jar spark as employed by Lord Rayleigh (Nature, vol. xliv. p. 249). This is so exceedingly convenient a method of producing a suitably timed spark *at any place* without the necessity of insulating the leading wires, that, for the sake of making it more generally known, I venture to repeat with a simplified diagram the description of the arrangement, though really identical with Lord Rayleigh's.

Prof. Worthington's timing sphere had been of ivory; it was only necessary to substitute a brass ball, and the original timing apparatus was suited to the new conditions. (Fig. 1.)

[1] A is a Wimshurst machine, whose + and − terminals are connected to the inner coats of two large Leyden jars, B and C, the capacity of each being roughly equivalent to that of a glass plate condenser, the area of each surface being 4380 square cm, and the thickness 2 mm. These inner coatings were also connected by insulated wires to two insulated knobs, D and E, between which the timing sphere, F, falls. The jars stand on the same imperfectly-conducting table, and from their outer coatings are led stout uninsulated wires through the partition wall of the dark room, where they terminate in a spark gap, H, between two stout magnesium wires. Here the spark is produced which illuminates the drop. K is a rough electrometer, consisting of a brass sphere, L, carried on a pivoted wire, on which slides a suitable counterpoise; L is connected with the inner coating of one jar, and is attracted towards the oppositely charged sphere, M, connected with the inner coating of the other jar. When the spheres D and E are sufficiently charged for the timing sphere to cause a discharge when it falls between them, L is lifted by the attraction of M and strikes a glass plate which separates them; this is the signal for letting off the drop and timing sphere F. The timing sphere F has been held on a ring carried by a horizontal wooden rod or lever about six inches long, and pivoted about a horizontal axis.

A smart upward fillip throws up the other end of this lever, and leaves the sphere in mid-air free to fall, and simultaneously breaks contact with crossed platinum wires beneath the lever, and breaks the current of the electromagnet, N, in the dark room, thus allowing an india-rubber catapult to toss up, in precisely the same way, one end of a similar lever, whose other end carries a smoked watch-glass, O, on which the drop has been lying without adhesion. Thus drop and sphere are liberated simultaneously,

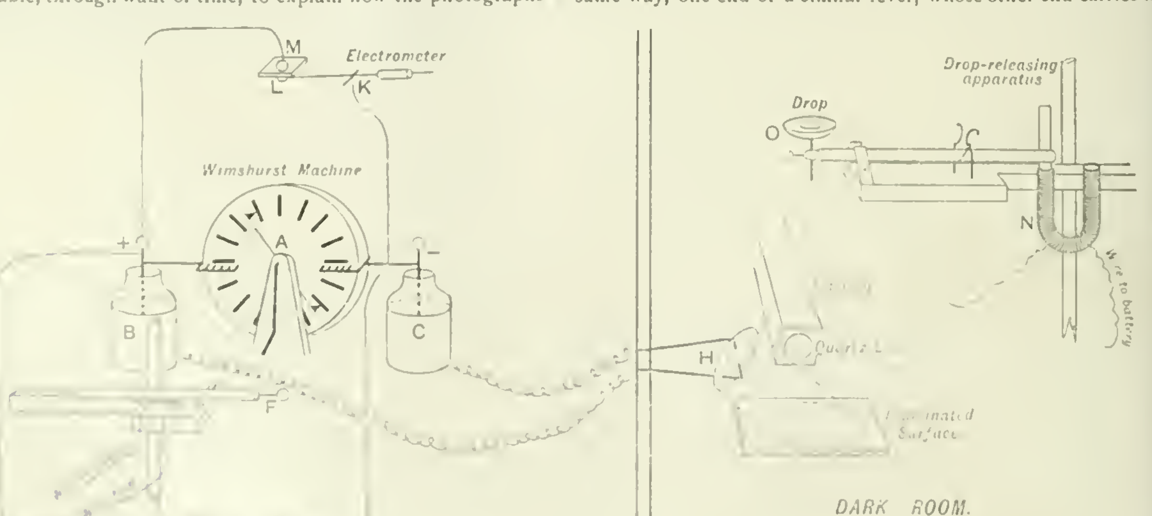

Fig. 1.—Apparatus for photographing a splash.

[1] The arrangement of jars was, I believe, first used by Dr. Lodge.

or if not so, with a very short and practically constant interval between them.

The discharge of the inner coatings of the jars by the timing sphere reaching the gap between them is accompanied by a simultaneous discharge of the outer coatings across the spark-gap in the dark room, and it is this that illuminates the splash, the stage of the splash that is illuminated depending on the height of fall of timing sphere, which can be adjusted at pleasure.

The duration of this discharge, if we may argue from Prof. Boys' experiments, probably did not exceed one-hundredth-thousandth of a second.

Great difficulty was at first experienced in getting enough illumination, and finally the spark-gap was placed in the focus of a small silvered watch-glass, which enclosed an angle of nearly 180°, and this was placed to illuminate the splash from one side, at an inclination of about 30° to the horizontal at a distance of 6 or 7 cm.; it is to this that most of the detail obtained was due.

FIG. 2.—Splash of mercury on xylonite.

The camera was inclined at an angle of about 30° to the horizontal, looking downwards, and was fitted with a single pebble spectacle lens to avoid the loss of the ultra-violet rays which occurs with glass; as the lens was far from achromatic, the proper adjustment of the distances of object and plate had to be found by preliminary experiments. The most rapid plates obtainable (not isochromatic) were used, and were developed for thirty or forty minutes with eikonogen, the developer being made as strong as possible in eikonogen. To avoid all chance of fogging, the operations were performed in the dark.

FIG. 3.—Splash of a drop of water into milk, early stage.

The mercury splashes with which we began turned out to be the most difficult to photograph, owing to the halation produced by the very bright reflection at some points, and the comparative darkness of the remainder (Fig. 2) We had to try various surfaces for the drop to fall on to find out how to obtain the best contrast; we finally adopted a piece of polished white xylonite.

Of many liquids tried, the easiest to photograph was milk, and with this there was plenty of detail (Fig. 3 and 4).

These photographs are, as far as we know, the first really detailed objective "views," as opposed to shadows, that have been taken with such a very short illumination.

Besides these we also took a number of shadow photographs, in much the same way as that in which Prof. Boys photographed a rifle bullet, by letting a drop of mercury fall on *the clean side* of the sensitive plate itself, and producing a spark between two magnesium knobs vertically above the splash. No difficulty was found in this case in getting enough exposure.

FIG. 4.—Splash of a drop of water into milk, late stage.

It will be observed that the method requires that different stages should be photographed from different splashes. We hope, however, to succeed in the more difficult task of photographing many stages of the same individual splash.

R. S. COLE.

On the Spreading of Oil upon Water.

IN a paper entitled "Die Lehre von der Wellenberuhigung," by M. M. Richter (see NATURE, vol. xlix. p. 488), the opinion is expressed that the tendency of oil to spread itself on water is only due to the free oleic acid contained in it, and that if it were possible to completely purify the oil from oleic acid, it would not spread at all.

This I found to be actually the case with olive oil, and though I agree by no means with the theoretical views of the author, I will mention the fact, for I may suppose it to be not yet generally known.

The Provence oil used in my experiment was shaken up twice with pure alcohol, and the rest of the latter being carefully removed, a drop of the oil was placed upon the freshly formed water-surface in a small dish by means of a brass wire previously cleaned by ignition. The oil did not really spread, but after a momentary centrifugal movement, during which several small drops were separated from it, it contracted itself in the middle of the surface, and a second drop deposited on the same vessel remained absolutely motionless.

Of course the surrounding water-surface proved to be in the anomalous state, the tension determined by the method of separating weights being =0·82 of the normal value. It has been diminished by the "solution-current" of the oil (as I have called the contaminating current, issuing from a body in contact with a clean water-surface), which may be observed if the surface be dusted over with sulphur or lycopodium before placing the oil upon it. The observation of the solution-current, preceding unpurified oil, is more difficult, because the oil itself covers rapidly the whole surface.

As soon as the relative tension 0·82 is attained, the slightest trace of a solution current ceases, whilst ordinary oil still shows solution-currents at much lower tensions. The surface-tension 0·82 is the lowest possible that can be produced on water by pure Provence oil; the surface then may be considered as saturated with oil.

This can be seen most clearly if the drop be deposited upon the adjustable trough filled with water, which was employed in my former experiments (NATURE, March 12, 1891, p. 437). The tension then remains constant on either expansion or contraction of the surface; on considerable contraction, however, one can perceive a slight precipitate of oil, which gives to the surface a turbid appearance.

Evidently the pure oil does not spread over a surface of the minimum tension attainable by its contact with water, because the sum of its surface-tension and the interfacial tension of oil and water, which we may call "tension of equilibrium," is greater than the minimum tension. Therefore upon a clean water surface the oil is repulsed by its own solution current.

On the other hand, a drop of common Provence oil placed upon the saturated surface spreads, while the surrounding surface diminishes its area and grows turbid. From this we see that the tension of equilibrium of the oil containing free sebacic acid is lower than its saturation tension, and this is also the reason why it is not prevented from spreading by its own solution-current.

I have repeated these experiments with various kinds of oil, and in each case found that by shaking up with alcohol the tension of equilibrium rose, and the tendency to spread was diminished.

In the case of ordinary olive oil there was but little difference between the purified and unpurified oil, although it was six times shaken up with fresh alcohol. With rape-seed oil and poppy oil I was more successful. Their tension of equilibrium was still somewhat inferior to the minimum tension, which was with rape-seed oil 0·85, and with poppy oil 0·82, but the spreading on a saturated surface was very slow, and upon a large clean surface the oils covered but a comparatively small area. The best success I had with almond oil, which behaved quite like Provence oil.

On the other hand, the tendency to spread, not only of pure oil, but also of benzol and petroleum, increased when oleic, palmitic, or stearic acid was dissolved in them.

Pure benzol can rest on water but in a rather thick layer. When the thickness is diminished to a certain degree, the layer breaks into drops, for which the following explanation seems to me most probable. The water-surface surrounding benzol, as in the case of oil, never is in the normal condition, the tension being diminished by the vapour streaming over the water. This vapour current ceases at the tension 0·88, which, as it appears, is somewhat lower than the equilibrium tension of benzol. Therefore a thin layer of benzol is broken by the vapour current.

When a floating fluid layer is not very thin, the tension of the surrounding anomalous water-surface, just balanced by it, is no longer equal to the sum of interfacial and surface tension. In the case of benzol it assumes a lower value than the minimum tension of the vapour-current, and therefore a sufficiently thick layer is allowed to spread coherently.

Benzol which is contaminated, for instance, by stearic acid or resin, behaves quite differently. The tension of equilibrium being lowered by those substances, it spreads so far as to show colours of thin plates.

Pure petroleum seems to be the only liquid which does not spread upon a normal surface. The vapour-current going out from petroleum ceases already at a relative contamination - 1, and therefore cannot produce a sensible decrease of tension. Nevertheless it may possibly prevent the floating drop from spreading. When sebacic acid is dissolved in petroleum, the latter shows a much greater tendency to spread.

In order to examine whether the effect of sebacic acids upon the tension of equilibrium be due to a decrease of the cohesion of the solvent, I have compared the surface-tensions of pure and contaminated benzol or petroleum, and those of the purified and unpurified oils. In no case have I found the surface-tension to be diminished by the sebacic acid, hence I came to the conclusion, that it is the interfacial tension which is altered.

Now let us consider the behaviour of common oil. It spreads in a coherent film to a certain thickness, which is different with various sorts of oil. Then small holes appear in the interior of the film, whilst the circumference of the latter is still increasing, and by the gradual increase in size of the holes the layer at last is broken and dissolved in small drops.

Why does the oil thus withdraw from the surface while its circumference is still increasing? The reason is, no doubt, that the oil spreads at the minimum tension of pure oil, but not at that of the free sebacic acid contained in it. The solution-current of the latter drives it back from the surface. Outside the oil film spreading upon a large water-surface the tension of the latter does not sink below the minimum tension of the pure oil; in the interior of the holes, however, a newly-formed surface would be instantaneously saturated with oil, and here the tension, therefore, can be further diminished by the sebacic acid.

The minimum tension of oleic acid, at which the latter also does not spread, is in relative measure 0·52, and that of palmitic acid about 0·55.

The depression of surface-tension which can be attained by unpurified oil is not so great, but much greater than that produced by pure oil, and depends upon the quantity of oil applied.

If the quantity be such as to cover the whole surface before breaking, the surface afterwards is not contaminated with oil at all, but only with sebacic acid; and the tension is still sinking slowly by the effect of the continued solution-currents of the single drops.

When less oil is employed, the free sebacic acid contained in it is often not sufficient to produce the lowest possible tension. Then one may observe that freshly added drops of oil still give solution-currents, whilst those of the older drops have already ceased.

When a water-surface, on which minute drops of oil which have not yet dissolved are present, is expanded, the tension rises to the minimum value for pure oil, and then remains constant till the whole oil is dissolved, where it begins to rise again in the same manner as the curve given in Nature, June 15, 1893, p. 152.

The value of surface-tension, at which the linear fall of the curve ceases, being identical with the minimum tension of pure oil, it is evident that the sudden change of direction at the relative contamination 1·3 means saturation of the water-surface with oil.

Agnes Pockels.

Prof. Ostwald on English Chemists.

"To see ourselves as others see us" is so difficult of attainment, that no mirror, however imperfect, should be passed by without a glance bestowed upon it. The image of us which Prof. Ostwald displayed to the electricians assembled in conclave at the second anniversary meeting of the German electricians on June 7, is the less pleasant by reason of the consciousness that the reflector is a good one. The opening words of the Professor's address were virtually as follows:—

"It is a positive fact that every year there are imported into Germany from England so many thousand centners of benzene, amounting to nearly the whole of the production of this material in the latter country. Now benzene is an intermediate product, destined to be converted into dye-stuffs, medicaments, and other commodities, so that we have the remarkable situation that the country of all the world, in which industry has flourished longest, relegates the most important and profitable part of one of her manufactures to a foreign country. The reason is of the plainest: England *cannot* undertake the conversion of its raw material into the finished product, and why? Because of the insufficient training of the English chemist. The would-be practical Englishman with the intention of entering a dye-factory, studies, not general chemistry, but the chemistry of dye-stuffs. The German studies chemistry, lock, stock and barrel, never wrecking what his calling is to be. Only when he has a really scientific foundation will he begin to build up his special knowledge. By and by there comes a change over the face of the industry in which these competing chemists are employed. The German—he is ready; without difficulty he adapts himself, and follows up the novel course. But the Englishman—he cannot imagine at what position he has arrived; he must begin, so to say, over again."

Thus spoke one of Germany's—nay, the world's—greatest thinkers. Let our manufacturers, who despise the college-bred youth, meditate thereupon.

A. G. Bloxam.

Goldsmiths' Institute.

"Testacella Haliotidea."

Tate, in his "Molluscs of Great Britain," gives a list of counties in which this mollusc may be found. In this list Worcester is not included. Hence it may be of interest to note that specimens are not infrequently collected in asparagus-beds here, as also are those of the much rarer *T. scutulum*. A good specimen of the latter was recently given by me to Mason College, Birmingham.

Nematus grossulariæ.—Here the gooseberry plantations are often devastated by the larvæ of this saw-fly, in the extirpation of which pest the insectivorous value of the cuckoo to planters may be appreciated through the following incident. Recently the attention of a resident of Crowle, a village near Worcester, was directed to his gooseberry plantation, close by a window of his house. A cuckoo was in one of the grub-infested bushes, fluttering its wings, and so causing numbers of the pests to fall on the ground, whence they were quickly gathered by the bird.

Daily the bird visited the garden till the bushes were cleared, and so the crop was saved. In Crowle this year these birds are numerous. I have a garden in a place in North Wales where this year there are few of these birds. The grub stripped the bushes of leaves, and the fruit died.

Worcester, June 23. J. LLOYD-BOZWARD.

On the Diselectrification of Metals and other Bodies by Light.

REFERRING to a footnote on page 135 of NATURE, June 7, Messrs. Elster and Geitel have been good enough to call my attention to a great deal of work done by them in the same direction and published in recent numbers of Wiedemann's *Annalen*. The most important statement about it is that they had observed the photoelectric power of fluorescent minerals and the electrical activity of sunlight, and had worked for some time at the influence of these facts on atmospheric electrification; the idea that atmospheric electricity was thus caused (by the discharging action of sunlight) having been already mooted apparently by von Bezold and Arrhenius.

OLIVER J. LODGE.

Absence of Butterflies.

IT may be worth while to put on record what has happened this spring and summer, viz. the total absence of butterfly life. Beyond an occasional white butterfly, there are none to be seen. I have a large garden where there is usually abundance of them, but a coloured butterfly has not been seen this year yet.

Gravesend, July 2. DELTA.

THE SETTLEMENT OF THE EPPING FOREST QUESTION.[1]

BY a happy coincidence the *Essex Naturalist*, containing the full official report of the discussion on the management of Epping Forest, which took place under the auspices of the Essex Field Club on April 28,[2] and the Report of the experts appointed by the Corporation of London, have been published almost simultaneously, the former having been issued a fortnight or so before the latter. As the proceedings of the Conservators had been subjected to a running fire of the most vehement criticism ever since last autumn, the question of the management of the forest may be considered to have excited an amount of popular interest such as had never before been raised since the public dedication by the Queen in 1882. The reason for the popular outburst of indignation on the present occasion is to be found in the circumstance that the thinning operations had been carried on in a district which is well known to contain the finest example of a beech wood that the forest offers, viz. Monk Wood, and the amassed heaps of felled trunks, drawn to the roadside for removal, naturally attracted the attention of every passer-by, and gave rise to a not altogether unnatural feeling of uneasiness as to the fate of the forest's show woodland. A fair and unbiassed examination of Monk Wood, however, soon sufficed to dispel any fears of unnecessary destruction or permanent injury, and those whose judgment in such matters is worthy of the most serious attention, did not hesitate to express their belief that the operations had on the whole been carried out judiciously, and for the future benefit of the forest. This conclusion was arrived at in many cases against the preconceived notions of some of the visitors who attended the meeting on April 28, and some speakers in the discussion with great candour admitted that the result of the visitation and the explanations given on the spot had been to cause them to modify their views. This appears most distinctly from the speeches of such well-known friends of the forest as Sir Frederick Young, Prof. Boulger, and Mr. F. C. Gould, and it is only fair to add that many others who, without any special knowledge of forestal operations, attended the meeting, of which the proceedings are now reported, as lovers of the naturally picturesque, had their judgment materially aided by the opportunity given them for comparing portions of the forest which had been severely thinned in former years with other portions which had not yet been attacked. The arguments for and against the conservatorial doings are fully set forth in the *Essex Naturalist*, and will form an important chapter in the history of the forest management.

But the Essex Field Club has of course no official connection with the Epping Forest Committee, and although, as everybody knows, the chief executive verderer is Mr. Edward North Buxton, this gentleman gave his services as a conductor of the meeting because of his special knowledge on the one hand, and on the other as an officer of the Field Club. The decision at which the meeting arrived, as already reported in these columns, is in no sense an official utterance of the Club as a body corporate, but is simply to be regarded as an expression of individual opinions consequent upon a personal visitation and a discussion raised thereby. It seems desirable to make this statement in order to avoid future misunderstanding.

The Corporation of London, as the official Conservators of the forest, on April 12 appointed a special Committee of experts, in their own words, "to view the forest, and advise us forthwith as to the effect of the thinning, and our future policy with regard to the management of the forest." The names suggested were Viscount Powerscourt, Dr. Schlich (the Professor of Forestry at Cooper's Hill), Mr. James Anderson of Manchester, and Mr. William Robinson, the editor of the *Garden*. Sir Joseph Hooker was also asked to nominate two other members, and he suggested the names of Earl Ducie, Mr. A. B. Freeman-Mitford, M.P. (formerly Secretary to H.M. Commissioners of Works), and Mr. Angus D. Webster, formerly forester to the Duke of Bedford. Lords Ducie and Powerscourt were unable to join the Committee, but the five signatures attached to the Report may be considered as strongly representative of the art and science of forestry as the names of any committee of experts that has ever been or possibly could be brought together in this country.

Taking the Report as a whole, it will be seen that the Committee practically give their sanction to the policy which has been, and is being, pursued by the Conservators, and endorse the decision arrived at by the majority of those who took part in the meeting and discussion on April 28. Surely after this most weighty verdict there need be no further alarm as to the future of the forest. A detailed analysis of the Report would occupy too much space in these columns, but some of the most important recommendations may be considered. And first of all, with respect to the opening out of views and the making of clearings, there is no uncertainty about their statement:—

"As there is much beautiful landscape in and around the forest, the opening up of which would add much to its charms, we think that the best views should be carefully opened up by making judicious clearings. Such views would be in every way a gain. . . . . The rides and drives are beautiful features of the forest, and those made in recent years are well designed. They should receive constant attention, lest the encroachments of vegetation should mar their picturesque effect. In this connection we would call attention to the beauty of the glades which already exist. These should be increased in number, where it can be done without sacrificing the finer trees, or interfering with the massive groups of the forest."

[1] "*The Essex Naturalist*, being the Journal of the Essex Field Club," edited by William Cole, Hon. Sec. Nos. 1–5, vol. viii., published June 1894. "Epping Forest, Report of Experts as to Management, &c. Report, Epping Forest Committee," presented June 14, 1894.

[2] A brief report of the meeting appeared in NATURE, May 3, p. 12.

With respect to the thinning out of superfluous trees, the Commissioners touch upon a point of considerable importance:

"A vast proportion of the area of the forest is covered by pollard hornbeams. In parts they are an interesting feature; but the practice of pollarding having been discontinued, the trees are now so dense that neither light nor air can penetrate. We consider that, with a view to encouraging the growth of better trees and varying the monotony of the forest, the best course will be, not generally to thin the trees, but to make bold clearances among them. The finer pollard oaks throughout the forest should be carefully preserved."

The importance of this recommendation lies in the circumstance that such a large area of the forest is covered by pollard hornbeams, often most unsightly through overcrowding, while pollard oaks, and especially such as could fairly be called "fine," are comparatively scarce. There are very few naturally-grown hornbeams throughout the forest area, and it is to be noted with satisfaction that the policy adopted by the Conservators, and further enforced by this recommendation of the experts, will give an opportunity for developing the natural growth of a tree which is an almost unique feature of the forest. The writer is not acquainted with any woodland in this country where the hornbeam forms such a prominent feature.

The Committee lay stress upon the importance of preserving the "massive character of the forest," and this also is a point on which it appears necessary to make some observations. Where the trees admit of being "massed," as the beeches in Monk's Wood, or the oaks in Hawk Wood, this policy would naturally find favour. But discretion has been, and no doubt will be, shown in this direction. A large number of trees might advantageously be removed from such an area as Hawk Wood without destroying its massiveness; and yet, when the Conservators come to deal with this part of the forest, there will no doubt be another outcry. With respect to this area the Committee state:

"Hawk Wood is in the main an oak wood, and the trees are not such as would be improved by wholesale thinning. It would be, in our opinion, wise to take out no trees except such as are obviously dying, and a few scrubby stunted trees which are injuring the others. Where, here and there, a single specimen of more than usual beauty can be encouraged into noble growth, it should be protected from overcrowding."

This is precisely what the Conservators proposed to do with Hawk Wood before the present agitation, and a very good suggestion has been made that the chairman of the Committee of experts should be invited to go over this wood and mark the trees which he would recommend to be removed. The Conservators have already marked the trees which they proposed to remove. A comparison of the results would be a most practical lesson in forestry, and, so far as the writer is acquainted with Hawk Wood (which is very thoroughly), it may be safely affirmed that there would be no very serious division of opinion between the chairman and the verderers.

In connection with the question of encouraging the growth of underwood the Committee "do not think that in all parts sacrifices should be made for the purpose of encouraging it where the trees do not allow of its healthy growth, as under beeches." This observation no doubt applies more especially to Monk Wood, and so far may be claimed as a ratification of the work done there. The thinning cannot in this district be fairly considered to have led to any serious sacrifices of good trees, and a ramble through that woodland will convince the lover of the picturesque that the massiveness has not been interfered with. In view of the circumstance that the public attention was first drawn to the recent thinnings by the operations in this district, it is to be regretted that the experts have not expressed themselves more fully on this point. They express no disapproval of what has been done, but they consider that the thinnings will be sufficient "for many years to come," an observation which will no doubt be fully concurred in by the Conservators. There was never any intention expressed of thinning further in this woodland for the present.

The Committee recommend also that the trees in High Beech should not be interfered with, that the hollies in Walthamstow Wood should be allowed to develop by removing the dead or dying trees or the pollards which are interfering with them, and that the "healthy oaks, even where crowded, should be left standing. The beauty of tall oak stems, often lichen-covered, when growing in close woods, should be considered." In connection with this last remark it may be interesting to add that for some reason or another lichens refuse to flourish on the trees in Epping Forest—certainly in the lower forest, and the hoary trunks which are such delightful features of the Kentish and Surrey woods are unknown in the southern portions of the forest. In Theydon High Wood "moderate and periodic thinning" is recommended. In Lord's Bushes it is recommended that the young trees should be allowed to take the lead, and only the "finer and more picturesque pollards" preserved. All these recommendations are, it will be seen, substantially in accord with the line of action pursued by the Conservators.

The following suggestion with respect to drainage will give extreme satisfaction to naturalists:—

"We consider that there should be as little artificial drainage as possible, though in the case of rides or drives it is sometimes necessary. The natural drainage is in most places sufficient, and the streamlets should be allowed to make their own courses."

Another recommendation, which we endorse most heartily, is that "it may be necessary for a time to protect certain spaces against the inroads of cattle, horses, and deer."

The experts are opposed to artificial planting in general, and are in favour of letting nature do her own planting, excepting in cases where tree growth is insufficient, when they recommend that the seed of indigenous trees should be introduced. Four of the Commissioners are even opposed to having a nursery, but Dr. Schlich does not agree with this. In view of the fact that a large area of forest land was formerly under cultivation, and has only been thrown open in recent years, we are disposed to agree with Dr. Schlich. None of us will ever live to see these tracts restored to anything like a natural condition unless planting is resorted to.

Taking the Report in its entirety, it may be said that the question of the management of Epping Forest is now settled beyond cavil, and settled in a manner calculated to give strength to the hands of the Conservators and to reassure the public. The ridiculous exaggeration of seekers after cheap notoriety may in future be allowed to pass by unheeded. As Sir John Lubbock said in his late address to the Selborne Society:—"A great debt of gratitude was due to the conservators and verderers of the forest"; and again in the *Times* of June 11: —"We are greatly indebted to the Corporation of London, to Mr. Buxton and his colleagues, and . . . Epping Forest will be even more beautiful fifty years hence than it is now." The Report of the experts concludes with the very pregnant paragraph:—

"In conclusion, we may say that we are not prepared to endorse the strictures which have been passed upon the work carried out in Epping Forest. We are of opinion that much has been done judiciously and well. In some instances we should not, perhaps, unanimously approve of the whole of the action of the authorities. In others, we may consider that more might have been done. But of one thing we are certain, that whatever has been done has been animated by earnest desire to preserve the finest features of the forest, and through intimate knowledge of its necessities and peculiar conditions." R. MELDOLA.

NOTES.

THE meeting held on Saturday last at the Royal College of Physicians, and reported in the *Times*, was a very satisfactory one. It was attended by delegates from nearly all the institutions which it was proposed, in the report of the late Royal Commission on the Gresham University, should form constituent colleges of the reorganised University of London. Dr. Russell Reynolds, F.R.S., occupied the chair. Since Sir Albert Rollit gave notice in the House of Commons of a motion asking that some action be taken to carry into effect the report of the Royal Commission, there has been ample time for the various institutions involved in the scheme for a Teaching University to deliberate and deliver their opinions on the recommendations. Practically all the constituent schools and colleges have availed themselves of the opportunity, and have, in the main, expressed approval of the proposals. The time has arrived, therefore, at which to set the machinery in action which would lead the Government to appoint a Statutory Commission to frame a scheme on the lines of the report of the late Commission. The necessary motive power is contained in the following resolutions put before Saturday's meeting. It was moved by Prof. Erichsen, the president of University College, and seconded by the Rev. Mr. Whitehouse—"That this meeting of delegates from institutions mentioned in the report of the Royal Commission on the Gresham University desires to express generally its approval of the proposals contained in the report of the Royal Commission, and would urge on the Government that a Statutory Commission be appointed at an early date with power to frame statutes and ordinances in general conformity with the report of the Royal Commission." This resolution was put to the meeting and was carried, the only dissentients being the representatives of King's College. It was also agreed, on the motion of Dr. Norman Moore, "That a copy of this resolution be forwarded to the Lord Chancellor, the Lord President of the Privy Council, the Home Secretary, and the Vice-President of the Council, to be accompanied by a request that they will receive a deputation on the subject, the same to consist of the delegates to this meeting."

PAST and present students of the Mason College, Birmingham, presented Dr. Tilden with a silver bowl and a congratulatory address last week, on his removal to the chair of Chemistry at the Royal College of Science, and as a mark of appreciation of his long and honourable career in connection with the college. The proceedings were of a very enthusiastic character, and Dr. Tilden's students and colleagues vied with each other in expressing their esteem for him as a teacher and an investigator. In the course of his reply, Dr. Tilden remarked that fourteen years ago he went to Birmingham quite a stranger, at a time when there was no science college actually opened. His three colleagues—Profs. Hill, Poynting, and Bridge—were appointed with him as the first four professors of the college, when the building was quite empty. In the first session they had some eighty students between them, and those days were exceedingly happy. Those first professors had unusual privileges and responsibilities. They were naturally given a free hand. They had no traditions to live up to, no standard to go by except that which they themselves set up. They were entrusted with the great duty, the heavy responsibility, of creating their several departments and building up the life of the college, and setting up standards of teaching and conduct which would serve for their successors. Referring to his successor, Dr. Tilden said that, under Prof. Percy Frankland's care, he had no doubt that the work of the college would advance in the right direction.

OUR continental neighbours must often be amused at the forms in which we raise monuments. It will be remembered that a year ago a subscription list was opened for the purpose of erecting a memorial of some kind to Gilbert White. The appeal resulted in £250 being obtained. With this money a hydraulic ram has been fixed at the spring head near the village of Selborne, to force water into a reservoir erected eighty feet above the village. The water runs from the reservoir through pipes laid along the main streets, and tapped at convenient intervals. Selbornites are thus enabled to obtain a supply of water without journeying to the fountain at the spring head, as had previously to be done. This useful and unpretentious memorial is in keeping with Gilbert White's character; nevertheless, it seems to us that the committee having the funds at their disposal should also have taken into consideration the fact that he does not belong to Selborne alone, but to all lovers of nature.

WE learn from the *British Medical Journal* that three further remarkable instances of the success of Prof. Haffkine's system of anticholera inoculation are reported from Calcutta. In the first case, four out of the six members of a family were inoculated last March. The cholera appeared in the neighbourhood lately, and the disease attacked one of the two who had not been inoculated, while the inoculated remained free. In the second case, five members of a family consisting of eleven persons were inoculated in March. The cholera lately attacked one of the six who had not been inoculated. In the third case, six out of a family of nine were inoculated. When the cholera prevailed in the neighbourhood a few days later the disease attacked one of the three not inoculated. It is stated that the Corporation of Madras have passed a resolution inviting Prof. Haffkine to visit that city and introduce his system.

THE Council of the Royal Statistical Society announce that the subject of the essays for the Howard Medal, which will be awarded in 1895 with 20*l*. as heretofore, is as follows:—"Reformatories, and industrial schools of that class, in their relation to the antecedents, crimes, punishments, education after conviction, and training of juvenile offenders: together with the nature and extent of their influence on the diminution or increase of crime generally. These particulars have to be collected and analysed on a statistical basis, both as respects the institutions and agencies, public and private, at home and abroad, for the reclamation of juvenile offenders, and the best means of dealing with them on release. This does not include the industrial and training institutions certified by the Local Government Board under the 25 and 26 Vict. cap. 43." The essays should be sent in on or before June 30, 1895.

THE death is announced of Prof. F. Q. Rodriguez, Professor of Crystallography in the University of Madrid.

DR. JOSEPH COATS has been appointed Professor of Pathology in the University of Glasgow.

MR. L. O. HOWARD has been appointed entomologist to the U.S. Department of Agriculture, in succession to Prof. C. V. Riley.

MR. J. WOLFE BARRY, the engineer of the Tower Bridge, has had the honour of the Companionship of the Bath conferred upon him by the Queen.

PROF. W. ERB, of Heidelberg University, and F. Jolly, of Berlin, representing an influential committee, invite subscriptions for the erection of a monument to the late Dr. Charcot in the Salpêtrière.

The death is announced of Dr. Louis de Coulon, one of the founders of the Société des Sciences Naturelles de Neuchatel in 1832, and its president for more than half a century from 1836 to 1890, when he became "Président honoraire." Dr. de Coulon was born July 2, 1804, and died June 13, 1894.

A Medical Congress will be held at Calcutta at the end of next December, under the patronage of the Viceroy, and the presidency of Surgeon-Colonel Harvey. The objects of the Congress are "to bring together men from all parts of the Indian Empire, and to discuss medical subjects connected with Indian diseases, and to place on permanent record some of the work which is now lost to science for want of proper publication."

The seventy-seventh meeting of the Société Helvétique des Sciences Naturelles will take place at Schaffhausen, from July 30 to August 1 inclusive. The Swiss botanical and geological societies will also hold concurrent meetings. Papers intended to be read before the different sections should be in the hands of the Committee before July 15. The President for the year is Prof. J. Meister, and the Secretaries, Dr. J. Nüesch and H. Wanner-Schachenmann.

A number of papers were read at the meetings of the Museums Association, held in Dublin last week. Mr. F. W. Rudler described the arrangement of a mineral collection, and Mr. G. H. Carpenter read a paper on collections to illustrate the evolution and geographical distribution of animals. Among the subjects dealt with on the concluding day, June 29, were "Classified Cataloguing, as applied to Palæozoic Fossils," by Mr. W. E. Hoyle, and "The Functions of a Botanical Museum," by Prof. T. Johnson.

The Register for 1893–94 of the Johns Hopkins University of Baltimore has been received. One of the changes we note is that Prof. Newcomb terminated his active duties as Professor of Mathematics and Astronomy at the beginning of this year, the requirements of the Government service having obliged him to do so. The instruction in higher mathematics is now carried on by Profs. Craig and Franklin, and that in astronomy by Drs. Poor and Chessin. In all the departments of the University facilities are afforded for original research. In physics, Prof. Rowland expects all advanced students to devote most of their time to laboratory work and to undertake investigations designed to be of permanent value. Again, the chief instruction in every course of chemistry is that given in the laboratory. Prof. Remsen does not pander to those who merely take up chemistry in order to obtain a degree. "What is desired," he says, "is a certain maturity of mind with reference to the science of chemistry, and an ability to deal with chemical problems intelligently. This condition of mind is reached, if reached at all, by long-continued laboratory training accompanied by careful study of chemical journals and treatises. It may be said that the arrangements of the laboratory are made mainly with reference to those who wish to take up the study of chemistry in a broad way, and that those who want short courses in special branches of chemistry are not advised to come here. It is believed that whatever object the student may have in view, whether he intends to teach or to follow some branch of applied chemistry, the best preparation he can have is a thorough training in the pure science." We have seen few prospectuses in which the aims of study are more clearly defined. It is the same in all the other branches of scientific knowledge fostered at Baltimore; after students have become familiar with the methods of investigation through the study of typical and described material, they are encouraged to undertake original work. No wonder that the Johns Hopkins University is able to keep going journals of mathematics, chemistry, and biology, as well as numerous bulletins, circulars, and memoirs. The training given is just that calculated to produce results worthy of publication.

The temperature in the shade exceeded 80° in several parts of England and Wales during the three days ending Monday last, and reached 87° at Cambridge on Sunday. Thunderstorms occurred on Sunday night and following days in many parts of Great Britain, accompanied by very heavy rainfall in places. At Jersey 1·1 inch was measured on Monday morning, and 1·7 inch at Stornoway on Tuesday morning. These storms had the effect of cooling the air; the maximum shade temperature in the neighbourhood of London had fallen about 10° on Tuesday compared with that on the previous day.

The report of the German Meteorological Institute for the year 1893 contains some interesting details of the activity of that office, in addition to the routine work of dealing with observations from nearly 2,000 stations. During the year the important magnetic observatory of Potsdam became affiliated to the central office in Berlin; the very complete observations made there will be included with regular yearly publications. With the co-operation of the Alpine clubs an attempt has been made to reorganise a meteorological station on the Brocken, but hitherto it has not been successful. Fifteen scientific balloon ascents have been made during the year, in which the officials of the Institute have taken part. After the sixth ascent the balloon was exploded by lightning, but this only temporarily interfered with the work, as the Emperor granted funds to continue it. A complete account of the results obtained will be published in a special volume, when the work is discontinued. The introduction of Central European time into Germany has interfered materially with the meteorological work at the stations during the year.

At the meeting of the Vienna Academy of Sciences on June 14, Dr. J. Hann submitted an investigation on the daily period of wind velocity on the summit of the Sonnblick (3100 metres), based on a careful and laborious calculation and discussion of anemometrical observations for six years, and also on the range on mountain summits generally. The minimum of wind force takes place on the Sonnblick very early, about 8h. or 9h. a.m., and the maximum occurs about 8h. p.m. On the Santis (2500 metres), the minimum also takes place relatively early, between 10h. and 11h. a.m. But from the accepted theories of the cause of the daily period of wind force on mountain summits, it might be supposed that the minimum would occur in the afternoon. He therefore examined the records for several other stations, and found that in the summer, for altitudes ranging from 1400 to 4300 metres, the mean time of the minimum occurred at noon. He then investigated these facts to see how they fitted in with the assumed causes of the daily range, and as he could not reconcile them, he suggests that the possible explanation of the daily range on mountain peaks may be that the surface of the mountain being much more warmed than free air during the day affects the anemometers. It is assumed, however, that the chief effect is only active for a few hundred metres below the summit, in the morning, and that later it would be interrupted by the wind coming from the valley. If the minimum were due to the great ascending current, it would occur during the afternoon.

An apparatus for discovering internal flaws in iron and steel is described in *Industries and Iron*. It is electrical, and consists of a small pneumatic tapper worked by the hand, with which the sample of steel or iron is tapped all over. With the tapper is connected a telephone with a microphone interposed in the circuit. One operator is required to apply the tapper, and the other to listen through the telephone to the sounds produced. Both are in electrical communication, and in separate apartments, so that the direct sounds of the taps may not interrupt the listener, whose duty it is to detect flaws. In applying the system, one operator places the telephone to his ear, and while the sounds produced by the taps are normal he does nothing. Directly a false sound, which is distinguishable from the normal sound, is heard, he signals for the spot to be marked, and by this means is able, not only to detect a flaw, but to fix its locality.

THE current number of the Johns Hopkins University (U.S.A.) *Circular* contains a preliminary note, by Edwin F. Northrup, on a new method of obtaining the specific inductive capacity of solids under either slowly or rapidly changing fields. It is of great importance in connection with Maxwell's electromagnetic theory of light that, since the refractive index for most substances has only been measured for very short waves, the specific inductive capacity be measured under such circumstances that the field of force alternates with such rapidity as to produce waves comparable in length to the waves with which the refractive index is determined. The apparatus employed by the author consists of three heavy brass plates, fastened parallel to each other, and separated by about three inches. Each plate is held in position by four insulating strips of ebonite, through the ends of which pass four iron rods with a screw-thread cut upon their whole length. To the centre of each of the two outside plates, and perpendicular to the plate, is fastened a brass tube. A rod, half of which is of ebonite, moves in this tube and carries at its end a thin plane plate of glass, the surface of which is coated with metal foil. These small movable plates are as nearly as possible parallel to the large plates, and their position is given by a vernier attached to the ebonite rods. The two outside plates are connected by a metal rod which carries a metal ball. Another ball, nearly opposite the first, is fixed by a short metal pin to the middle plate so that the distance between the balls can be adjusted. In employing the apparatus to measure specific inductive capacity with rapidly varying fields, the following arrangement is used. The two outside plates and one terminal of a large induction coil being connected to earth, the other terminal of the coil is connected to the middle plate. When the coil works, sparks pass between the balls, and oscillations are set up. The lines of force, when air only is the dielectric, divide evenly between the plates, and in the region of the small plates the field may be considered as uniform; hence if these plates are at equal distances from the centre plate, they will always remain at the same potential. If, however, a plate of some other dielectric is placed between the centre plate and one of the movable plates, in order that the two small plates may remain at the same potential, they will have to be placed at unequal distances from the centre plate, and from their relative positions the specific inductive capacity can be deduced. In order to "weed" out the effects of the slow changes of potential due to the charge and discharge of the coil, the two small plates are connected to the primary of a small transformer, the secondary of which contains a spark-gap. In this way the effects due to the slow changes are eliminated, since the rate of variation of the induction in the transformer, due to these slow changes, is not sufficient to raise the potential in the secondary to the 300 volts or more required to break down the dielectric in the spark-gap.

STUDIES of the eastern Yucca Moth (*Pronuba yuccasella*) and its importance in Yucca pollination, have, from time to time, been recorded in reports of the Missouri Botanical Garden. In a recent report, Mr. J. C. Whitten describes observations which complete the knowledge of the life-history of this interesting insect. The observations refer to the time when the larva ceases feeding in the capsule, until it is encased in its underground cocoon, when, the following spring, it is to change to the pupa state. It was found that the larvæ made their escape from the capsules of *Yucca filamentosa*, and entered the soil during rainy weather, when the ground was softened, and consequently easily penetrable. They did this either during the daytime or at night, and not exclusively toward the end of the night, as Prof. Riley had predicted. The larvæ descended to the ground both by use of a thread and by crawling.

A CATALOGUE of works on entomology, being No. 26 of *Bibliotheca Entomologica*, has been issued by Herr Felix L. Dames, Berlin, Koch-Strasse 3.

WE have received from the Revenue and Agricultural Department of the Government of India a copy of the Returns of Agricultural Statistics of British India and the Native State of Mysore for 1892-93.

THE May number of the *Journal* of the Jersey Biological Station (*Jour. of Mar. Zool. and Micros.*, edited by James Hornell, vol. i. No. 3, 1894) contains several original contributions by the editor, in one of which is given an interesting account of the variability of the opercular filaments in *Serpula pectinata*. Elementary and picturesque descriptions are also given of the metamorphoses of the Crustacea *Squilla desmarestii* and *Scyllarus arctus*, and of the structure of anemones. The number is illustrated by several autographic plates and woodcuts, and contains a frontispiece giving a photographic view of the aquarium of the laboratory, which would seem, from the editorial report, to be making well-merited progress.

THE special articles, official reports, notes, communications, and reviews in part ii. of vol. v. of the *Journal* of the Roya Agricultural Society, issued on June 30, make up a number replete with information. The first two meetings of the Society—Oxford 1839 and Cambridge 1840—are described by Mr. Ernest Clarke. Profs. J. McFadyean and G. T. Brown write on the prevalence of anthrax in Great Britain, Mr. Joseph Darby on irrigation and the storage of water for agricultural purposes, and Dr. Fream on some minor rural industries. Among the official reports, we note one by Dr. J. A. Voelcker on aubury, club-root, or finger-and-toe, in turnips. Dr. J. M. H. Munro writes on sewage disposal and river pollution, and Lord Egerton of Tatton describes the Tewfikieh College of Agriculture, Egypt.

THE makers of a very neat little camera, Messrs. R. and J. Beck, have just send us a copy of the "Frena Handbook," in which the inventor says practically all there can be said with regard to the description, method of use, manipulation, &c., connected with this instrument. For the benefit of "some future philologist" who may at some time be in doubt as to the derivation of the word "Frena," an etymological note informs us that it is derived from "faro" and "crena," the former being the name of the well-known game of cards, and the latter meaning a notch; the instrument automatically discharging one film after another like a *faro-box*, and doing this by means of notches. In this camera notched films are used, being thin and stiff sheets of transparent cellulose film, and as many as forty can be carried in the holder at the same time. With regard to some of the technical data of the No. 2, quarter-plate, size, the lens is an "autograph" rapid rectilinear of focal length $5\frac{1}{2}$ inches, normal aperture F - 11, and covers a $3 \times 4\frac{1}{4}$ inch film; the dimensions of the case are $11\frac{1}{4} \times 5\frac{1}{2} \times 4\frac{1}{4}$ inches, and when filled with forty films the apparatus weighs four pounds. Among many of the advantages of this camera may be mentioned the arrangement by which the films may be tilted, thus providing a neat and easily worked form of swing-back. After the introduction, the author of this handbook gives a very brief and concise summary of the outline of operations necessary for the veriest beginner, printing them in red ink. This, however, s supplemented with fuller details by a series of extensive notes on the use of the "Frena," occupying nearly eight times as many pages as the "outlines" above mentioned. These notes contain some sound advice, of which the novice could not do better than take advantage, and they are written in a clear style. The illustrations and figures are exceedingly neat and clear, and the whole get-up of the book is all that can be desired.

Some new facts concerning the nature of the molecule of calomel are contributed to the current issue of the *Berichte* by Prof. Victor Meyer and Mr. Harris. The determinations of the vapour density of mercurous chloride made by Mitscherlich, Deville and Troost, and Rieth, in each case afforded numbers in close agreement with those demanded by the simple formula HgCl. Odling, however, disputed the possibility of the existence of molecules containing only one atom of each element, involving the assumption of univalency for mercury, and showed that when gold-leaf is immersed in the vapour it becomes amalgamated, indicating the presence of free mercury vapour. Erlenmeyer subsequently showed that this experiment was open to the objection that the amalgamation might be due to a chemical reaction between gold and calomel vapour, and pointed out that the presence of free mercury may be more conclusively shown by immersing a glass tube, cooled by containing a column of quicksilver, in the vapourised calomel, when an abundant condensation of mercury globules is observed. Debray afterwards immersed in the vapour of calomel a bent tube of silver, gilded outside and kept cool by the passage of a current of cold water, and found that both mercury and corrosive sublimate were condensed upon it, but that the greater portion of the sublimate consisted of unchanged calomel. Debray therefore concluded that dissociation into mercury and corrosive sublimate only occurred to an insignificant extent. Prof. Meyer and Mr. Harris now show that if a piece of gold-leaf is immersed for an instant only in the vapour of calomel it is invariably amalgamated, but if it is allowed to remain in the vapour for a few minutes it becomes pure gold again, the mercury being volatilised. They have further carried out a series of vapour density determinations by Prof. Meyer's well-known method, at the temperature of the vapours of boiling sulphur (448°) and phosphorus pentasulphide (518°). The numbers obtained are all in close proximity to that calculated for the molecular condition HgCl, agreeing in this respect with the older determinations above referred to, in which other methods were employed. The calomel was introduced into the apparatus in the form of a compressed pastille, thus obviating the necessity for a containing bulb or tube, and enabling almost instantaneous volatilisation to be achieved. A second series of experiments were then made with a mixture in the proper proportions of free mercury and corrosive sublimate, and the results were almost identical with those obtained from calomel. Of course this does not afford any conclusive evidence, but experiments are next described in which an attempt at identification of the substance or substances present in the vapour was made. It was shown that when the cylindrical bulb of the density apparatus was constructed of porous earthenware, a very large amount of mercury vapour diffused through it, and could be condensed upon an outer enveloping glass cylinder. Further, that when calomel is vapourised in a retort connected with a Sprengel pump, and in which the pressure has been reduced by the latter to about 30 mm., the upper portion of the apparatus becomes covered with a layer of mercury globules, and a proportionate quantity of mercuric chloride is formed. Chemical evidence is also adduced to prove the presence of mercuric chloride vapour in the gaseous product of heated calomel, for it is shown that pieces of caustic potash previously heated to the same temperature become instantly covered with orange-coloured mercuric oxide, just as when plunged into vapour of corrosive sublimate, proving the absence of any large quantities of mercurous chloride, which would have afforded a black deposit of mercurous oxide. Prof. Meyer and Mr. Harris therefore conclude that when calomel is vapourised it dissociates into mercury and corrosive sublimate, $Hg_2Cl_2 = Hg + HgCl_2$, and the necessity for the assumption of monadic valency for mercury is thus avoided.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♂) from India, presented by Mrs. McHugh; three Barbary Turtle Doves (*Turtur risorius*) from North Africa, presented by the Misses E. and P. Mackenzie; a Common Cuckoo (*Cuculus canorus*), British, presented by Mr. W. Keen; two Horned Lizards (*Phrynosoma cornutum*) from Texas, presented by Miss Maitland, an Anomalous Snake (*Coronella anomala*) from South Africa, deposited; an Ostrich (*Struthio camelus*, ♀), from Africa, two Red-headed Merlins (*Hypotriorchis chicquera*) from India, purchased; an Æthiopian Wart Hog (*Phacochærus æthiopicus*, ♀), from South-East Africa, received in exchange; a Thar (*Capra jemlaica*, ♂), a Burrhel Wild Sheep (*Ovis burrhel*), a Great Kangaroo (*Macropus giganteus*, ♀), born in the Gardens.

Prof. W. R. Fisher requests us to make the following correction in his contribution to our last number:—On p. 193, line 8 from top, for "1·025" read "$1·025^{45}$."

OUR ASTRONOMICAL COLUMN.

The First Observation of Sun-spots.—A contribution to the history of the rival claims of the various alleged discoverers of sun-spots appears in the *Rendiconti dei Lincei*, from the pen of Prof. E. Millesovich. It is a criticism of Dr. Berthold's pamphlet on "Master Joann Fabricius and the Sun-spots," setting forth the claims of the son of the Frisian astrologer David Fabricius to the name of the true discoverer of the solar phenomenon in question. The other claimants are, of course, Galileo and the Jesuit Scheiner, known under the name of Apelles. The claims of Fabricius are based upon his book *De Maculis in Sole observatis, narratio*, &c., published at Wittenberg in 1611. He had been studying at Leyden University, whence he brought home Lippershey's newly-invented telescope to his father at Osteel. The latter was already well known among astronomers as the discoverer of the variability of Mira Ceti. The method of projecting the solar image on a screen is set forth in detail in the work referred to, as well as the correct conclusion that the sun rotates about an axis. Prof. Millesovich grants that the name of Fabricius was probably known to the Jesuits and suppressed as that of a heretic, but he comes to the conclusion that Galileo was actually the first discoverer, having observed the spots as early as the summer of 1610, whereas Fabricius saw them independently on March 9, 1611, and Scheiner about the same time, without, however, paying much attention to them before the publication of Fabricius's *Narratio*. He then observed them assiduously, and collected a large number of valuable records.

The Progress of Astronomical Photography.—Under this title, Mr. H. C. Russell, C.M.G., F.R.S., the Government Astronomer at Sydney, delivered an address, as President of Section A (Astronomy, Mathematics, and Physics), at the last meeting of the Australasian Association for the Advancement of Science. The address has now been issued, and it is the most complete statement that we have seen of the advance of astronomical photography from the time when Prof. J. W. Draper took daguerreotypes of the moon, in 1840, to June 1893. The references distributed through the address add to its usefulness. Reference is made to eighty-one sources of information in all, and of these, Nature claims the large proportion of thirty-two. Like many other enthusiastic workers in the realm of celestial photography, Mr. Russell believes that astronomical observations will eventually be automatically made by means of the sensitive plate of the photographer.

MR. TEBBUTT'S OBSERVATORY, NEW SOUTH WALES.—The report of Mr. Tebbutt's Observatory, Windsor, New South Wales, shows that there was no relaxation in the observations carried on during 1893. The work done is quite equal in importance and amount to that of previous years. In addition to constant meridian work, a number of occultations were observed. Interesting phenomena were noted at the disappearance of τ^1 Arietis on January 26, 1893, and Mr. Tebbutt thinks that the star should be examined with a powerful telescope, as it is probably a triple one. The conjunction of Saturn and Virginis in April was observed · also the occultation of Saturn and Titan on May 25. Brooks' Comet (1892 VI.) was followed from November 28, 1892, to June 19, 1893, and the Rordame-Quenisset Comet (1892 II.) from July 29 to August 13, 1893. A series of measures of the binary star α Centauri were also made. When it is remembered that all the astronomical, and nearly all the meteorological, observations are made by Mr. Tebbutt himself, as well as the greater portion of the astronomical reductions, it is impossible not to admire his devotion to astronomical work. The smallness of the number of southern astronomers makes his observations all the more important.

A NEW SPIRAL NEBULA.—At a recent meeting of the Royal Astronomical Society, Dr. Roberts exhibited a photograph of a new spiral nebula in Perseus (*Monthly Notices R.A.S.*, April 1894). The nebula is in R.A. 2h. 29m. 58s. Decl. + 38° 31′·4. It is 3m. 51s. *preceding*, and 5′·4 *south* of the nebula No. 1023 in the New General Catalogue. The accompanying cut, from one of Dr. Roberts' photographs, shows the latter nebula as a

lenticular body a little below the centre, while the new object appears as a faint patch almost directly above it near the top of the figure. The illustration will serve to indicate the position of the nebula, but the spiral character has been lost in the reproduction. Dr. Roberts thinks that the nebula is new to science, for it is not recorded in the New General Catalogue. With regard to its character he says:—"The convolutions of the spirals are very faint, but clearly visible on the negative, and involved in them are four 14-15 mag. stars, and six or seven stars, or star-like condensations, less bright than the 16th mag. The convolutions are symmetrical, and proceed from a very faint star-like nucleus."

TWENTY-FIVE YEARS OF CHEMISTRY IN RUSSIA.

IN November last, the Russian Chemical and Physical Society commemorated the twenty-fifth anniversary of its foundation, and the addresses delivered on this occasion are now published in a separate pamphlet, as an appendix to its journal. The activity of the Russian chemists having been chiefly centred round the Society, the addresses on the progress of physical chemistry, by N. N. Beketoff; of organic chemistry, by N. A. Mensbutkin; on researches in the aromatic series, by Th. Beilstein—all in connection with the Russian Chemical Society—may be taken as so many excellent reviews of the progress of these respective branches of chemistry in Russia. The first two addresses are especially full of interest, as there is not one of the great questions which have occupied the attention of chemists during the last five-and-twenty years to which Russian chemists have not contributed some work of importance. The researches in connection with the periodical law, by its discoverer himself, and later on by Bazaroff and Prof. Flavitzky; the work of Prof. Gustavson, on the double substitutions of anhydrides; the researches of Prof. Potylitzin, into the mutual substitutions of haloids, also in the absence of water and at a high temperature, which induced Berthelot to make new researches in order to verify his law; and the discovery, by the same chemist, of the dependency between the limit of substitution of chlorine by bromine and their atomic weights, are passed in review. Next come P. D. Khrushchoff's researches into the heat of solution of mixtures of salts, which gave a further confirmation of the Berthelot, Guldberg, and Waage's law; the well-known exhaustive researches of Prof. Menshutkin into the speeds of reactions; and those of Kajander (prior to those of Arrhenius), into the dependency of these speeds upon the electrical conductibility of the combining bodies; the thermochemical work of Lughinin and Werner, and other works of minor importance. And, finally, the Russian chemists have contributed many and varied researches into the dependencies of physical properties of bodies upon their chemical composition and structure; such, for instance, as Goldstein's, which have led to the discovery of a law expressing the rise of the boiling point of many hydrocarbons as a function of their molecular weights; while the important contributions of Mendeléef, Konovaloff, Alekséeff, and also Scherbacheff, to the theory of solutions, and Prof. Bunge's work in electrolysis, are well known to West European scientists.

The work done in Russia during the same period in organic chemistry is, perhaps, even still more important; but it can hardly be dealt with in a few lines, although, out of more than a thousand papers contributed in this department, Prof. Menshutkin only mentioned those "of which," he said, "the history of chemistry will retain some impression." Many works of importance have been grouped by the reviewer around Butleroff's researches into the tertiary alcohols—a whole school of explorers of the fat series having been created by the well-known Kazan professor; while another series of researches into the aromatic compounds was made under the impulse given to these researches by Zinin and Beilstein. These last are so extremely valuable that they rightly form the subject of another well-filled address, delivered by the present leader of this school, Prof. Beilstein. Th. R. Wreden, in Russia, was one of the first to recognise the importance of those organic compounds which stand between the fat and the aromatic series; and though his work, which went against the then current opinions in science, did not attract the attention it fully deserved, the ulterior researches of Beilstein, Kurbatoff, and Markovnikoff into the compounds entering into the composition of the Baku naphtha have shown that he was on the right track, and fully confirmed his suggestions. The existence of these intermediate forms, which have their rings composed of atoms of carbon only, is now a recognised fact, and their study has already led to many important discoveries, while it promises many more. A short review of the work done in Russia, in connection with stereo-chemistry, and with the relations between the physical properties of organic compounds and their chemical composition and structure, concludes this most interesting address. "Chemistry," Prof. Menshutkin says towards the end of it, "is rapidly approaching the time when it will be no more a descriptive science, but a mechanics of atoms, and the history of the Russian Chemical Society is intimately connected with that part of the history of science."

THE LANDSLIP AT GOHNA, GARHWAL.

SIR E. BUCK has sent to us, through Mr. E. D. Maclagan, Under-Secretary to the Government of India, an advance copy of a report, with maps and plates, by Mr. T. H. Holland, of the Indian Geological Survey, on the great landslip in the Kumaon Hills. The landslip has been more than once referred to in these columns, but Mr. Holland's report, from which the following extracts have been made, is the first detailed information that has reached us on the occurrence.

Mr. Holland made a journey to Gohna last February, that is, five months after the landslip, and when the lake, formed by the barrier fallen across the Birahi Ganga valley, had risen to within 290 feet of the top of the dam. His investigations lead him to believe that the lake will be full and will overflow the barrier about the middle of August. Means for recording, by instantaneous photographs, the effects of the water on the dam have been arranged by the Government of the North-Western Province.

Gohna in British Garhwal (lat. 30° 22′ 18″ N., and long. 79° 31′ 40′ E.) is a small village in the valley of the Birahi Ganga, a river running westward and joining, at a point 8 miles west of Gohna, the Alaknanda, one of the principal tributaries of the Ganges. The village is about 130 miles north of Naini Tal, and by the road which follows the valley of the Alaknanda, it is 160 miles from Hardwar.

The bed of the Birahi Ganga, sloping at about $2\frac{1}{2}$°, is at Gohna 4600 feet above sea-level, and is the bottom of a narrow gorge with steep, and sometimes precipitous, sides. The gentler slopes are grass-covered, and higher up clothed with evergreen oak, fir, and rhododendron. In the more open parts of the valley, a small amount of cultivation is carried on by the few inhabitants of the small groups of houses dignified by the name of villages. The river basin, which is twenty miles long and nine miles wide, is bounded on the north and east by a snow-clad ridge rising to 21,286 feet. A considerable portion of the water of the river is therefore derived from the melting snows, and it consequently receives its greatest supply during the warmer months. The area of the basin east of Gohna, and consequently the area draining into the lake which has been formed by the landslip, is about ninety square miles.

From the account of the villagers there seem to have been fields along the sloping portion of the gorge near Gohna on both sides of the river, whilst the hill they speak of as Maithána—the one which fell—rose almost vertically above the slope on the north side of the river. Two years ago there was a small slip between Maithana and Gohna village. On the 6th of last September (1893), and towards the close of the rainy season, two falls took place, damming back the river to form a lake. Falling continued for three days with deafening noise and clouds of dust which darkened the neighbourhood and fell for miles around, whitening the ground and tree-branches like snow. Further slips occurred at subsequent intervals after heavy rain; and at the time of Mr. Holland's visit, a day's rain or fall of snow was always succeeded by falls. Blocks of several tons would bound from ledge to ledge for more than 3000 feet over the broken hill face with a low rumbling noise and the production of clouds of dust. The hill which fell was a spur of over 11,109 feet high; but except on the edge of the precipice, where pieces could be pushed over with the foot, Mr. Holland found no cracks in the hill. The rocks exposed on the cliff-front are crumbled and faulted in a complicated manner and with varying dip; but on the west side of the slip the dip is towards the valley at a lower angle than that of the precipice, the average inclination of which is 54°. The mass of broken material which fell stretches for two miles along the river valley, and rests against the cliff of similar rocks on the opposite side a mile away. On the higher mounds, from which the mud has been washed away, large masses, sometimes weighing hundreds of tons, of crumpled dolomitic limestones are seen pitched in obliquely and shot out like a pack of cards. In the first fall, at any rate, the hill must have pitched forward and not have slipped down in the usual fashion of smaller slides. Blocks hurled a mile away against the opposite cliff have knocked down numbers of trees. The second main fall now stands as a heap of irregularly piled blocks weighing from about thirty tons down to ordinary hand specimens.

The surface of the dam exposed in early March was about 423 acres; but it was gradually being submerged on the eastern side by the rising lake. The lake in the beginning of March was $2\frac{1}{4}$ miles long, 1 mile wide at the widest part, and covered 370 acres. It was then rising at the rate of about six inches per day; but with the melting of the snows in the hot season, the rise must become more rapid. When full it will, unless a cutting is made, overflow at a point 5850 feet above sea-level; and the stream, rushing down an incline of 11°, will rapidly cut with increasing head a channel in the mud and loose stones, which cover that portion of the dam, until its speed is checked by the reduction of slope and the exposure of large blocks of dolomite which must occur below at no great depth. Mr. Holland found it impossible from mere inspection to estimate the thickness of the soft mud, but he thinks that if the rapid erosion becomes arrested before 100 feet has been cut, there will be preserved above a lake $3\frac{1}{4}$ miles long and $1\frac{1}{4}$ miles wide, the destruction of which by gradual erosion of the dam and silting up of the basin, though a matter of time geologically considered short, will be sufficiently slow for what historically may be called a permanent lake. The lake view from the dam is the crowning charm of scenery typically Himalayan and wild. The steep mountain slopes, partially clad with fir, evergreen oak, and gorgeously-flowered rhododendron, slope steeply down on either side to the blue-green waters of the lake, whilst to the east Tirsúl and two associated peaks, rising over 20,000 feet, with snow-clad slopes and glaciers, form the background of the picture (Fig. 1).

It is pointed out that at several places in the Himalayas, lakes have in the recent past been formed by landslips, filled, and afterwards cut through by their own streams. Mr. Oldham has described the very interesting case of Turag Tal near Gonain in Almora District, which was formed behind a barrier of slipped limestone 250 feet high. The level of the alluvium in the lake is now within 50 feet of top of the barrier, so the age of the lake is measured by the time required to deposit alluvium to a thickness of 200 feet. (*Rec. Geol. Surv. India*, vol. xvi. 1883, p. 164.)

Whilst the steep slopes of the mountains around the lake at Gohna add greatly to the beauty of the view, they are unfortunately a source of danger to the lake itself on account of their liability to follow the example of Maithána and slide down, displacing proportionately large bodies of water. At one spot, a little to the south-east of the dam and half-way to Durmi, where the dolomites dip in the direction of the steep slope towards the lake, the hill side may at any time slide into the lake. In 1869, higher up the same valley, a small lake, Gudyar Tal, having been formed in the same way by a landslip, became suddenly nearly filled with a second slip and displacement of a body of water, which flooded the valley of the Alaknanda and washed away part of Srinagar, 78 miles below. That this, sooner or later, will take place, seems to be certain; but when, it is impossible to say. The very size of the lake, however, will be a safeguard against high floods. Suppose, for instance, that the permanent lake had an area of 500 acres, and a slip of 12,500,000 cubic feet occurred—the maximum possibility near the south-east corner of the dam—the result would be that the water in the lake would rise about 7 inches. There are, however, one or two steep precipices on the north side of the lake, which Mr. Holland could not examine, and which he thinks might probably give larger slips.

Fears have frequently been expressed concerning the danger of the dam bursting under the hydrostatic pressure of the water accumulating in the lake above. The sections and map accompanying Mr. Holland's report should be sufficiently convincing to any engineer; but to remove any doubt concerning the security of the barrier, the strength of the dam is conveniently compared by a simple calculation with the actual hydrostatic pressure which it will have to resist before overflow occurs.

The point referred to as 5850 feet above sea-level is approximately in the centre of the dam, and lies in its weakest section. It is shown that this weak section would weigh about 401,922 tons. When the overflow is about to take place, the horizontal hydrostatic pressure against the section will be 13,950 tons.

The weight of the section is thus nearly twenty-nine times the horizontal pressure of the water. But even supposing this section to be free of friction from the sides, and only offers the resistance estimated by its own coefficient on a bed of the same material, it would require about four-fifths of its own weight to move it; that is to say, a pressure of 321,536 tons. But as the maximum horizontal pressure of the water will only be 13,950 tons, the weakest section of the dam is *at least* twenty-three times the necessary strength. This estimate would, of course, be still higher if the weight of the thousands of tons of dolomitic blocks which rise on either side the weak section and point of overflow were taken into consideration. Finally, the enormous pile of rubbish, weighing quite 800,000,000 tons and lying in a valley nearly one mile wide, would, if shifted, become jammed into a gorge only 500 feet wide.

Mr. Holland traces several causes, which were some time conspiring to the one end of bringing about the catastrophe that has been attended with such serious consequences at Gohna.

Among these the principal, or more correctly, the one which gave facilities for the action of all the others, is the dip of the strata towards the gorge. Over Gohna village, the dip of the dolomites in the south-east direction increases, until in Marthána itself the beds are inclined in the face of the cliff at an angle of about 45°–50°, and consequently large platey surfaces are exposed by the fall. As the dip of the rocks is greater than the angle of repose of dolomite or shale-slabs, sliding would naturally take place when necessary facilities are presented. So long as the slope of the surface does not exceed in angle the dip of the strata there is no danger of a slip; but when, as in this case, the foot of the slope is undermined by the action of a river and by springs, the average slope of the surface is increased, and there is a tendency for the beds lying between the line of slope and the line of dip to slide off.

It is pointed out that the influence of the dip of the strata in fashioning the surface slope is well illustrated in the Cheddar Valley. The river has cut a gorge approximately in the direction of the strike of the carboniferous limestone, which dips on both sides of the river at an angle of 15°-24° south. The south side of the gorge is an almost perpendicular cliff 400 feet high, whilst on the north side the slope is only slightly greater than the dip of the beds, which are constantly, though gradually, slipping down as the river is deepening its valley. Thus, whilst an almost perpendicular cliff is safe on the south side in which direction the rocks dip, there is a perpetual slipping on the north side, and no slope greater than the angle of repose of the loose blocks would be safe.

In the landslip at Gohna not only was the support removed by undermining at the foot of the slope, and loosening of the beds, but the beds were impelled outwards by a series of changes following as a natural consequence of the processes which destroyed the originally compact nature of the strata. These causes combined, taking advantage of the stratigraphical facilities, precipitated the mass of material which now dams back the Birahi Ganga. They are as follows:—

(1) *Those producing a loosening of the strata.*

(*a*) Dolomitisation.
(*b*) Solution by atmospheric waters.
(*c*) Reduction of coefficient of friction by water.

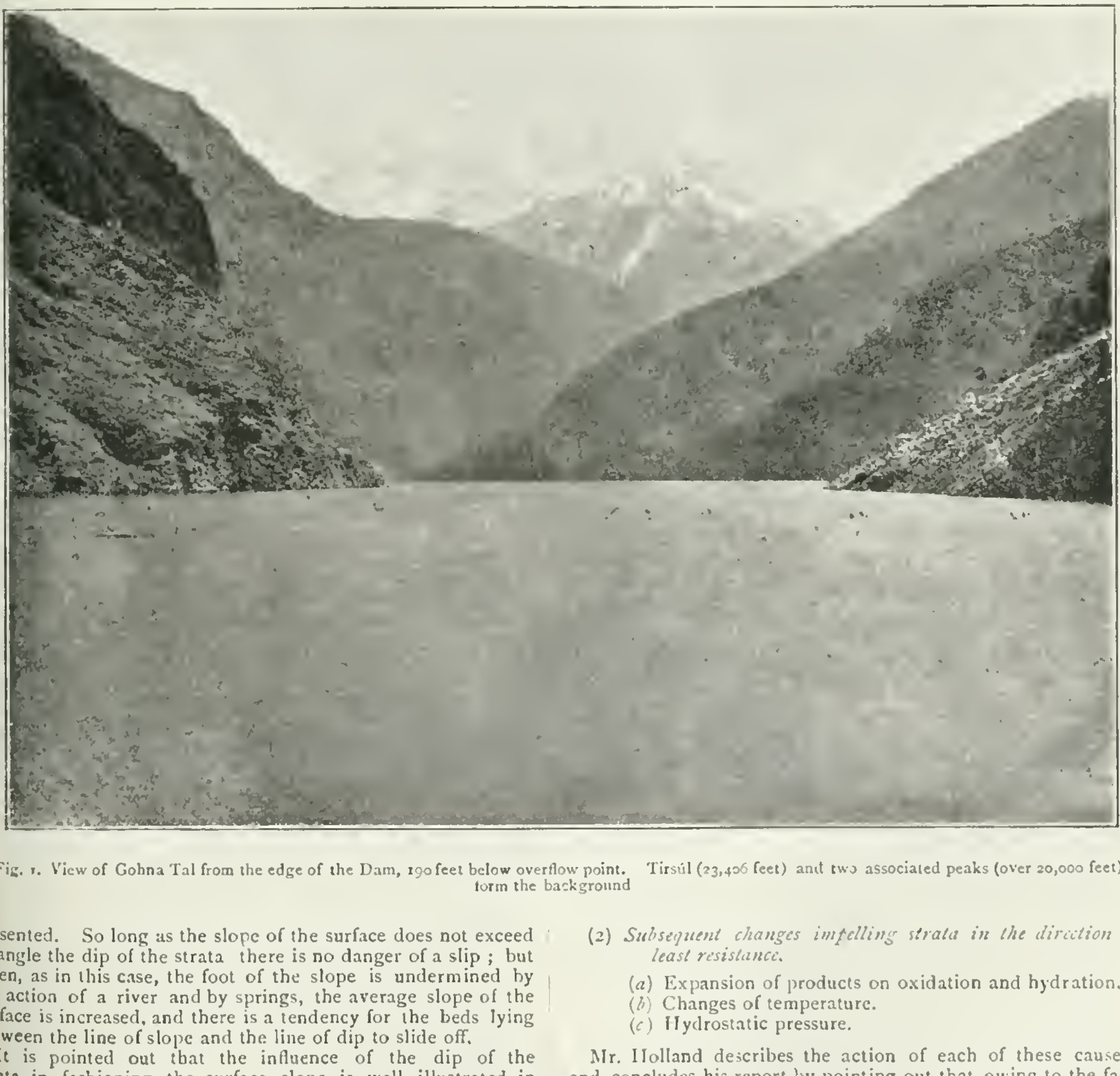

Fig. 1. View of Gohna Tal from the edge of the Dam, 190 feet below overflow point. Tirsúl (23,406 feet) and two associated peaks (over 20,000 feet) form the background

(2) *Subsequent changes impelling strata in the direction of least resistance.*

(*a*) Expansion of products on oxidation and hydration.
(*b*) Changes of temperature.
(*c*) Hydrostatic pressure.

Mr. Holland describes the action of each of these causes, and concludes his report by pointing out that owing to the fact that the folding of the Himalayan range has continued to times geologically recent, if not still in action, there has resulted a condition of strain frequently manifesting and relieving itself by earthquakes, and of steep slopes with rushing torrents, frequently resulting in landslips. When subsequently the inequalities of level have been sufficiently reduced by denudation, the slopes will be more stable, rivers less violent, and the scenery tamer—a condition of affairs exemplified by the more geologically old-fashioned peninsular portion of India. Water, the great agent of denudation, has, by its chemical and physical action, been the cause of the landslip at Gohna, but the effects of the potential energy accumulating in the lake have to be patiently awaited.

SCIENCE IN THE MAGAZINES.

In the *Fortnightly* Prof. Karl Pearson heads a forcible article on "Socialism and Natural Selection" with the following quotation from Darwin:—"What a foolish idea seems to prevail . . . on the connection between Socialism and Evolution through Natural Selection." His contribution is a diatribe against the views set forth by Mr. Kidd in "Social Evolution" and the reviewers who have hailed the work as scientific in its construction and conclusions. Dr. Louis Robinson points out the glaring moral inconsistency of the majority of anti-vivisectionists, who "while they claim to be actuated by the great principle that kindness to all living creatures should be a rule from which only the direst necessity can excuse us . . . are content to ignore the cruelties which are most wanton, most severe, and most frequently inflicted. Moreover, this strange callousness to the great mass of animal suffering is not deemed inconsistent with a frenzied onslaught on the practice of experimenting upon animals in the interest of medical science, although such experiments are deemed absolutely needful by nearly all those who know anything at all about the subject, and although the pain so caused is but as a drop in the ocean when compared with that inflicted in sport, or for monetary profit. . . . . Now what would all the good humanitarians say, if some man of science, pursuing knowledge rather than pleasure, were deliberately to smash the leg of an animal, and lacerate its flesh with some blunt instrument, and merely to save himself a little trouble, were to let it crawl about the laboratory, with a compound fracture and wounds unattended to, while he busied himself with something else? What, if he were to commence an operation on a pigeon by wrenching off a wing and gouging out an eye, and then were to stroll off to lunch, and a game of billiards, intending to come back and finish the business when he had leisure? What if he were to tear open the abdominal cavity of a rabbit, and, rather than spend a quarter of an hour in completing the operation he had begun, were callously to let it die in all the unspeakable agonies of peritonitis? What, again, would they say if, when the vicar dropped in to afternoon tea and asked about the result of the experiments, our investigator were to smile and rub his guilty hands as he replied that he had had a most enjoyable morning? And, lastly, what would they say about the vicar if on hearing this shameless avowal he joined in the abominable rejoicings of his host, and accepted a gift of the mangled carcases of the victims?"

The *Contemporary* contains a reply by Prof. Bonney to Dr. Wallace's arguments in favour of the excavation of lake basins by glaciers (*Fortnightly*, Nov. and Dec. 1893). Prof. Bonney winds up by saying: "Notwithstanding Dr. Wallace's ingenious advocacy of the erosive power of glaciers and ice-sheets, I maintain that these can excavate only under the most favourable conditions, and then but to a limited extent, and that they are proved by a close study of the Alpine peaks and valleys to have been incapable of hollowing out the great lakes of that chain."

Dr. Carl Lumholtz has been for the past three years making explorations in the almost unknown regions of the Sierra Madre in Mexico. The first of a series of papers on his discoveries appears in *Scribner's Magazine* under the title, "Among the Tarahumari." The paper is profusely illustrated from photographs taken by the author. The following extracts are of interest:—

"Cave-dwellers are found among the following tribes, counting from the north: The southern Pimas, the Tarahumaris, and the allied tribe of Huaregios, and the Tepehuanes. All these tribes inhabit the State of Chihuahua and are more or less mountaineers living almost entirely in the great Sierra Madre range. Of these people the Tarahumaris are most attached to caves, the Tepehuanes the least. All are linguistically related. In some of their customs and manners they also greatly resemble each other, while in others, as well as in character, they are strikingly different. Very little that may be called accurate was known of these tribes. The Tarahumaris, the most primitive of them and the least affected by Mexican civilisation, are the most interesting."

As to the relation of these people to the cliff-dwellers of the south-west, Dr. Lumholtz remarks: "Are the cave-dwellers related to the ancient cliff-dwellers of the south-western part of the United States and northern Mexico? Decidedly not. Their very aversion to living more than one family in a cave, and their lack of sociability, marks a strong contrast with the ancient cliff-dwellers who were by nature gregarious. The fact that people live in caves is in itself extremely interesting, but this alone does not prove any connection between them and the ancient cliff-dwellers. Although the Tarahumari is very intelligent, he is backward in the arts and industries. His pottery is exceedingly crude, as compared with the work found in the old cliff-dwellings, and its decoration is infantile as contrasted with the cliff-dwellers' work. The cliff-dwellers brought the art of decoration to a comparatively high state, as shown in the relics found in their dwellings. But the cave-dweller of to-day shows no suggestion of such skill. Moreover, he is utterly devoid of the architectural gift, which resulted in the remarkable rock structures of the early cliff-dwellers. These people, so far as concerns their cave-dwelling habits, cannot be ranked above troglodytes."

Prof. N. S. Shaler, of Harvard, continues his popular studies of domestic animals with a paper on "Beasts of Burden," showing the great part they have played in the civilisation of man. The article is richly illustrated.

A chatty article on British vipers is contributed to *Chambers's* by Dr. A. Stradling. This journal also contains "Wintering on Ben Nevis," by Mr. R. C. Mossman, being a description of meteorological phenomena observed during a winter's exile in the Ben Nevis Observatory. We also note a description of some of the methods adopted by the modern pharmaceutist to make the medicines he dispenses less objectionable than formerly; an article on diamonds, and others on recent developments of photography, "The Sleep of Plants," and "Nest-building Insects."

Sir Henry Roscoe writes on "The New Education" in the *Humanitarian*, and states in his article what is being done in the way of technical instruction. The same journal is the arena of a more or less heated discussion on vivisection. Lady Burton expatiates upon "The Position of Animals in the Scale of Nature," and Dr. E. Berdoe replies to Prof. Victor Horsley's criticisms which appeared in the June number. Lady Burton suggests that criminals sentenced to death should be given the option of being experimented upon or of dying a felon's death. The same idea has been put forward by another writer. In the *Sunday Magazine* we find a concluding article on "The Stuff we are made of," by Dr. J. M. Hobson.

Sir Robert Ball must have a rather poor opinion of the readers of *Cassell's Family Magazine*, or he would not offer them such "an old, old story" as that he tells in "A Talk about the Pleiades." A few remarks on the visibility of stars in the cluster are followed by some trite conclusions upon the gregarious character of the proper motions, a vague statement as to the spectra of the components, and a description of the photography of the group. All this is illustrated by two cuts from one of the author's books and a reproduction of the plate based upon the photograph taken by the Brothers Henry some years ago. Nothing but the author's reputation would have secured the insertion of such a commonplace contribution. An article of a better stamp is his sketch of the life of Sir William Herschel in *Good Words*, being the third of a series on "The Great Astronomers." This series is evidently intended to be published in book form when completed. Misconception will certainly result, however, from the description of the discovery of Uranus. From Sir Robert Ball's account, readers are led to believe that Herschel knew that the object that came within his ken in March 1782 was a planet, as soon as he had found that it was a disc capable of magnification. But it is well known that Herschel thought the object was a comet; in fact, he announced his discovery as cometary, and it was not until some months later that its planetary nature was established by considerations of the orbit it pursued. We would, therefore, suggest to the learned Lowndean professor that he would do well to modify the following statement—"Great then was the astonishment of the scientific world when the Bath organist announced his discovery that the five planets which had been known from all antiquity must now admit the company of a sixth."

The *Century* contains the third part of "Across Asia on a

Bicycle" by Messrs. T. G. Allen and W. L. Sachtleben, an article on "Coasting by Sorrento and Amalfi," and one on "The Higbroad from Salerno to Sorrento," all of them being well illustrated.

In addition to the magazines named in the foregoing, we have received *Longman's*, containing "Polar Bear Shooting on the East Coast of Greenland," by Dr. Nansen, and "Chamois Hunting above the Snow Line," by Mr. Hugh E. M. Stutfield.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following are the speeches delivered by the Public Orator, Dr. Sandys, Fellow and Tutor of St. John's, on June 27, in presenting Sir John Bennet Lawes, Bart., F.R.S., Sir Joseph Henry Gilbert, F.R.S., and Prof. Mendeléef, for the honorary degree of Doctor in Science:—

(1) Salutamus tandem par nobile collegarum qui de agrorum cultura, de pecudum alimentis variis, experimentis exquisitis una elaborandis annos quinquaginta, magnum profecto aetatis humanae spatium, dedicarunt. Tot annorum autem labores non modo chartae fideles in perpetuum custodient, sed etiam saxum ingens nomine utroque insculptum inter posteros testabitur. Ab ipso autem "monumentum aere perennius" erit exactum, experimentis tam utilibus, tam fructuosis, munificentia ipsius etiam in posterum continuatis. Auguramur, nec nos fallit augurium, in agri culturae annalibus talium virorum nomina fore immortalia.

Duco ad vos Baronettum insignem, Regiae societatis socium, virum doctoris titulo bis aliunde merito ornatum, IOANNEM BENNET LAWES.

(2) Quos tot annorum labores una coniunxerunt, eos in laudibus nostris hodie divellere vix possumus. Constat tamen labores illos viri huiusce scientiae admirabili et industriae indefessae plurimum debere. Constat eosdem eiusdem scriptis, eiusdem orationibus, non modo in patria nostra sed etiam peregre maximo cum fructu esse patefactos. Cum collega suo summa concordia coniunctus, Plinii verba iure optimo posset usurpare: "nobis erat nullum certamen, nulla contentio, cum uterque pari iugo non pro se, sed pro causa niteretur."

> "Felices ter et amplius
> quos irrupta tenet copula."

Duco ad vos Regiae societatis socium, virum ab ipsa Regina equitem propter merita nominatum, IOSEPHUM HENRICUM GILBERT.

(3) In scientia chemica investiganda diu inter peritos quaerebatur, quaenam ratio interesset inter atomorum pondera e quibus rerum elementa constarent et vires eas, sive chemicas sive physicas, quae elementis ipsis velut propriae inhaererent. Qua in ratione penitus perscrutanda atque ad certam quandam legem redigenda nemo plura perfecisse existimatur quam vir illustris qui Siberia in remota natus, et undecim abhinc annos a societate Regia Londinensi numismate aureo donatus, hodie nostra corona qualicumque decoratur. Magnum profecto est inter tot elementa rationem certis intervallis velut circuitu quodam recurrentem observasse, eque rerum notarum observatione etiam ignota providisse. Viri huiusce ingenio etiam elementa prius inaudita mentis divinatione singulari praedicta sunt posteaque in ipsa rerum natura reperta. Quae elementa, trium gentium insignium nominibus Gallium, Scandium, Germanium nuncupata, nomen ipsius illustrius reddiderunt et Russorum famam, quantum ad ipsum attinet, feliciter auxerunt. Ergo virum de scientia chemica tam diu tamque praeclare meritum, totque titulis aliunde ornatum, hodie etiam nostrorum

> "turba Quiritium
> certat tergeminis tollere honoribus."

Newtoni certe in Academia honos ei praesertim debetur, qui etiam in scientia chemica Newtoni in vestigiis tam fideliter insistit, ut alumni nostri "qui genus humanum ingenio superavit" imaginem intuens, Lucretii verba paululum mutata possit usurpare:—

> "te sequor, o Grantae magnum decus, inque tuis nunc
> ficta pedum pono pressis vestigia signis."

Duco ad vos scientiae chemicae professorem Petroburgensem, DEMETRIUM IVANOVITCH MENDELEEF.

SCIENTIFIC SERIALS.

American Journal of Science, June.—Notes from the Bermudas, by Alexander Agassiz. The story of their present condition is practically that of the Bahamas, with the exception that at the Bermudas we have an epitome, as it were, of the physical changes undergone by the Bahamas. The development of the true reef builders, of the massive corals, is insignificant. Subsidence has brought about the existing outlines of the islands, but there is no evidence to show that the original annular coral reef was formed during subsidence. That reef has disappeared, and nothing is left of it except the remnants of the æolian ledges extending to sixteen or seventeen fathoms outside the reef ledge flats, ledges which owe their existence to the material derived from it: the former æolian hills of the proto-bermudian land.—Discovery of Devonian rocks in California, by J. S. Diller and Charles Schuchert. During the field seasons of 1884 and 1893, the U.S. Geological Survey acquired six lots of Devonian fossils, comprising about thirty species, mostly corals. They demonstrate the undoubted presence of middle Devonian deposits in California, where rocks of this age have long been looked for by geologists, more particularly since the recent discovery of Silurian fossils.—New method of determining the relative affinities of certain acids, by M. Carey Lea. This method is based on the principle that the affinity of any acid is proportional to the amount of base which it can retain in the presence of a strong acid selected as a standard of comparison for all acids. When to free sulphuric acid a salt is added in sufficient quantity to cause the whole of the sulphuric acid to saturate itself with the salt base, it is possible by means of the herapathite test to determine the exact point of such saturation. From this we can deduce the exact nature of the resulting equilibrium. A series of equilibria thus obtained with different salts enables us to determine the comparative strength of the affinities of the acids of these salts. The fact that even small quantities of weak acids added to sulphates will set free a certain quantity of sulphuric acid, can be rendered visible to the eye by a well-marked chemical reaction.—A recent analysis of Pele's Hair and a stalagmite from the lava caves of Kilauea, by A. H. Phillips. The stalagmite is of the kind characteristic of the lava caverns of Kilauea, differing very slightly from Pele's Hair in constitution, but widely from ordinary stalagmites formed by undoubted solution. They are suggestive of fused drops, which falling one on the other are at the time sufficiently plastic to be quite firmly welded together and congealed in a slightly drooping position.

Bulletin of the New York Mathematical Society, vol. iii. No. 8, May 1894. (New York: Macmillan.)—"Utility of quaternions in physics" is an analysis by Prof. A. S. Hathaway of A. McAulay's essay, which is well known to our readers (see NATURE, December 28, 1893, amongst other references). The reviewer considers it to be "of undoubted scientific value, and the work of a man of genuine power and originality," and that it will go far towards accomplishing the author's purpose of arousing serious interest in quaternion analysis.—Prof. Eneström, in a note upon the history of the rules of convergence in the eighteenth century, calls attention to two other mathematicians, in addition to those named in a notice by Prof. Cajori, in vol. ii. pp. 1–10, viz. Maclaurin and Stirling: for the former he claims "a signal place in the history of these rules."—Prof. F. Franklin concisely abstracts Dr. Franz Meyer's "Bericht über den gegenwärtigen Stand der Invariantentheorie," a work which gives a remarkably full abstract of researches in the domain of algebraic forms and Invariants.—Cajori's "History of Mathematics" (pp. 190–197) is a work which Prof. D. E. Smith submits to a searching examination, the commencement of which is a severe condemnation of great part of the book, founded on a side by side comparision of Cajori's statements with those of previous writers on the subject, which he is alleged to have copied without giving due credit to the authors cited. He states the book to be weak in bibliography, and carelessly written. Its merits are that it tells the general story of the growth of mathematics in a popular way, is well printed and "altogether an attractive piece of book-making." Not having seen the work we cannot say if this witness is true, but he certainly adduces evidence which it will be hard to rebut.—"Gravitation and absolute units of force" is an abstract of a paper read before the New York Mathematical Society by Prof. W. Woolsey Johnson. Prof. Greenhill's views are noticed. The "notes" say that in a discussion on the paper, Mr. C. S. Peirce proposed that the term "Galileo" be applied to the unit of acceleration in the C.G.S. system. We also find in them an account of the proceedings at the centenary celebration of the birth of Lobachevsky by the Physico-Mathematical Society of the University of Kazan. Further we learn that Lambert's essay (cf. our notice of the *Bulletin* for December 1893) is to be incorporated in a volume entitled "Die Theorie du Parallellinien" (Teubner, of Leipzig), to be edited by Drs. P. Stoeckel and F. Engel. The prime factor will be the "first book of the marvellous work by Saccheri, 'Euclid vindicated from every fleck,'" in which (in 1733) the two hypotheses which, besides Euclid's, are possible are developed, and all the results obtained which have been ascribed to Legendre. There is a list of new publications in higher and applied mathematics.

Wiedemann's Annalen der Physik und Chemie, No. 7.—Further electro-optical experiments, by J. Elster and H. Geitel. The capacity of thin layers of sodium, potassium, and rubidium applied to the walls of vacuum tubes of promoting the passage of a current when illuminated differs for different colours. For long waves, rubidium is the most, and potassium the least sensitive. If the layers are illuminated by polarised light the current intensity is greatest when the plane of polarisation is perpendicular to the plane of incidence. Electric oscillations of small period can be transferred to rarefied gas by illumination in presence of an alkali metal.—A new phenomenon attending the passage of electricity through badly conducting liquids, by O. Lehmann. This is a description of the formation of halos round the electrodes in a solution of pigments in water thickened with gelatine, sugar, or glycerine. Considerable disturbance is produced where the different coloured halos meet, while the rest of the solution remains undisturbed.—Experiments with Tesla currents, by F. Himstedt. The author gives an account of methods by which Tesla's experiments can be repeated with ordinary laboratory apparatus. High potential and rapid oscillations were produced by a Lecher wire combination used for producing Hertz oscillations.—On the demonstration of Hertz's experiments, by P. Drude. The author avoids the necessity of a high tension accumulator, as used by Zehnder, by allowing the sparks of the resonator to discharge an electroscope charged by a dry pile. The point behind the concave mirror is put to earth; also one pole of the dry pile, the other pole being connected with the electroscope and the sphere behind the mirror. When sparks pass, the leaves of the electroscope collapse partly or totally. This may be shown to a large audience by projecting an image of the electroscope on to a screen.—The change of phase of light by reflexion at thin films, by W. Wernicke. Under the name of "optical phase analysis" the author describes a method of detecting exceedingly minute impurities on the surface of polished glass or glass covered with a thin layer of gelatine. The influence of the play of cohesive force upon free molecules as regards their optical properties is investigated for pigments and the metals, with especial reference to silver.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 8.—"Thermoelectric Properties of Salt Solutions." By George Frederick Emery, late Scholar of Trinity College, Cambridge.

In a circuit formed by a metallic wire and a solution an electromotive force is developed proportionately to the difference of temperature between the junctions. The solution to be examined is put in a U-tube with an electrode and thermometer in each limb, round one of which is a hot water-jacket. δ is $\equiv$ E.M.F. per 1° C., unit δ being 10^{-4} volt. Experiments were made with acetate, chloride and sulphate of zinc, and sulphate nitrate and acetate of copper. δ varied considerably with concentration. The value for pure water appears to be about 8·6, but cannot be measured directly; for some salts δ increases with concentration, for others it diminishes. In all cases examined the current would go from hot to cold through the solutions. With zinc salts amalgamated zinc electrodes were used; with the copper salts the electrode used was a fine wire projecting from the end of a drawn-out glass tube. Values of δ for mixed salts seemed to show that differences from the water value are qualitatively but not quantitatively additive. Thus δ, starting from about 8·6, tends for moderate concentrations to a nearly constant value for each salt. M. Bouty, with very strong solutions of zinc chloride, found that δ rapidly diminished, whence the entire curve for all concentrations between zinc chloride and pure water would have a point of inflexion. If, keeping the salt a fixed quantity, we use mixtures of two solvents, we get a complete curve for δ. Experiments on 1 per cent. of cadmium bromide gave good results with all solvents used; with mixtures of methyl alcohol and water with alcohol, it gave the following values:—

Methyl alcohol per cent.	δ
100·0	11·3
90·0	11·0
81·3	10·76
70·0	10·4 – 10·5
50·0	10·27
30·0	9·86
18·7	9·64
10·0	8·9
0	8·15

Water per cent.	δ
100·0	7·0
98·9	6·86
90·0	5·83
75·0	5·053
50·0	4·075
25·0	4·123
0	8·15

In the first we have an inflected curve never far from the mean, in the second a small admixture causes a large drop in δ. These two pairs of solvents represent two classes. The alcohols mix quietly without chemical action, while alcohol and water mix with evolution of heat, and change in bulk.

A few experiments, believed to be entirely novel, were made on the E.M.F. in a circuit composed of two kinds of liquid with junctions at different temperatures. Zinc sulphate 4 per cent. and weak zinc chloride gave $E/(t' - t) = 1·36 \times 10^{-4}$ V.

Zinc acetate and zinc sulphate gave $E/(t' - t) = 0·8 \times 10^{-4}$ V, $1·05 \times 10^{-4}$ V, $1·13 \times 10^{-4}$ V, mean value $= 1 \times 10^{-4}$ V.

Lastly, measurements of the Peltier effect at a metal-liquid junction were made with various apparatus with fairly consistent results.

For 15 per cent. copper sulphate and copper, different measurements gave the heat evolved per unit $\equiv$ H = 0·1992, 0·1927, 0·1956, 0·2078, 0·2091, 0·1952.

The last and best gives $H/T = 6·83 \times 10^{-4} = \delta$ for the solution. Cupric nitrate with $\delta = 6·14$ gave $H = 0·1764$, $H/T = 6·1$. Thus these thermoelectric effects are of a reversible nature.

May 10.—"The total eclipse of April 16-17, 1893. Report of results obtained with the slit spectroscopes." By Captain E. H. Hills, R.E.

This paper deals with the results obtained from the photographs of the spectrum of the eclipsed sun taken in Brazil and Africa at the total eclipse of April 1893. The instruments employed, of which there were four, were slit spectroscopes of the ordinary type, and were each arranged to take one photograph during totality. Of the four resulting photographs two were partially unsuccessful and were not measured. The two others each show a strong prominence spectrum, and on both sides of this a continuous coronal spectrum, in which latter are seen a number of very faint lines. The wave-lengths of these lines were determined by using the known lines in the prominence spectrum as reference points, and from these constructing an interpolation curve. The coronal lines, whose wave-lengths were thus fixed, were, in almost all cases, apparently identical with lines which had been observed at previous eclipses, instruments of a similar type having been employed at the eclipses of 1882, 1883, and 1886.

The prominence spectrum, as shown on the photographs, extends from w.l. 3667 to w.l. 5316. It is chiefly remarkable for the extended hydrogen series, there being eight lines beyond the one at w.l. 3699, the wave-lengths of which are given as 3692·5, 3687, 3682, 3678, 3675, 3672, 3669·5, 3667.

"Researches on Modern Explosives" (preliminary communication). By William Macnab and E. Ristori.

A series of experiments with explosive compounds has been undertaken by the authors for the purpose of studying chemical reactions at high temperatures and pressures, and of elucidating certain thermal constants relating chiefly to the specific heat of gases under such conditions. Nitroglycerin, nitrocellulose, and several combinations of these two bodies, which are used as smokeless powders, have been chiefly employed in these experiments. The results given in this communication relate principally to the amounts of heat evolved by explosion in a closed vessel, and the quantity and composition of the gases produced. The following table contains the results of some of the experiments:—

Table Indicating the Quantity of Heat, also the Volume and Analysis of the Gas developed per gram with Nitro-glycerin, Nitro-cellulose, and with several different Combinations of these two Explosives made at Ardeer Factory.

Composition of explosive.	Calories per gram.	Permanent gas.	Aqueous vapour.	Total volume of gas calculated at 0 and 760 mm.	Per cent composition of permanent gases.						Coefficient of potential energy.
					CO_2	CO	CH_4	O	H	N	
		c.c. per gram.	c.c. per gram.	c.c. per gram.							
A. Nitro-glycerin	1652	464	257	741	63·0	—	—	4·0	—	33·0	1224
B. Nitro-cellulose (nitrogen = 13·30 per cent.)	1061	673	203	876	22·3	45·5	0·5	—	14·9	16·9	929
C. { 50 per cent. nitro-cellulose (N = 12·24 per cent.) / 50 per cent. nitro-glycerin .... }	1349	568	249	817	36·5	32·5	0·2	—	8·4	22·4	1102
D. { 50 per cent. nitro-cellulose (N = 13·3 per cent.) / 50 per cent. nitro-glycerin .... }	1410	550	247	797	41·8	27·5	0 0	—	6·0	24·7	1124
E. { 80 per cent. nitro-cellulose (N = 12·24 per cent.) / 20 per cent. nitro-glycerin .... }	1062	675	226	901	21·7	45·4	0·1	—	15·7	17·1	957
F. { 80 per cent. nitro-cellulose (N = 13·30 per cent.) / 20 per cent. nitro-glycerin .... }	1159	637	227	864	26·6	40·8	0·1	—	12·0	20·5	1001
G. { 35 per cent. nitro-cellulose (N = 13·30 per cent.) / 5 per cent. vaseline .... / 60 ,, ,, nitro-glycerin }	1280	627	236	863	26·7	39·8	0·5	—	12·8	20·2	1105

Results are also given when several recognised smokeless powders were fired under various conditions.

The authors are continuing their investigations, and are especially endeavouring to measure the actual temperature of explosion, in which direction considerable success has been attained.

June 7.—"Contributions to the Life-History of the Foraminifera." By J. J. Lister, St. John's College, Cambridge.

In this paper it is shown from an examination of a large number of specimens of *Polystomella crispa* (*Linn*), that the individuals of this species fall into two sets, corresponding with the forms A and B (of Munier-Chalmas and Schlumberger), which have been shown to exist in species of *Nummulitidæ*, *Miliotidæ*, and other families of Foraminifera. The two forms may be distinguished as *megalospheric* and *microspheric*, being characterised by a marked difference in the size of the chamber occupying the centre of the shell.

Associated with this difference in structure there is a marked difference in the nuclei of the two forms.

Individuals of the microspheric form, whose central chamber is about 10 μ in diameter, have many small nuclei distributed through the inner chambers. Evidence is brought forward to show that in this form the nuclei multiply at first by simple division, and that ultimately they give off portions of their substance, which become distributed through the protoplasm in the form of irregular deeply staining strands. The ultimate fate of the microspheric form was not traced in *Polystomella*.

The megalospheric form, whose central chamber is generally about 70 μ in diameter, has, in the usual condition, a single large nucleus which grows in size with the growth of the protoplasm, and passes from chamber to chamber, moving towards the centre of the protoplasm contained in the series of chambers. There is evidence to show that in this form, also, the nucleus parts with portions of its substance. Ultimately the nucleus disappears, and in its place hosts of minute nuclei (1–2 μ in diameter) are found, which eventually become evenly distributed and divide by karyokinesis, the entire protoplasm being aggregated about the dividing nuclei in spherical masses. Resulting apparently from this division, flagellated swarm cells, having a diameter of 3–4 μ, are produced, which escape, leaving an empty shell.

In *Orbitolites complanata* (*Lamck.*), in which species the microspheric form attains the larger size, specimens of this form, with young in their peripheral annuli (brood chambers) were examined. It was found that the protoplasm was withdrawn from the central chambers, being represented by the megalospheric young massed in the brood chambers. The young contain a nucleus in their primordial chamber, which maintains this position during a large part of the period of growth of this form. While the production of megalospheric young by a microspheric parent, which was recorded by Brady, was thus confirmed, the production of megalospheric young by a megalospheric parent was also observed in three cases.

The relation of nuclear characters to the two forms was analogous to that found in *Polystomella*, and a similar relation was found in *Rotalia beccarii* (*Linn.*) and *Calcarina hispida*, Brady.

In conclusion, the question of the relationship of the two forms, under which the Foraminifera present themselves, is discussed, and reasons are urged for regarding them as distinct from their origin.

The hypothesis that they represent the two sexes is negatived by the case of *Orbitolites* in which both forms have been found producing the young of the megalospheric form, a condition incompatible with the view that either is male.

It is suggested that the two forms are members of a recurring cycle of generations, and on this view it must be supposed, from the condition presented by *Orbitolites*, that the megalospheric form may, at least in this genus, be repeated for one or more generations before the microspheric form recurs.

June 7.—"Niagara Falls as a Chronometer of Geological Time." By Prof. J. W. Spencer.

Various estimates of the age of Niagara Falls already have been published, the maximum being 55,000 years, the minimum 6000. The author, after describing the topography and geology of the district, calls attention to the fact that the Niagara river in pre-glacial times had no existence. The peculiar extension of the chasm at the Whirlpool and the buried valley at St. David's belong to a separate and shallower buried valley, through which the Niagara cañon has been cut. The drainage of the tableland in ancient times was across the direction of the Niagara river, and was strongly marked by bold limestone ridges, which have only been penetrated by the Falls in modern times. Even the Erie basin emptied by a route several miles west of the Niagara.

The basement of the present river channel is described, and the discharge estimated. Attention also is called to the fact that during a considerable portion of the life of the river, only the waters of the Erie basin, or 3/11 of the whole drainage of the great lakes, passed over the Falls.

From four surveys, extending over a period of forty-eight years, the mean modern rate of recession of the Falls is found to be 4·175 ft. a year. Its rate is variable with secular episodes of rapid medial recession, followed by its cessation along the axis, but with increased lateral retreat. This cycle appears to take about fifty years. This rate is, however, excessive, on account of the geological conditions favouring the rapid modern recession, but the rate taken for the mean recession under the conditions of the modern descent of the river with the present discharge is 3·75 ft. a year.

At one time a great proportion of the lake region was covered by a single sheet, or the Warren water. Upon its dismemberment—in part, at least, by the rise of the land—one large lake was formed occupying the basins of Huron, Michigan, and Superior; and another a portion of the Erie extending into the Ontario basin. The waters in these two basins were subsequently lowered, so that they fell to their rocky eastern rims; the three upper lakes discharged by way of Lake Nipissing and the Ottawa river, and the Niagara had its birth, draining only the Erie basin. Then the Niagara river descended 200 ft. In course of time the waters subsided 220 ft. more, but eventually they were raised again 80 ft. at the mouth of the Niagara, thus reducing the descent of the river from the head of the rapids above the falls to the foot of the last rapids in its course to the lake to 320 ft. During the lowest stage, Ontario lake receded twelve miles from the end of Niagara gorge, where the falls had been located at their nativity.

After a discussion of the laws of erosion, the author sketches as follows the history of the Niagara Gorge and Falls:—

First episode: Water falling 200 ft., in volume, 3/11 of modern discharge; gorge, 11,000 ft. long; duration, 17,200 years. Second episode: river descending 420 ft., in three cascades; first stage, only the discharge of the Erie waters; length of chasm, 3000 ft.; duration, 6000 years; second stage, drainage of all the upper lake; length of chasm, 7000 ft.; duration, 4000 years. Third episode: same volume and descent as in last, but the three falls united into one fall; length of chasm, 4000 ft.; duration, 800 years. Fourth episode: volume of water as at present, the level of lower lake as to-day; first stage, a local rapid making the descent of 365 ft.; work particularly hard; length of gorge, 5500 ft.; duration, about 1500 years; the second stage as at present; work easy; length of canon, 6000 ft.; descent of water, 320 ft.; rate of recession here taken as the full measured amount of 4175 ft. a year; duration, 1500 years. Thus the age of the Falls is computed to be 31,000 years, with another 1000 years as the age of the river before the nativity of the Falls. The turning of the Huron waters into the Niagara was about 8000 years ago. A difficult question was the amount of work done in each episode. This was in part determined by the position of the remaining terraces corresponding to different stages of the river, and by the changing effects of erosion.

These terraces in the lake region have been deformed by unequal terrestrial elevation, to which the changing conditions of the river are largely due. The deformation affecting the Niagara district, since the commencement of the river epoch, amounts to 2·5 ft. per mile; east of Lake Huron, 4 ft. per mile; and at the outlet of Lake Ontario, 5 ft. per mile; all in a north-eastward direction. Taking the amount of movement in each district as representing also the proportional measure of time, then calculations can be made upon several of the beaches, and in terms of the age of Niagara their antiquity can be inferred. In the application of these results it appears that the rate of terrestrial uplift in the Niagara district is about 1·25 ft. a century; 2 ft. east of Lake Huron, and 2·5 ft. at the outlet of Lake Ontario.

These sketches lead to the conclusion that the beginning of the lake age was about 64,000, or possibly 80,000 years ago; assuming that its waters were not held up by ice-dams. If that were so, the date would be much less remote. If the present rate of uplift continues, the Falls will be brought to an end, before they have reached Lake Erie, by the diversion of the waters of the upper lakes, by way of Chicago, to the Mississippi, which change might be expected 7000-8000 years hence.

June 14.—"Flame Spectra at High Temperatures. Part II. The Spectrum of Metallic Manganese, of Alloys of Manganese, and of Compounds containing that Element." By W. N. Hartley, F.R.S.

The spectrum of manganese has been the subject of much investigation; the spark spectrum was examined by Huggins, Thalén, and Lecoq de Boisbaudran; the arc spectrum was studied by Ångström, Thalén, Cornu, Lockyer, also Liveing and Dewar; the flame spectra obtained from compounds of manganese were investigated by Simmler, Von Lichtenfels, Lecoq de Boisbaudran, and Lockyer, while Marshall Watts has given us accurate measurements of the wave-lengths of lines and bands observed in the spark and oxyhydrogen flame-spectra of spiegel-eisen, manganese dioxide, and other compounds of this metal.

Photographs of the spectra of metallic manganese and of manganic oxide were taken and compared. They were also compared with the spectra of the alloys of manganese. The periods of exposure varied from a mere flash in the case of spiegel-eisen when being poured into a Bessemer converter, to 30 minutes and even as much as 80 minutes with manganic oxide.

The leading features of the spectra of manganese and manganese oxide are the same, but they differ in detail, as may be observed by comparing the wave-lengths of the lines and bands in their respective spectra.

A striking group of lines, the most persistent in the whole of these spectra, is situated in the violet. The following measurements were made:—

4036·5	4034·9	Ångström, also Cornu.
4032·0	4032·9, 4031·8	Ångström.
4029·5	4029·4	Ångström.

June 21.—"A Contribution to the Study of (i.) some of the Decussating Tracts of the Mid- and Interbrain, and (ii.) of the Pyramidal System in the Mesencephalon and Bulb." By Prof. Rubert Boyce.

Chemical Society, June 7.—Dr. Armstrong, President, in the chair.—The following papers were read:—The crystallography of the normal sulphates of potassium, rubidium, and cæsium, by A. E. Tutton. The author shows that the whole of the crystallographical properties of the strictly isomorphous rhombic normal sulphates of potassium, rubidium, and cæsium are functions of the atomic weight of the metal which they contain. —Observations on the nature of phosphorescence, by H. Jackson. The phenomena of fluorescence, of phosphorescence in air on exposure to light, and of phosphorescence of substances in a vacuum under the influence of the electric discharge, seem to be of the same order, and consist in a response on the part of the substances to the operation of radiant energy propagated after the manner of light in undulations of short length. —Note on the viscosity of solids, by J. Dewar. The author has investigated the viscosity of solid substances by forcing them through a narrow orifice by means of a hydraulic press; many substances, such as crystalline sodium sulphate, ammonium chloride, graphite, urea, &c., easily flow under a pressure of 30-40 tons pressure on the square inch. A number of substances, such as starch, sodium chloride, &c., could not be made to flow into wire under a pressure of 60 tons on the square inch.—Boiling points of homologous compounds; part ii., by J. Walker. The formula $T = aM$ which the author has previously used to represent the boiling points of members of homologous series is now applied to a number of other such series. —The action of methyl iodide on hydroxylamine, by W. R. Dunstan and E. Goulding. Attempts to prepare β-methylhydroxylamine hydriodide by the action of methyl iodide on hydroxylamine, as described by L. de Bruyn, were unsuccessful; the main product of the reaction is a trimethylhydroxylamine salt.—The reduction products of nitro-compounds, by W. R. Dunstan and T. S. Dymond. The action of various weak reducing agents on aliphatic nitro-compounds is being examined.—Notes on meta-azo-compounds, by R. Meldola and E. S. Hanes. The authors have prepared metanitrobenzene-azo-β-naphthol and several allied compounds.—Conversion of ortho- into para-, and of para- into ortho-quinone derivatives. III. The hydroximes of the lapachol group, by S. C. Hooker and E. Wilson. The action of mineral acids on the hydroximes of lapachol and hydroxyhydrolapachol yields the same hydroxime as is obtained by the interaction of hydroxylamine hydrochloride and β-lapachone; the authors are able to deduce from these facts the structural formulæ of the substances mentioned.—The behaviour of alloys in a voltaic circuit, by A. P. Laurie. If an alloy of several metals is merely a mixture in which no actual chemical combination exists between the constituents, then the E.M.F. generated by the alloy should change gradually as the composition of the alloy changes; the existence of chemical combination should be indicated by discontinuities in the curve connecting E.M.F. and composition. The author has already shown that compounds exist in the series of Cu : Sn, Cu : Zn and Au : Sn alloys, and is applying the method indicated above to other cases.

Zoological Society, June 19.—Dr. A Günther, F.R.S., Vice-President, in the chair.—Mr. Sclater exhibited the skin of a monkey of the genus *Cercopithecus*, and pointed out that it unquestionably belonged to the local form which he had spoken of in his recent paper on the *Cercopitheci* as *Cercopithecus diana ignitus*. Mr. Sclater also exhibited the typical specimen of *Cercopithecus grayi*, Fraser, formerly in the Knowslev collection, and stated that it was the same as *C. erxlebeni*, Pucheran.—Mr. H. Scherren exhibited a bottle in which an amphipodus crustacean (*Amphithoe littorina*) had built a nest and a series of runs of sand and pieces of weed.—Prof. Ray Lankester, F.R.S., read a paper on the external characters which distinguish the two Dipnoid fishes *Lepidosiren* and *Protopterus*, and pointed out that there could be no doubt that these two forms should be referred to distinct genera.—Dr. Fowler exhibited a specimen of antlers of the fallow deer, belonging to Mr. J. A. R. Wallace, of Loch Ryan, which showed the effect of the removal of one testis on the development of antlers; and made remarks on the effect of different degrees of castration upon antlers, as shown by specimens in the museum of the College of Surgeons. The continuity of variation displayed in the total length, and lengths of brow- and tray-tines, in abnormal antlers in the Natural History Museum was also commented upon.—Mr. P. Chalmers Mitchell gave an account of his observations on the perforated flexor muscles in certain birds recently dissected in the laboratory in the Society's Gardens.—A communication was read from Messrs. R. R. Mole and F. W. Urich containing biological notes upon some of the snakes of Trinidad, B.W.I. To these notes was added a preliminary list of the species of Ophidians recorded from that island.—A communication was read from M. E. Simon containing the second portion of a memoir on the spiders of the Island of St. Vincent, based on specimens obtained through the agency of the Committee for the exploration of the Natural History of the West Indies.—A communication was read from Mr. W. E. Collinge, containing the description of a new species of slug of the genus *Janella* from New Zealand, and giving a detailed account of its anatomy.—A communication was read from Mr. R. J. Lechmere Guppy, containing an account of some Foraminifera from the Microzoic deposits of Trinidad.—Mr. Arthur E. Shipley read notes on some nematode parasites obtained from animals formerly living in the Society's Gardens.—Messrs. F. E. Beddard, F.R.S., and P. Chalmers Mitchell gave an account of the anatomy of *Palamedea cornuta* as compared with that of its allies.—A communication was read from Dr. A. G. Butler, giving an account of a collection of Lepidopterous insects made by Dr. J. W. Gregory during his recent expedition to Mount Kenia. The specimens were referred to 215 species, of which ten were stated to be new to science.

Mineralogical Society, June 19.—Prof. N. S. Maskelyne, F.R.S., President, in the chair. The following papers were read:—A chemical study of some native arseniates and phosphates, by Prof. A. H. Church, F.R.S. This paper dealt with the composition of clinoclase, linoconite, berzeliite, tyrolite, and other minerals, especially as regards the water which they contain, and the amount which is lost on drying or on heating to various temperatures. The author finds calcium and carbon dioxide to be an essential constituent of tyrolite, but in berzeliite to be due in all probability to intermixed calcite.—The occurrence of mispickel in the stewartry of Kirkcudbright, by P. Dudgeon.—A goniometer for demonstrating the relation between the faces of a crystal and points representing them upon a sphere was exhibited by Miss M. Walter. In this instrument the crystal can be turned about two rectangular axes, and each face is adjusted in the usual way by telescope and collimator; a brass sphere turns rigidly with the crystal, and by an ingenious contrivance a small mark is stamped upon the sphere corresponding to each face. The angles between the faces are then ascertained by applying a graduated great circle to the sphere.—At the invitation of the President, Dr. J. E. Talmage, of Salt Lake City, gave an account of the occurrence of gigantic crystals of selenite in Wayne County, Utah, and also described a phosphate of aluminium, so-called turquoise, recently found in Utah.

Linnean Society, June 21.—Mr. C. B. Clarke, F.R.S., President, in the chair. Mr. G. Brebner exhibited and made remarks upon specimens of *Scaphospora speciosa*, Kjellm. describing with the aid of lantern-slides the structure and mode of fructification in this and other allied algæ.—Mr. J. R. Jackson exhibited the cone of a stone pine, *Pinus Pinea*, Linn., picked up by the Comte de Paris in the Coto del Rey, Seville, which had sprouted and continued to grow for a month afterwards. This peculiarity, which had been often noticed in the larch, was said to be of rare occurrence in the pine.—Mr. Thomas Christy exhibited and made remarks on a small-berried coffee-plant from Inhambane, East Africa, somewhat similar to a variety from Sierra Leone and other parts of the West Coast. It was said to be valued for its fine aromatic bitter taste, which made it useful for flavouring beans and other material ground up and sold as coffee.—Mr. A. B. Rendle gave an abstract of a paper upon a collection of plants from East Equatorial Africa, brought home by Dr. J. W. Gregory and Rev. W. Taylor, amongst which were several new species.—A paper by the President followed, on "Tabulation Areas," in which the views of Dr. A. R. Wallace and others on geographical distribution were discussed, and the best mode of tabulating results considered. The Society adjourned to November 1.

NEW SOUTH WALES.

Linnean Society, April 25.—The President, Prof. David, in the chair.—A contribution to a further knowledge of the cystic cestodes, by James P. Hill.—Notes on Australian Coleoptera, with descriptions of new species, part xv., by the Rev. T. Blackburn. One genus and twenty-nine species from various parts of Australia and Tasmania are described as new.—On an aboriginal implement believed to be undescribed, supposed to be a hoe, by R. Etheridge. The implement described was obtained from an aboriginal tribe living on the headwaters of the Endeavour River, N.Q., about 150 miles from the coast. It consists of the columellar portion of the body-whorl of the large melon shell ground to a cutting-edge and wedged into a hole in a stick fashioned by an iron tool. The implement is probably not of local manufacture, but was obtained by barter from one of the Torres Straits Islands.—On the life-history of Australian coleoptera, part ii., by W. W. Froggatt. An account of the life-histories of beetles bred during the season 1892-3, with a notice of their food-plants.—On some naked Australian marine mollusca, part i., by C. Hedley. Under this heading a description and drawings were presented of the external appearance of *Oscanius hilli*, n.sp., a huge sea slug from Sydney Harbour and Broken Bay, of a genus not known before from the South Seas.—Observations upon the anatomy and relations of the "dumb-bell-shaped bone" in *Ornithorhynchus*, with a new theory of its homology; and upon a hitherto undescribed character of the nasal septum in the genera *Ornithorhynchus* and *Echidna*, by Prof. J. T. Wilson. The full text of the paper, a preliminary note to which was communicated at last meeting (*vide* Abstract, March 28, 1894, p. vii.). Description of a new *Isopogon* of New South Wales, by Baron Ferd. von Mueller, K.C.M.G., F.R.S. A rare plant with always entire leaves, from the margin of the Grose Valley in the more elevated part of the Blue Mountains. With the aspect of the S.W. Australian *I. longifolius*, it is most nearly allied to *I. anemonifolius*, R.Br., which occasionally produces undivided leaves (Fragmenta, vi. 238).—Description of some new species of *Araneidæ* from New South Wales, No. iv., by W. J. Rainbow.—Two new Sydney spiders are described and figured—*Drassus perelegans* and *Cyrtarachne caliginosa*, g. et sp. n.—Australian plants illustrated, No. vii.—Genus *Notothixos*, by R. T. Baker. Two forms of *Notothixos* were recorded whose characters do not agree with those of the three species recognised by Oliver and Bentham (but united by Baron von Mueller): and the whole five are figured.—List of mollusca collected at Green Point, Watson's Bay, by A. U. Henn, with descriptions of new species, by John Brazier. The specimens on which this list is based (in number 1365, representing 154 species) were contained in a discarded bottle found in a rock pool accessible only at very low tides. A genus new to Australia and several new species were recorded.—On a new *Patella* said to have been found at the Kermadec Islands, by John Brazier.—On a new Australian *Croton* and on a supposed new species of *Acacia*, by J. H. Maiden and R. T. Baker.—Under the name of *C. affinis*, a species allied to *C. [illegible]*, from near Tinteobar, was described. It differs from the latter species in the number and length of the stamens, the marked occurrence of petals, the persistent calyx under the fruit, the shape of the capsule (broader than long), which is both furrowed and deeply lobed, and the thin texture of the leaves.

Amsterdam.

Royal Academy of Sciences, May 26.—Prof. van de Sande Bakhuyzen in the chair.—Some observations on oxygen, by J. H. van't Hoff.—The remarkable fact that gaseous oxygen sometimes exhibits more energetic chemical activity in the dilute than in the more concentrated condition, has been investigated in van't Hoff's laboratory by Dr. Ewan, the course of the slow oxidation of sulphur and of phosphorus being selected for study. With phosphorus and oxygen (saturated with aqueous vapour at 20°) it was observed that for pressures of oxygen greater than 700 mm. the velocity of oxidation is excessively small or nothing at all. Below 700 mm. it increases very rapidly. This limit corresponds to that found by Joubert, below which phosphorescence begins. After reaching its maximum velocity a very simple relation exists between the rate of oxidation and the pressure of the oxygen, provided that the change in the rate of evaporation of the phosphorus, which, according to Stefan, is produced by the change in pressure, is taken into account. The rate of oxidation is then directly proportional to the pressure of the oxygen. In absence of water the oxidation also begins suddenly, but at a lower pressure (about 200 mm.). Taking into account the change in the rate of evaporation, the velocity of oxidation then reaches a maximum at a pressure which is approximately the same as that which van't Hoff formerly found to be the most favourable for the explosive combustion of phosphine. After the maximum the relation between the velocity of the reaction and the pressure could not be made out with certainty, because in dry oxygen the coating of oxide which forms on the surface of the phosphorus disturbs the regular course of the reaction. With sulphur and dry oxygen, where the slow oxidation can be conveniently followed at 160°, this relation has, however, been obtained. It appears, again taking into account the change in the velocity of evaporation, that the velocity of the oxidation is proportional to the square root of the pressure. This would appear to point to the conclusion that in the absence of water, the active part of the oxygen is only that very small part of it which is broken up into atoms. This conclusion is perhaps supported in the case of phosphorus by the composition of one of the products of the oxidation in dry oxygen, viz. P_4O.—Mr. Bakhuis Roozeboom discussed the equilibrium of solutions and solid phases formed of the system: HCl, H_2O and Fe_2Cl_6. In a three-dimensional representation the solutions which may coexist with a hydrate of Fe_2Cl_6 form a vault, whose summit lies in the melting point of the hydrate; the isotherms are not unlike half a circle. With a compound of the three components, solutions may coexist, whose compositions are represented for each temperature by a closed curve, surrounding the point which indicates the composition of the solid compound. Two of these were discovered: $Fe_2Cl_6 . 2HCl . 8H_2O$ and $Fe_2Cl_6 . 2HCl, 12H_2O$; melting points:—3° and −6°. The different ways in which the vaults for all the existing solid phases may encounter are discussed.—By diagrams and models Dr. Schoute showed that the natural connection between the homogeneous divisions of space by means of cubes and of orthic tetrakaidekahedra (*see* Lord Kelvin's paper in NATURE, March 8 and 15, 1894) is given by the known theorem, that the plane, orthogonally bisecting a central diagonal of the cube, cuts it in a regular hexagon. Every cube of a given homogeneous division in cubes, we divide into eight equal minor cubes by means of three planes, parallel to the faces. In each of these eight minor cubes we draw the central diagonal ending in the centre O of the original cube, and we divide these into two equal parts by means of planes orthogonally bisecting the diagonals. In this manner every original cube is divided into sixteen equal parts. The eight parts that surround the centre O of the original cube form a tetrakaidekahedron. The remaining "intercellular" parts form equal tetrakaidekahedra, the centres of which are the vertices of the original cubes.—Mr. Kamerlingh Onnes communicated the results of further experiments made by Dr. Kuenen in the Leiden Laboratory, "on the abnormal phenomena near the critical point." Dr. Kuenen has explained the abnormalities observed by Zambiasi, de Heen, and others, by impurities of the matter used. He has now repeated with the utmost care the experiments, from which Galitzine drew the startling conclusion, that ether above the critical temperature has very different densities according to its having been before entirely fluid or partly vapour. The differences found by Dr. Kuenen in the duly corrected densities at some degrees above the critical temperature are only slight, and probably due to the admixture of not more than a two-hundredth of a milligram of a non-coercible gas. This gas, if not air, perhaps originates by the decomposition of some ether during the sealing of the tube before the blowpipe.

BOOKS AND PAMPHLETS RECEIVED.

Books.—Alembic Club Reprints, No. 6 (Clay, Edinburgh).—Nature's Method in the Evolution of Life, 1894 (Unwin).—Climbing in the British Isles: W. R. H. Smith (Longmans, 1894).—Tourist Guide to the Continent.: N.E., 1894 (30 Fleet Street).—Elektro-chemie Erste und Zweite Liefg: Dr. W. Ostwald (Leipzig, Veit).—A Selection of Photographs of Stars, Star Clusters and Nebulæ: Dr. J. Roberts (Universal Press).—The Country Month by Month, July, 1894: J. A. Owen and Prof. Boulger (Bliss).—Elementary Treatise on Natural Philosophy, 13th edition: Prof. J. D. Everett, 1894 (Blackie).—Repartition de la Pression Atmospherique sur l'Ocean Atlantique Septentrional d'Après les Observations de 1870 a 1889: par le Capitaine G. Rung, 1894.—Returns of the Agricultural Statistics of British India and Native State of Mysore, 1892-3 (Calcutta, 1894).—Malaysian Spiders, Parts 1, 2, and 3: T. and M. E. Workman (Belfast, 1894).

Pamphlets.—Ebbe und Fluth in Luftmeer der Erde: Prof. Dr. J. Hann (Paetel, Berlin).—Journal of the Royal Agricultural Society of England, Vol. 5, Part 2 (1894 Murray).—Proceedings of the Bath Natural History Antiquarian Field Club, Vol. 8, No. 1 (Bath, 1894).—Transactions of the Institute of Brewing, Nos. 7 8 (J. S. Phillips).

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THURSDAY, JULY 12, 1894.

THE CATALOGUE OF SCIENTIFIC PAPERS.

Catalogue of Scientific Papers (1874–1883). Compiled by the Royal Society of London. Vol. X. (London: Clay and Sons, 1894.)

WE are glad to welcome this new volume of the Royal Society's great Catalogue. In February 1892 we noticed Vol. IX., which was the first of the three volumes that are to contain the titles of papers published in the decade 1874–83. The present volume, containing the second instalment of the material for those years, forms the tenth in the entire series of that monumental piece of bibliography for which the scientific world is indebted to the Royal Society. The section of the alphabet it includes extends from *Gis* to *Pet*, covers 1048 pages quarto, and contains considerably over 30,000 entries, giving references to the papers published in some 570 different serials. In a year or two we may hope to have the concluding portion in our hands, and our only regret is that the complete index could not have been issued within the ten years following the close of the period it covers. Such a bibliography is a work of enduring value, but it is undoubtedly most urgently needed and its services most readily appreciated in the years more immediately following the dates of the papers themselves. However, if ten or twelve years should appear an over-long interval, we must remember the magnitude of the task and the fact that the Royal Society have carried out the work single-handed. The six volumes of the first series of the Catalogue sufficed for something more than six decades (1800–1863), but for the next ten years (1864–73) two volumes were required, and now three are found necessary for 1874–83. Moreover, it is probable that the proportion of important serials which the Catalogue has *not* taken cognisance of, has gone on increasing. At any rate the Society, as we know, have now found it advisable to devote a supplementary volume (which we believe is in active preparation) to the contents of these hitherto neglected series. This want of comprehensiveness, which is, perhaps, the only blemish on this great work as it stands, is the more noticeable as the selection of serials for indexing shows traces of having been either arbitrary or dependent upon some fortuitous circumstance. Thus it may puzzle a medical writer, whose work has appeared in both, to find papers of his cited from the *New York Medical Journal*, but none from the *British Medical Journal*. But no doubt the Royal Society would be the last to claim perfection for their work, for which, as it stands, they are entitled to the highest praise. These volumes are handsomely printed, the contents are easy to consult and astonishingly free from inaccuracies of any kind. This last, their crowning excellence, is one that can be appreciated best by those who make the most use of the work. Our own experience is that for checking a series of references, to turn to the Royal Society's Catalogue is practically the same as hunting up the originals themselves, and of course vastly more expeditious. And the volumes now issuing are even more easy to consult than their predecessors; for instance, the volume numbers are now given in Arabic instead of Roman numerals—a much more legible fashion and much safer, especially in the case of high numbers. Again, the year of publication is printed in heavy type, so that this vitally important particular catches the eye at once. The abbreviations of the titles of the serials remain practically as before, and though no doubt much longer than specialists are in the habit of using in their own notes and publications, they possess the great advantage which is claimed for them—that they are "so clear as to speak for themselves." For the chemist *Ber.* may be quite sufficient, but would require interpreting to his fellow-workers in other departments of science, who would recognise at the first glance the meaning of the abbreviation adopted in the Catalogue—*Berlin Chem. Ges. Ber.* Perhaps, however, so familiar a series as the oft-quoted "Comptes Rendus" might safely admit of a shorter form than *Paris Acad. Sci. Compt. Rend.*

Altogether, anyone with any acquaintance with bibliography cannot be insensible to the enormous amount of tedious labour involved in the production of these volumes. Perhaps not more than half the entries are mere reproductions of a single title and reference, the title simply transferred as it stands from its original source to its place in the Catalogue. Many titles to make them at all intelligible have had to be amplified, in some cases they have been entirely supplied, the names of new species described are filled in, and so forth; while a large percentage of the entries contain two or three, or even more references, to reprints, translations, abstracts, &c., which with such a mass of material implies a task of alarming magnitude in their satisfactory collation. Then there is the perplexing work of distinguishing rightly among the numerous authors bearing the same name—thus we count more than fifty Müllers, and nearly as many Meyers. There is, too, the initial difficulty which besets the compiler in the case of serials of general or technical character, of deciding which "papers" are proper to be indexed, and which should be passed over. The result, as presented in these volumes, is no doubt not an exhaustive enumeration o all the contributions in the whole body of scientific serial literature, but it is a catalogue of all the best and the most worth studying. More than this no bibliography is ever likely to be.

But withal the Catalogue of Papers furnishes but the one half of what is required. It furnishes the key to the workers, and only through them to the work. The complementary volumes, which should supply a direct key to the work, and thence to the workers, are still a desideratum. Until this also is supplied, equally systematically and comprehensively, the bibliography of science at large will remain regrettably one-sided, in spite of the numerous special *Records*, *Fortschritte*, and *Jahresberichte*. The fact of course is that a great Subject-catalogue or index is a far more difficult undertaking than the Author-catalogue to which it would run parallel. We all know the object to be aimed at—to enable the worker in science to ascertain readily what work has already been done upon his particular subject—and we are all agreed as to the desirability of attaining it. It is in the practical execution of the work that the difficulties come in, and there they meet us in battalions. At the outset, the co-operation of working specialist and practical bibliographer is required; but viewing the subject from different standpoints, the specialist has his ideas and the bibliographer his, and we are fortunate if we escape the familiar difficulty—*quot homines, tot sententiæ*. As to the difficulties of execution, they are, of course, primarily, how the whole system of the sciences should be divided, how far the divisions should be carried, and how the material, the particular items to be entered, should be distributed among them. For it is clear that for so vast a material no mere alphabetical index would suffice. All the contributions to one particular subject must be brought under the eye in one group, not scattered up and down through a thousand pages, according to the mere accident of the words used by the authors in their titles. The mere alphabetical arrangement attracts by its simplicity; but in a work of this extent it would be misplaced, the entries would be lost, and the exhaustive search which would always be required would take longer than the time needed to make one's self acquainted with the scheme of classification adopted, which trouble would only need to be taken once for all. There are, moreover, important collateral advantages attaching to the preparation of practically distinct indexes for the different branches of science. Not to enlarge further on the difficulties of a Subject-catalogue such as terminology, translation, consultation of originals, &c.—we would only say there is no royal road through all these obstacles. The path through them must always be a thorny one. Neither is there any standard of perfection, nor would it be attainable if there were. The best that can be expected is a sensible workable compromise. This is attainable, and we have little doubt will ultimately be attained, and so a key furnished to the whole series of contributions to the growth of every twig and branch of the tree of scientific knowledge from one end of the nineteenth century to the other. Since the inception of their present undertaking, the Royal Society have not ceased to occupy themselves with the question of a parallel Subject-catalogue, nor is it any wonder if the result has so long continued to be only negative. But with each decade the matter becomes more urgent, and to deal with it increased efforts are demanded, and greater sacrifices become justifiable. We believe that the Society are now on the eve of starting actual work upon the undertaking, and so commencing another monumental contribution to the "Improvement of Natural Knowledge."

EPIGENESIS.

Gestaltung und Vererbung. Eine Entwickelungsmechanik der Organismen. By Dr. Wilhelm Haacke. Pp. 337, with illustrations. (Leipzig: T. O. Weigel Nachfolger, 1893.)

WHILE it is correct to say that, as a matter of history, epigenesis implies merely the observed fact that the fertilised egg-cell, from which the new organism of each generation arises, is, under the microscope, a nucleated mass of protoplasm not differing from other cells, it is not so certain that the simplicity of the historical conception is any help to the problem as it exists for us to-day. For in the growth of an idea as it passes from mind to mind, there is, at the best, but a formal continuity. Most often the meaning of the word has been so added to, and so taken from, that it becomes like the famous patched coat, which contained none of the original material. For the present, the question at issue is very different from the problem of those who used the word in earlier times. We know that we must not expect to see under the microscope the character of an elephant or of a mouse stamped upon the protoplasm of the fertilised egg-cell. We wish to know whether the observed facts of development and inheritance can be co-ordinated under the idea that the protoplasm of the fertilised egg-cell is as like the protoplasm of other cells as it seems; or, under the idea of preformation, that each structure of the adult has a structural representative in the egg. But many side issues arise, and identical sets of facts really devoid of bearing upon the main question are brought forward with equal triumph by advocates of either theory. Take an example, not one that, so far as this writer knows, has been employed, but which may serve as a type. The intestine of the higher animals is very much longer than the length of their bodies, and is disposed in coils and loops. Dr. Gadow has shown that this disposition in the case of birds falls into seven or eight well-marked types which are so constant as to have high corroborative value in classification. It may well be that these varieties of twisting and coiling depend upon physical conditions, upon the relations of the growing intestine to the growth and structure of the surrounding viscera and of the skeletal tissues. Here, the advocate of epigenesis would say, are characters that need no preformation in the egg, that are stamped in due course upon its simple protoplasm. But no preformationist need suppose that the invincible elements in the germ are to grow up by their own force out of all relation to surrounding conditions. The centrifugal activities of the egg, if they exist, are there to supply those differences for which there is no cause in the outer world. They supply the factor, the resultants between which and the forces of the outer world show differences under what seem to be identical conditions.

In Dr. Haacke's book a large number of instances are brought forward in which facts of the organic world seem to be explicable by physical conditions. These are all used as arguments against preformation, and specially against Weismann and, as is the fashion just now, against the generalisations of Darwin.

Thus, under the name *Epimorphism*, he groups together a number of facts that seem to show the existence of grades and lines of development apparently independent of utility. Such are, for instance, the increase of size in organs like horns or, indeed, of whole animals; increases which in the past history of the earth have apparently actually led to the destruction of the animals in question. Again, in most groups gradual alterations of form generally leading from regular symmetry to irregular form can be traced. Specific markings, colours and so forth, as Eimer before has showed, in many cases seem to follow in regular sequences independent of utility and adaptation. The degeneration of useless or of unused organs goes on independently of direct advantage to the animals. Geographical distribution, as Dr. Haacke showed in an interesting paper, published in 1885, reveals that for most groups of animals a distribution of forms exists, such that the higher are found nearer the centre of the great land masses that radiate from the North Pole; the lower towards the ends of continents and the islands reaching down into the watery waste of the southern hemisphere. This sequence of form he now explains by an interesting view. The natural selection of individuals does not depend upon their protective or adaptive qualities, but upon their good or bad constitutions. If an insect-eating bird gets upon the track of a set of caterpillars, it is unlikely to distinguish between the slight variations they may have in protective colouration. But in the struggle between race and race, the race better protected will, on the whole, attract the attention of enemies a less number of times. The selection between individuals is a selection between the generally strong and the generally weak, between those whose life-pulse beats high and those of low vitality; not between those with an organ or an adaptation a shade weaker or stronger. The appearance of the differences between races which tend to the adaptation of some and the non-adaptation of others are due to causes independent of selection. Thus it happens that in cases where there is a wide range there are more varied local conditions, more local races, and a greater material for that competition between races which is the cause of progress. And thus where continents spread widely evolution is more rapid than in the confined areas which stretch towards the South Pole. This view is complicated by the further view that the result of crossing is not a production of variation by the mingling of characters, but an equalisation of the divergent characters of individuals.

Those who are interested in controversy will find these and a number of most interesting views and collections of facts in Dr. Haacke's book. But they are so entangled with elaborate and chiefly mathematical arguments against the views of Weismann, that they form somewhat difficult reading for the uncontroversially disposed. Moreover, they are complicated by a highly elaborate theory of Dr. Haacke's own invention. He accepts the view of Verworn that the nucleus is an organ of metabolism for the cell, and sees in the plasma with the centrosome as its organic centre, the true bearer of heredity. The plasma is composed of ultimate elements called "gemmæ." These are rhombic prisms, the ultimate shape of which is as proper to protoplasm as are the shapes of inorganic crystals to their chemical compositions. These "gemmæ" are built up into "gemmaria" by association into variously shaped layers and rods. The shape of the "gemmaria" determines the shape of the whole organism, and a number of ingenious references of symmetry to hypothetical gemmarial structures are given. The "gemmaria" of a whole organism are identical, and by a system of attractions and repulsions remain in a condition of equilibrium. But outer forces acting upon any part of the organism disturb this system of equilibrium until the organism settles down into a new position of equilibrium. As the germ cells contain gemmaria like all the gemmaria of the body, outer changes cause a new condition of equilibrium in them, and this new condition naturally is the starting-point of the new organism. The differences between individuals are chiefly differences between the degrees of closeness in which the gemmæ of "gemmaria" are attached to each other. Those with weak attachment have weak constitutions, and in each generation are weeded out. In sexual union, the primary cause of which is the attraction between similar crystalline systems, the inequalities of attachment between the gemmæ are redressed.

It is perhaps unnecessary to add that Dr. Haacke considers that acquired characters are inherited, but that it is absurd to expect any proof of this inheritance, as, he says, the whole organic world is a proof of it, and because without it epigenesis would be impossible.

P. C. M.

AGRICULTURAL ENTOMOLOGY.

Handbook of the Destructive Insects of Victoria. (Prepared by order of the Victorian Department of Agriculture.) By C. French, F.L.S., Government Entomologist. Part II. (Melbourne: 1893.)

TWENTY notorious insect pests are dealt with in this volume, each being illustrated by a coloured plate, which shows not only the metamorphoses of the insect, but the nature of the mischief of which it is the cause. The chapter on each insect is complete in itself, and there is no definite order of treatment of subjects; nor in a volume of this character was any such sequence called for. Arranging the insects systematically, however, it is found that the Homoptera are represented by the green peach aphis, the black peach aphis, the orange aphis, the grape louse, the cabbage aphis, the cottony-cushion scale, the oleander scale, the lemon scale, and the red scale of the orange; the Coleoptera by the plum curculio, the cherry green beetle, the apple root-borer, and the strawberry beetle; the Lepidoptera by the orange moth, the case-moth of the orange, the vine moth, the silver-striped vine moth, the potato moth, and the cabbage moth; and the Neuroptera by the so-called "white ant," *Termes australis*, Hagen. With three or four exceptions, therefore, most of the insects dealt with are pests of fruit trees, and not more than half a dozen of them have acquired notoriety in England.

As the main object of the work is to supply to growers information as to the means whereby they may protect their crops against the ravages of injurious insects, we naturally look for very full information under this head, and it must be admitted that the author has admirably acquitted himself in this respect. In addition to the concise details of methods of prevention and of remedy given under the head of each pest, there is a well-illustrated appendix, containing descriptions of the various kinds of apparatus which are coming more and more into use for insecticidal purposes. Several appreciative references are made to the ingenious English-made spraying machine known as the "Strawsonizer"; but the light knapsack modifications of this apparatus, termed the "Antipest" and "Notus" respectively, are of too recent introduction to find a place in the volume. The list of insecticide materials given in the first volume of the work is supplemented here by a further series. Moreover, as part i. contained a list of the insectivorous birds of Victoria, so part ii. contains a list of the fruit and grain eating birds of the colony. We are glad, also, to note the many references to insectivorous insects: for it is quite as important that a cultivator should know what insects to protect and encourage, as to recognise those which it is to his advantage to suppress. Several of the coloured plates afford illustrations of the insect foes of insect pests, and not merely of the familiar hymenopterous parasites, but of such friends to the cultivator as the species of Syrphus which devours the cabbage aphis, and of the Australian ladybird, a species of Novius, which orange-growers both in Australia and in California have found so effective an ally in keeping their groves free of the dreaded cottony-cushion scale, *Icerya Purchasi*, Maskell.

In noticing the first part of this work we appealed to the author to add to its international value by appending in every case the authority for the systematic name. We are glad that Mr. French has been able to adopt this suggestion. The agricultural entomologists of the United States are great offenders in this respect: indeed, they sometimes give no systematic names to the injurious insects which are made the subjects of their bulletins, whilst they not infrequently coin trivial names which are certainly not elegant, though they may be expressive. Hence it becomes difficult to know with any degree of certainty what is the precise species referred to; confusion consequently arises, and the bulletin has only a local value. In connection with the trivial names themselves, there is room for improvement. For instance, in the volume before us, descriptions are given of the "green peach aphis" and the "black peach aphis"; but as it is the aphis and not the peach to which the colour refers, the names "peach green aphis" and "peach black aphis" would be more descriptive. This is no mere quibble, for in the volume itself the principle is conceded in the name of the "cherry green beetle." In the year 1892, when *Plutella cruciferarum*, Zell.—an insect described in this volume as the cabbage moth—wrought tremendous destruction amongst the cruciferous crops of England and Scotland, the newspapers teemed with descriptions of the ravages of the "diamond-back turnip moth." This naturally led to inquiries, perhaps ludicrous, as to the nature of diamond-back turnips; but our Board of Agriculture set a good example by describing the pest in an official leaflet as the "turnip diamond-back moth," and thus reverting to the name by which John Curtis made the insect familiar half a century ago.

We welcome this second instalment of a valuable publication, and trust Mr. French may be encouraged to bring to a successful conclusion a work of the highest economic importance to agriculturists and horticulturists.

OUR BOOK SHELF.

Proceedings of the Edinburgh Mathematical Society. Vol. i. Session 1883. (London: Williams and Norgate, 1894.)

From time to time we have noted the annual volumes of this Society from vol. ii. to vol. xi., which appeared last year. The volume before us fills up a lacuna and now makes the series complete. In the early days of the Society the publication of *Proceedings* was not contemplated, and when an accession of members rendered publication possible, the cost of printing absorbed the major part of the funds, and each session's subscriptions have only sufficed for the current session's volume. Some few years since a special appeal was made and funds sufficient to warrant publication obtained. The result is the admirable piece of geometrical work before us. For, in fact, the volume is almost entirely one man's work. The first president was Dr. J. S. Mackay, whose edition of Euclid for the Messrs. Chambers in 1884 gave ample evidence that there was an elegant and specially learned geometer in our midst. The article on "Euclid" in the *Encyclop. Britannica* confirmed this discovery. It has been long known that Dr. Mackay had large stores of notes, and we are glad to find that he has found an outlet for much of this interesting matter. At the second meeting of the Society the president read a paper on the triangle and its six scribed circles. A portion of this paper was given in abstract in vol. ii., and was considerably enlarged in vol. xi., under the heading "History of the Nine-point Circle." In the long interval, with the permission of the Council, Dr. Mackay has amassed a collection of notes, divided into twenty sections, filling more than 1600 quarto pages of manuscript. A selection has been made which most nearly corresponds with what was actually communicated to the Society in 1883. The nine-point circle is accounted for above. The sections embraced in the present instalment treat of the centroid, the circumcentre, the incentre, the excentres, the orthocentre, Euler's line, relations among the radii, and area. They occupy pp. 6–128, and are accompanied by sixty-eight lithographed figures. Each property is traced back, as far as can be ascertained, to the first discoverer, the author having had the assistance of French, German, and Belgian mathematicians in addition to the aid of personal friends in Great Britain. The result is a rich repertory of almost, if not quite, all that is known on the special points indicated above.

We sincerely hope that Dr. Mackay may be recouped for the vast amount of work he has gone through, and the expense to which he has been put, by an appreciative and purchasing audience. This will encourage him to put his remaining notes into the hands of some publisher, or possibly he may adopt the present mode of publication.

The only other paper is a collection of notes on Plucker's first equation connecting the singularities of curves, by Dr. C. G. Knott. These are printed in the form in which they were handed over to the committee eleven years ago.

The Starry Skies. By Agnes Giberne. (London: Seeley and Co., 1894.)

This small book will be found a very useful addition to the series in which it is published. It is written in a clear and intelligible style, and should just suit those young readers who wish to obtain some of the more elementary ideas about the world on which we dwell, the moon, and the planetary and stellar systems in general. Great tact seems to have been shown throughout in the choice of suitable examples for giving the reader a good mental grip of distances, sizes, shapes, &c., of the heavenly bodies, without over-burdening his or her mind with too much detail. The clear print and the not too liberal use of dark type render the book very pleasant reading, while the questions and answers at the conclusion of each chapter will be serviceable. The illustrations throughout are very good indeed; the majority of them being excellent reproductions from the more or less important recent photographs. Among them we recognise Roberts' Andromeda nebula, the Pleiades, a fine Orion picture, cluster in Hercules, and several others nearly equal in quality. As a book for the young, we can heartily recommend these pages on the starry skies.

W. J. L.

LETTERS TO THE EDITOR.

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

New Army Regulations.

IT appears, from the letter in the daily papers of yesterday, signed by the Headmaster of Eton, that the headmasters are beginning to cry out under the smart of the rod they have made for their own backs. When, five or six years ago, Latin was made a compulsory subject for the Army Entrance Examinations, I for one, as a schoolmaster, welcomed it in that capacity, from its value as a mental discipline, and as a remedy to some extent for a certain illiterateness and incapacity for accuracy of expression, which one met with too often in Army candidates. But it was soon found that the position assigned to it was taken advantage of by men of non-scientific education, as a pretext for driving science into the background, and making it contemptible in the eyes of boys and parents, by a considerable curtailment of the time previously given to it, and then, with Egyptian logic, wondering that the marks fell off.

I do not say that the headmasters were altogether to blame for this. The spirit of the cram-shop has invaded the public schools, and is utterly spoiling their intellectual life; and, when this spirit allies itself with other motives, the pressure may be too strong for the most noble-minded headmasters. But they, like other mortals, must reap as they sow, and accept the results of their policy. Their intellectual incapacity as a body to appreciate the value of scientific training *per se* is the fault, not so much of themselves, as of the traditions, which still hold the dominant place in this country, among those in whose hands their appointment rests. I sincerely hope that all will be done, that can be done, to minimise the mischief with regard to Latin, which is deprecated in the circular; but I do trust that, for the public weal, the military authorities, having "put their foot down," will remain firm in insisting upon *all candidates for the scientific branches of the Army being trained, not crammed, in Experimental Science.* This they will doubtless do with their hands strengthened by the strong Committee which has been dealing with the matter in its relation to Woolwich during the last two years.

When we recollect that back in the '70's and the earlier '80's, though Latin was a *voluntary subject*, classical scholarship continued to flourish in the public schools, it is difficult to read without a smile the alarmist predictions contained in Dr. Warre's letter, as to what is likely to ensue from what he calls "the degrading of Latin from Class I., and making it a voluntary subject." The headmasters have had their opportunity, and had they, in the spirit of their intellectual ancestors of the sixteenth century, shown more magnanimity towards the "New Learning" of the nineteenth century, this rude shock to their intellectual consciousness might have been unnecessary.

Looking at the matter now from the outside, one can perhaps see the true perspective of the whole better than one could while in the thick of the fray.

A. IRVING.

Hockerill Vicarage, Herts, July 6.

Erosion of the Muir Glacier, Alaska.

DR. WRIGHT, in his "Ice Age in North America," has calculated that the Muir Glacier erodes its bed annually to the depth of one-third of inch (p. 64), and Prof. Harry Fielding Reid, in his very interesting "Studies of the Muir Glacier" (*American National Geographical Magazine*, March 21, 1892, p. 51), arrives at the still more startling result of three-quarters of an inch per annum. As one who has paid some attention to rates of denudation by various eroding agencies, I felt some curiosity to know in what way these figures were arrived at. I find that these two calculations are substantially the same, the difference arising from Prof. Reid crediting the whole of the erosion to the glacier bed which occupies only half of the watershed of 700 square miles.

As this rate of erosion is nearly 244 times that of the glaciers of Norway descending from the Justedalsbræen, calculated from the observations of Prof. Amund Helland (*Q. J. G. S.*, 1877, vol. xxxiii. p. 158), and is altogether an abnormal and unprecedented rate of erosion of any agency we know of that acts over so large an area, I think most geologists will agree with me that before it can be accepted we must be satisfied that the data are reliable and beyond question.

Dr. Wright unfortunately gives no particulars of the method adopted of sampling the sub-glacial waters, or the number of specimens taken, or the times and circumstances under which they were taken, all of which form material elements in the calculation. He contents himself with the bare statement that —"The amount of sediment contained in each United States gallon (231 cubic inches) of water collected from the sub-glacial streams is, as determined by the analysis of the late Prof. H. C. Foote, of Cleveland, 708·48 grains.

This proportion of sediment is nearly eighty-five times the mean of that from the sub-glacial rivers of the Norwegian glaciers descending from the snow and ice field of Justedalsbræen, and nearly twenty times the mean of the sediment from seven of the sub-glacial rivers of Greenland (*Q. J. G. S.*, 1887, p. 158), as observed and recorded by Amund Helland.

It will be seen from these bare figures that this prodigious calculation requires some explanation. It is certainly a wonderful amount of "work" to credit a glacier with that only moves 2555 feet per annum at the surface in its central position, and of course at a considerably less average rate on its bed.

The American geologists have supplied us with so much and such accurate information on many points which could not be investigated in this country, that I trust those who are able will help to correct this little sum.

T. MELLARD READE.

Park Corner, Blundellsands, June 7.

IN response to the questions contained in the communication by Mr. Reade, I would say that the estimations, both of Prof. Reid and myself, concerning the erosion of the Muir Glacier are based upon a specimen of water collected by me from a large sub-glacial stream issuing from near the south-east corner of the glacier at a height of about 150 feet above tide-level. This stream is only one of many which issue from the ice-front; but it is practically the only one from which any calculations could be safely made. At two or three places where the front of the glacier is pushed out into tide water, powerful sub-glacial streams issue, boiling up at low tide with great force just in front of the ice, and discolouring the water of the inlet for miles beyond. The head of the inlet is a mile and a half wide, enlarging very soon to nearly twice that distance. The water in the middle is more than 100 fathoms deep.

The appearance and everything else indicated that the stream chosen for examination was truly representative. It was a rushing torrent from ten to fifteen yards wide, which could be waded with difficulty. The specimen was collected about the middle of August 1886, when the melting upon the surface of the glacier was proceeding at its maximum rapidity, so that the volume of water was probably much larger than the average through the year. Prof. Foote had a high reputation for accuracy, and kindly analysed the water for me, evaporating the entire amount and distilling it, so that after he had weighed the sediment the identical elements were reunited, and, as I write, it stands before me as characteristic a specimen of glacial milk as one can anywhere find.

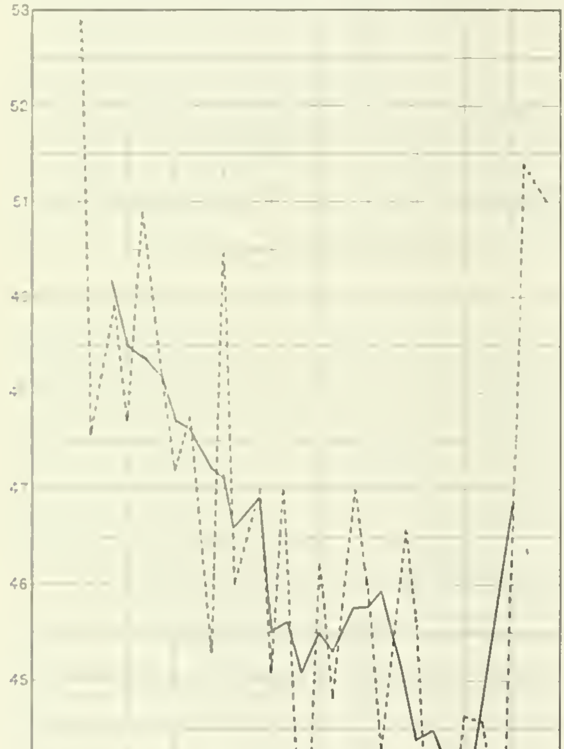
As stated in my "Ice Age in North America" (p. 64), the estimates of erosion are based upon the supposition that the total rainfall in the drainage basin of the Muir Glacier is the same as at Sitka, namely, 100 inches, and that a certain proportion of this passes off as icebergs and in evaporation, and that the balance which is carried away by subglacial streams is properly represented by this specimen. Of course if there is any serious error in either of these data it will affect the result. But I can scarcely believe that the error can be so great as to account for all the difference between our calculations and those made concerning the erosion of glaciers in Norway and Greenland; for the conditions are very different in the Muir Glacier from those either in Norway or in Greenland, as observed by Helland. The glaciers of Norway have a very slow movement as compared even with Prof. Reid's estimate of the movement of Muir Glacier; while in Greenland the continental proportions of the ice and the unknown conditions of the country upon which it rests quite preclude comparison; for it is evident that the best of the Muir glacier has a rapid gradient, while it is not certain that the best of many of the Greenland glaciers has any gradient at all. Judging from Helland's description of the appearance of the sea-water in the fiords of Greenland, I should think it was much less milky than that of the Muir inlet in Alaska.

I am thankful to have had my attention called to the subject by Mr. Reade just upon the eve of departure for a few weeks among the glaciers of Umenak Bay, in Greenland. I will give special attention to the subject, and report upon my return in the autumn. G. FREDERICK WRIGHT.

Oberlin, Ohio, June 23.

On a Recent Change in the Character of April.

THE months are all, of course, continually changing in temperature, rainfall, &c. And, as a rule, those changes are not long in one direction; the curve of variation has many zig-zags. Yet, by methods of averaging, one may sometimes detect a gradual process of change extending through a good many



years; we might compare it to the slope of an ocean-swell underlying the surface-ripples. The mean temperature of April at Greenwich is a noteworthy example of this.

Here are the values since 1865, and averaged in fives in a second column:

	M.T. April.	Av.		M.T. April.	Av.		M.T. April.	Av.
1865	52·9	—	1875	47·0	47·6	1885	47·6	46·1
66	48·6	—	76	48·0	47·9	86	46·6	45·4
67	49·9	50·2	77	46·1	46·5	87	44·2	45·5
68	48·7	49·5	78	48·0	46·6	88	43·5	45·1
69	50·9	49·4	79	44·5	46·1	89	45·7	44·6
70	49·2	49·2	80	47·2	46·5	90	45·6	45·2
71	48·2	48·7	81	45·8	46·3	91	44·2	46·8
72	48·8	48·6	82	48·0	46·7	92	46·9	47·8
73	46·3	48·2	83	47·0	46·7	93	51·4	—
74	50·5	48·1	84	45·3	46·9	94	51·0	—

Thus from a maximum of 50°·2 in 1867, the average went down, with some slight interruption at one point, to 44·6 in 1889 (*i.e.* 5·6 degrees), the extreme actual values being 52°·9 in 1865 and 43°·5 in 1888 (difference 9·4 degrees). Last year and the present yield values in marked contrast to those just before, and a pronounced rise appears in the average curve.

The data for Paris and Geneva give results very similar, so that the process is not merely local. Thus the smoothed values for Geneva descend from 10°·6 C. in 1864 to 7°·9 in 1889.

A general, though less continuous, decline in the mean temperature of the entire spring (March to May), at Greenwich, may also be noticed.

I do not know whether any cause can be assigned for prolonged changes like these in April: some of your readers may be able to throw light on the matter.

The accompanying diagram illustrates the change referred to.

A. B. M.

The Deposition of Ova by "Asterina Gibbosa."

I RECENTLY brought back from Jersey three specimens of *Asterina gibbosa*, all of which deposited ova in the small aquaria in which they were kept. As it appeared evident that the ova exuded from the oral surface, two specimens were selected for experiment.

The first was placed with the oral surface uppermost in a small glass well, with just sufficient water to cover it. When examined about half an hour later, ova had exuded from a genital pore on the oral surface, and had floated up to the top. Had the opening been on the aboral surface, they would have been retained beneath the starfish.

The second specimen was then placed in a glass dish with the aboral surface uppermost. Sufficient water was added to allow the animal to be moved easily with a pair of forceps, but not enough to enable the tube-feet to act. Consequently ova, if deposited, could not float away. In this position it was left for about an hour. When turned, so as to bring the oral surface uppermost, it was seen that ova had exuded. The starfish was killed with the eggs still adhering.

The sexes of starfish are generally said to be separate. But in this case only three specimens were brought: all deposited ova, and in one small aquarium there are now young Asterinas.

HENRY SCHERREN.

BIFILAR PENDULUM FOR MEASURING EARTH-TILTS.

INSTRUMENTS designed for measuring movements of the earth's crust belong to two classes. The first consists of seismographs which register the amplitude and period of the rapid vibrations of earthquake-shocks, and by their records enable the velocity and acceleration of an earth-particle at any instant to be determined. The second class includes nadiranes and various forms of pendulums (such as the bifilar pendulum here described) which are, or should be, unaffected by vibrations of short period, and which indicate only slow tilts or bendings of the ground, showing the change of inclination at any spot, the rate at which it is taking place, and, if periodic, the length of its period. No part of the earth, so far as we know, is free from such movements. Every day, and every year, the surface of the ground at any spot tilts forward and backward through a small angle, perhaps not exceeding a small fraction of a second. Sometimes regular pulsations are observed, each a very few seconds or minutes in duration, and lasting, it may be, for hours; at other times the tilting is irregular and occasionally abrupt; but invariably it is so slight, and takes place so slowly, that without the aid of refined instruments it could never be perceived.

The report of the Earth Tremor Committee (British Assoc. Report, 1893, pp. 291–303), presented at the last meeting of the British Association, contains an account of a new bifilar pendulum designed by Mr. Horace Darwin, and of some of the first experiments made with it at Birmingham. This preliminary trial brought to light one or two slight defects which Mr. Darwin has endeavoured to remedy in the latest form of the instrument, of which a description is given in the present article.[1] The objects of the improvements are (1) to lessen the disturbing effects of the changes of temperature which take place in the neighbourhood of the instrument, and (2) to enable the angular value of the scale-divisions to be determined with greater ease and accuracy.

The chief novelty, both in the old and new forms of the bifilar pendulum, is the introduction of the double-suspension mirror for the purpose of magnifying the movements of the pendulum. This method was used by the Messrs. Darwin, at the suggestion of Lord Kelvin, in 1881, but it was also employed ten years earlier by M. Delaunay at the Paris Observatory.[2] In the latter case, however, the pendulum had a suspending wire 30 metres in length, and was installed in a deep pit, in which the effects of changes of temperature were so great that the successful working of the instrument was impossible.

The Double Suspension Mirror.—A small mirror, M (Fig. 1), is held in a light frame, from the upper edge of which there project two hooks or eyelet-holes, H H'. The mirror hangs by these on a fine silver wire or a silk thread, W, the ends P and P' being attached to two supports very close to one another. In the figure

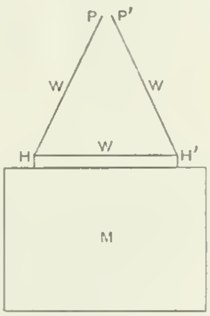


FIG. 1.

these are shown in the same horizontal line; but this is not essential. All that is necessary is that the horizontal distance between them should be small.

It is evident that the wire must always lie in a vertical plane passing through the centre of gravity of the mirror and its frame. If, then, while the point P' remains fixed, the point P be slightly displaced at right angles to the plane of the wire, it follows that the mirror must turn through the same angle as the line P P'. To take a numerical illustration, let P P' be one millimetre, and suppose the displacement of the point P to be one-thousandth of a millimetre, then the mirror will turn through an angle of 3' 26", a ray of light reflected by the mirror will turn through an angle of 6' 52", and consequently the image of the source of light upon a scale three metres distant will move through about six millimetres.

If the distance P P' be diminished, the angle through which the mirror turns for a given displacement of the point P is increased, and the arrangement becomes more sensitive. In the position of the supports shown in Fig. 1, the thickness of the wire imposes a limit to the sensitiveness that may be attained. But if one support is placed above the other, the horizontal distance between them may be made as small as desired. It will be seen that this arrangement is the same as that in Mr. Darwin's pendulum, and therefore, in physical investigations in which the double-suspension mirror is used, the vertical distance between the points of support should be small, otherwise the accuracy of the results may be affected by the occurrence of earth-tilts.

If the support P were rigidly connected with the end of the pointer of a delicate balance, the plane of the mirror being perpendicular to that of the beam, the delicacy of the balance will, as Dr. Poynting has shown, be greatly increased. This is, in fact, the method used by him in his recent determination of the density of the earth.[1] Or, if the support P were attached to the bob of a pendulum, the movements of the latter might be magnified many hundred times, and the most minute earth-tilts be rendered visible. Here we have in principle the apparatus employed by Messrs. G. H. and H. Darwin to investigate the lunar disturbance of gravity. Their inquiry, as is well-known, did not lead to the desired result, the movements due to the action of the moon being masked by the much larger ones produced by the continual tilting of the earth's surface.[2]

The Bifilar Pendulum.—The modified form of the bifilar pendulum was designed by Mr. Horace Darwin for

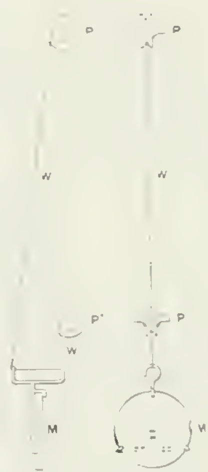


FIG. 2. FIG. 3.

the special purpose of observing and recording these earth-tilts and pulsations, the points in which it chiefly differs from that used in 1881 being that the mirror itself is the bob of the pendulum, and the whole instrument is much smaller. Fig. 4 is a sketch of the complete instrument, while Figs. 2 and 3 show the manner in which the mirror is suspended.

A circular mirror, M, about 20 mm. in diameter, hangs by two small hooks on a very fine silver wire, W.[3] The ends of this wire are fixed to two points, P P', in the instrument, one of them very nearly vertically over the other. The distance between these points is about 180 mm. If the instrument be tilted about a horizontal line in the plane of the wire, the point P will be displaced relatively to P' in the direction at right angles to that plane, and the mirror will in consequence turn round a vertical axis. At a short distance from the mirror is a lamp with a translucent disc in front, and the reflection of this disc in the mirror is observed by a fixed telescope. The stand supporting the lamp and disc is moved along a scale, and the position on the scale is read when the

[1] I am indebted to Mr. Darwin for notes about the changes made in his pendulum, as well as for the loan of the electros of Figs. 2-4. The pendulum was made by the Cambridge Scientific Instrument Company. One, of the improved form, has recently been placed in the Royal Observatory on Calton Hill, Edinburgh.

[2] C. Wolf, "Sur un appareil propre à l'étude des mouvements du sol." *Comptes Rendus*, vol. xcvii. 1883, pp. 229-230.

[1] *Phil. Trans.* 1891 A, pp. 572-574, 581-2: "The Mean Density of the Earth," pp. 78-80, 83-89.

[2] British Assoc. Report, 1881, pp. 93-126; 1882, pp. 95-119.

[3] The plane of the mirror is arranged at right angles to the plane of the suspending wire, in order that heat effects may as far as possible be eliminated. (See British Assoc. Report, 1893, pp. 300-301.)

image of a wire in front of the disc coincides with the cross-wire of the telescope. The change of readings gives the tilt of the earth's surface about a line parallel to the plane of the wires supporting the mirror. Or, keeping the source of light fixed, a continuous record can be taken on a moving piece of photographic paper, and the value of the instrument will of course be greatly increased.

If the instrument be tilted about a horizontal line at right angles to the plane of the suspending wire, the only effect is to alter the horizontal distance between the points of support, P P, and therefore to change the sensitiveness. If the tilt be about any other horizontal line, it may be resolved into two components, one about a line parallel and the other about a line perpendicular, to the plane of the wire. The first of these deflects the mirror, the second alters the sensitiveness; but this change of sensitiveness is nearly always very small, and may as a rule be neglected, because the displacement of P is always very small compared with the horizontal distance between P and P. It will be obvious, however, from these remarks that the instrument is only capable of measuring tilts, or components of tilts, in one definite direction. For a complete knowledge of any given movement, it would be necessary to have a combination of two such instruments placed with the planes of their suspending wires at right angles to one another.

The body of the instrument consists of a copper tube fixed into a heavy gun-metal casting, containing a small chamber very little larger than the mirror, and covered in front by a glass window. Each end of the fine silver wire is attached to a small pulley, and the axles of the pulleys are gripped tightly so that the weight of the mirror is not sufficient to turn them. A strong copper frame carries the pulleys, and can be easily removed from the instrument, thus rendering possible the delicate operation of manipulating the silver wire. The bottom of the frame rests in a hollow cone inside the instrument just above the window; and the length of the silver wire is adjusted by turning the copper pulleys so that the mirror hangs in the small chamber facing the window. The top of the frame is pressed by a spring against the point of a micrometer screw, and can move only in a straight line in the direction of the screw, which is at right angles to the plane of the suspending wire.

A turn of the screw thus tilts the frame of the instrument about a line parallel to the plane of the wire. Knowing the dimensions of the frame and the pitch of the screw, the tilt caused by one turn, or given fraction of a turn, of the screw can be calculated, and the corresponding change of scale-reading determined. The screw is turned through a small angle by means of a lever (Fig. 4), and adjustable screw-stops are arranged at the bottom of the lever so as to allow it to move through only that amount which will make the frame tilt through an angle of two seconds. The lever is moved by a rocking-arm turned by means of two small bellows, into which air is forced by squeezing two india-rubber balls connected with them by long tubes.

The instrument stands on three screw-feet, which are turned by two tangent-screws fixed to long rods. The ends of these rods are shown in Fig. 4. The tangent-screws are arranged so that turning one will tilt the instrument about an axis parallel to the plane of the suspending wire, and will therefore move the spot of light sideways, so that, when it has nearly left the photographic paper, it is easily brought back to the required position without approaching the instrument. Turning the other screw tilts the instrument about an axis perpendicular to the plane of the suspending wire, and this alters the sensitiveness.

When the ends of the silver wire have been fixed to the pulleys, and the frame, to which the latter are attached, has been inserted in the instrument, the copper tube is completely filled with paraffin oil. If the frame is tilted, the mirror then comes to rest very slowly, and rapid

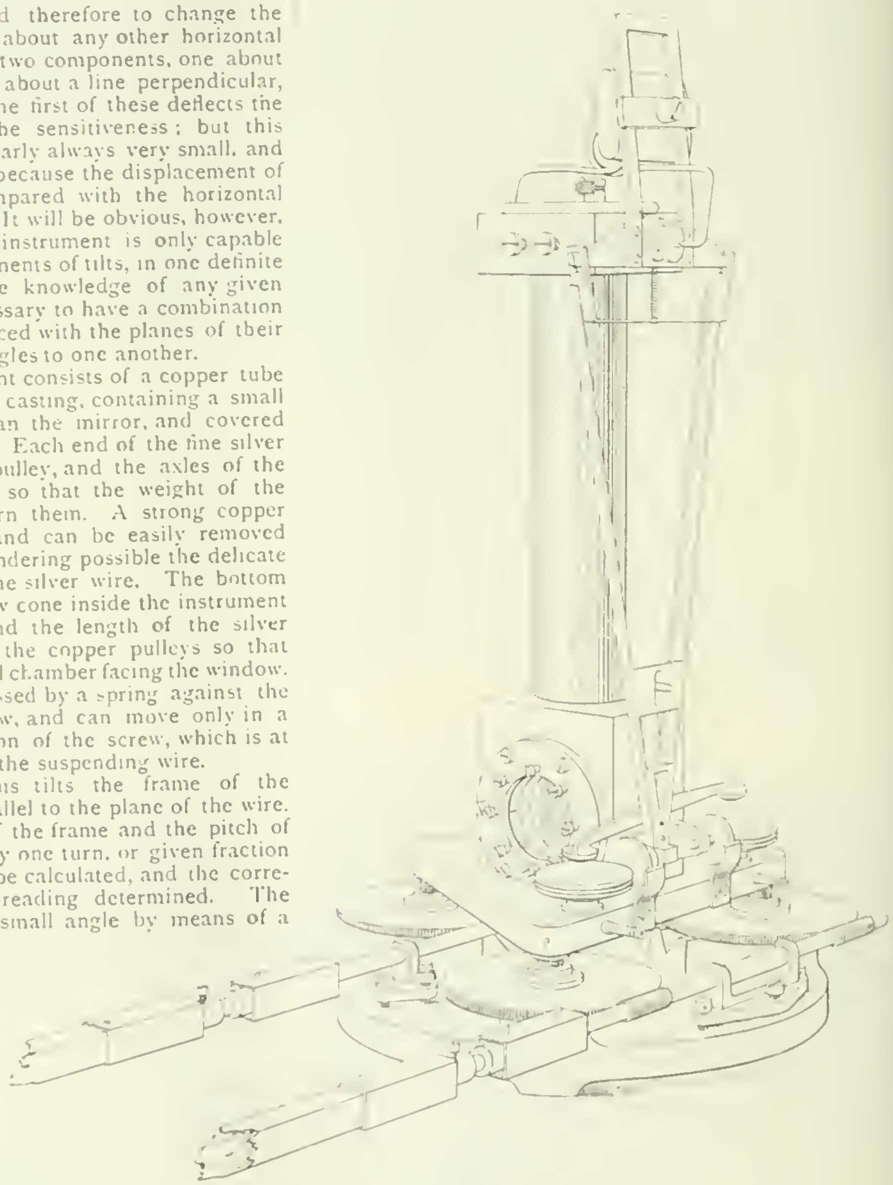


FIG. 4.

vibrations, like those caused by passing carts and trains, do not affect it. Thus the pendulum is designed, not so much for the study of earthquakes, as for the investigation of slow tilts and pulsations of the earth's crust, by whatever cause they may be produced.

Delicacy and Uses of the Bifilar Pendulum.—In the pendulum with which the preliminary experiments were made at Birmingham, the vertical distance between the points of support of the silver wire is one foot, while the horizontal distance between them is about $\frac{1}{250}$ of an inch. If the instrument be tilted through an angle of one second about a line parallel to the plane of the suspending wire the mirror turns through an angle of 49′, and the magnifying power of the instrument is therefore very nearly 3000. A scale is placed at a distance of ten feet, and 3·44 inches of this scale correspond to a tilt of one second. If the lamp be displaced by $\frac{1}{100}$ of an inch, the movement can be clearly perceived. It follows, therefore, that it is possible to observe with this pendulum a tilt of less than $\frac{1}{300}$ of a second, an angle less than that subtended by a line an inch long placed at a distance of a thousand miles.

It would seem, then, that the bifilar pendulum is admirably adapted for measuring the minute changes of level, which are perhaps the cause of some of the uneliminated errors in many astronomical and physical inquiries. Indeed, it may be hoped that the time is not far distant when a pendulum of this kind will be regarded as a part of the ordinary equipment of every great observatory. Again, the bendings of the earth's crust by changes of barometric pressure,[1] by the ebb and flow of the tides, &c., may be studied, as well as the long-period pulsations produced by violent earthquakes in almost any part of the world. It is not too much to expect, also, that in time we may be able to trace out and measure the slow secular movements of the earth's crust which, after the lapse of ages, become perceptible to the geologist; and that the vexed question of the origin of lake-basins may receive an answer that will remove this most debatable of subjects from the domain of controversy for ever.

C. DAVISON.

THE SPECTRUM OF OXYGEN IN HIGH TEMPERATURES.[2]

AT a previous meeting, I brought before the Academy a method, founded on the use of electricity, of bringing gases under pressure to a high temperature without heating sensibly the recipients which contain them.

Before rendering an account of the experiments already made on oxygen by means of this method, I shall mention first those which have preceded them, and in which temperatures not exceeding 300° have been realised by means of a line of gas jets playing directly on the tube containing the oxygen.

The arrangement was as follows:—A steel tube ten metres long, lined inside with red copper, and closed at its extremities by glass, according to our ordinary modes of closing, was placed in a trough containing a sand-bath. This trough was immediately warmed by a line of a hundred gas jets. The temperature of the tube was taken by means of thermometers metallically connected to the tube.

After having introduced the oxygen at the required pressure, and before the heating of the tube has begun, a good spectrum of a luminous light source is obtained, the beam being thrown along the tube in such a way that any change in the spectrum brought about by heating the gas is perceptible.

When the jets are lighted, the spectrum changes in proportion, as the temperature increases at the same time as the pressure. If the experiment is well conducted, the the pressure of the gas at the end, that is to say, when lights have been extinguished and the temperature has become what it was at first, returns to its original value. To obtain this result there must be no loss of gas during the experiment.

This loss of gas is caused principally by the lengthening of the pins that unite the pieces of steel which hold the glasses at the extremities of the tube. In order to prevent this lengthening, bands of brass have been placed between the heads of the pins and the disk, the length of which has been calculated to compensate by their expansion that of the pins. Thus the same degree of pressure is obtained at all temperatures.

The experiments have been made with varied pressures of oxygen. They show that from the ordinary temperature up to about 300° the bands and lines of the spectrum of absorption of oxygen do not undergo modification.

But quite a new feature is produced. A remarkable point is the very remarkable augmentation of transparency of the gaseous column with the increase of heat, a transparency revealed by a considerable augmentation of the brightness and the limits of the spectrum, above all on the side of the red. I shall have to return to the theoretical consequences of this important fact.

To ascend further in the scale of temperatures, it is necessary to make use of the platinum spiral tube rendered incandescent by the passage of the current.

I will not repeat the general arrangement of the experiment already described. The incandescence of the

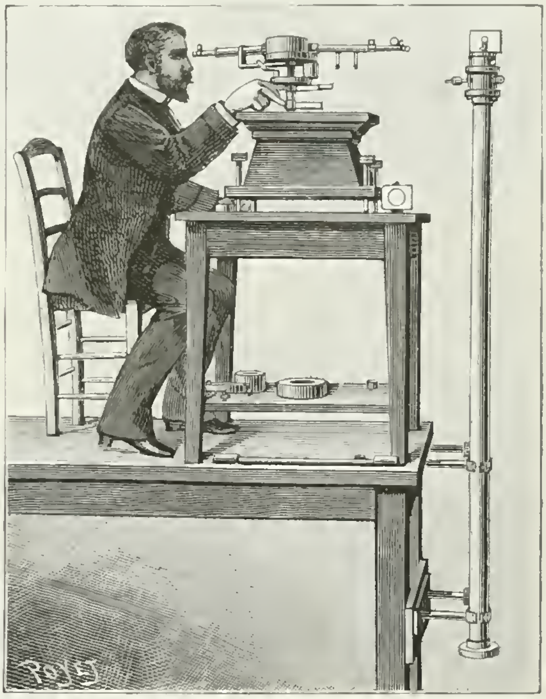


FIG. 1.—Experiments with a vertical tube and incandescent spiral.

spiral is more difficult to obtain if the pressure of the gas is greater.

The temperature to which the spiral is carried can be determined in different ways:—(1) The thermo-electric couple; (2) the observation of the increase of the pressure of the gas caused by the passage of the current; (3) and finally, the brightness and length of the spectrum given by the incandescent spiral, when it furnishes the light alone.

The experiment works thus:—

The tube being placed in a vertical position, the lamp, which must produce the beam to be analysed after its passage in the tube, is first regulated, and then the spectrum analysing apparatus is arranged. Pressure is then put on, and the constitution of the spectrum having been well observed, a current is made to pass, the power of which is proportional to the temperature which has to be obtained.

[1] Such observations would gather additional interest if made in the neighbourhood of a great line of fault.

[2] A communication made by Dr. Janssen to the Paris Academy of Sciences. Translated from *La Nature*.

The pressure increases immediately, and stops when equilibrium is established. The spectroscopic phenomena are always followed and compared at the beginning and when equilibrium is established.

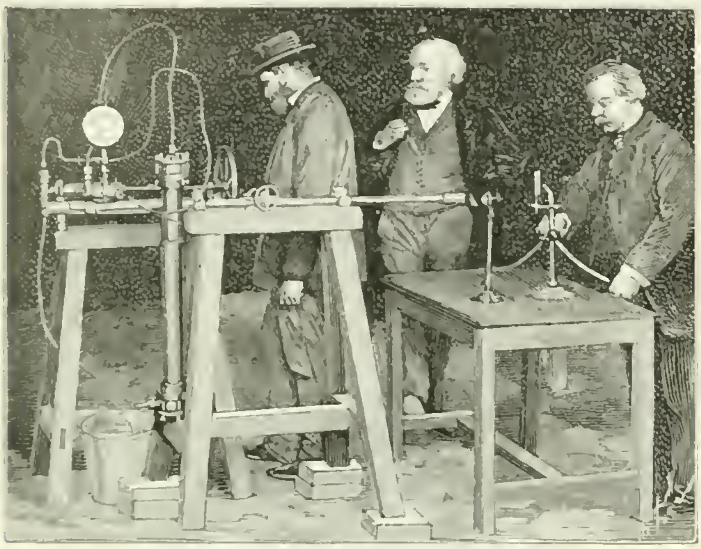


FIG. 2.—Apparatus for experiments at high pressure.

In the experiments made with the tube of two metres in length, and with gaseous pressures up to 100 atmosphere, perceptible modifications in the length of the spectrum observed have not been noted. The attained temperatures have been estimated between 800 and 900°, according to the spectrum given by the spiral.

To obtain higher temperatures it is necessary to increase the power of the electric generators, and that is what it is proposed to do; but it must be observed that the solar phenomenon point of view, it is the exterior and middle parts of the coronal atmosphere which interest us most. It is those which, if they contain oxygen, would, above all the others, produce steam, by reason of their lower temperatures. But temperatures of 800 and 900°, which have already been realised, correspond to the deep parts of the coronal atmosphere, and in these, as well as in those which are more exterior, and consequently colder, the absence of oxygen may be affirmed.

PHOTOGRAPH OF A LANDSCAPE IN LIVING AND DEAD BACTERIA.

A FILM of living bacteria in Agar was distributed over very thin (cover-slip) glass sterilised, this thin glass alone separated the film from the negative. After exposure over a mirror for two hours, and then forty-eight hours' incubation, the bacteria behind the transparent parts of the negative were killed; those behind the opaque parts developed normally; those partly protected were retarded, giving the half tones. The photograph was sharper when first made, several weeks before reproduction.

NOTES.

LORD KELVIN has been awarded the Grande Médaille of the Société d'Encouragement pour l'Industrie Nationale of Paris, for his scientific works. Among other awards we note the following: 3000 francs to M. Dulac for a means of diminishing smoke at industrial centres; 1000 francs to MM. Fuchs and de Launay for their work "Gîtes Minéraux"; and 500 francs to M. Chapel for his "Caoutchouc et la Gutta-Percha"; 2000 francs to Prof. Roberts-Austen for his work on alloys (see NATURE, June 7); 1500 francs to M. Pagnoul; and 500 francs to the Société d'Agriculture in the Meaux district, for investigations on the comparative physical nature and chemical constitution of the soils of certain regions.

AFTER a long illness the Right Hon. Sir Henry Layard passed away on July 5, at the age of seventy-seven. His excavations at Nineveh and Babylon, and his travels through various parts of Asia, have made his name eminent among archæological investigators and discoverers.

WE regret to record the death at Paris of M. Mallard, the Professor of Mineralogy in the Ecole Nationale Supérieure des Mines.

THE *Times* correspondent at Calcutta telegraphs that, since the beginning of the rainy season, the water in the Gohna Lake has been rising about two feet daily, and is now 160 feet from the top of the dam. As percolation has begun through the dam, and is increasing with the increased pressure, it is thought that the overflow will probably not occur before the middle of September.

A REUTER telegram from St. John's, dated July 7, states that the Peary Auxiliary Expedition has sailed on board the steamer *Falcon* for Inglefield Gulf, Greenland, to bring home Lieut. Peary's party. They will call at Carey Island, where the Swedish naturalists Bjorling and Kallstenius were wrecked in the schooner *Ripple* in 1892, and will also search at Cape Faraday and Clarence Head to ascertain the fate of the naturalists. The party will explore Jones's Sound and make a chart of the coast, returning to Bowdoin Bay for Lieut. Peary on September 1. The expedition is expected to return by September 20. Dr. Ohlin, the Swedish zoologist, and Messrs. Chamberlain and Libbey, represent the scientific side of the party, which is under the leadership of Mr. Bryant.

Dr. M. A. Veeder informs us that the Jackson-Harmsworth Polar Expedition, which starts from London to-day (see p. 255) for an extended sojourn in the Arctic regions, will co-operate in observation of the aurora upon the concerted plan which is in use by a large number of observers in various parts of the earth, and by the expeditions of Lieut. Peary and Dr. Nansen. This, together with what has already been done, insures the continuance and perfecting of these observations, which are having results that promise to be of great practical value both to astronomical and meteorological science, as well as to the study of physics in general.

At the last meeting of the Physical Society it was announced that in future the meetings of the Society will be held in the rooms of the Chemical Society, Burlington House. Since its foundation in 1874 the Society has met in the Physical Lecture Theatre of the Royal College of Science.

Violent earthquake disturbances were experienced in Constantinople on Tuesday afternoon. The first shock occurred shortly after noon, and is said to have lasted twenty seconds. Another wave was felt at four o'clock. In both cases the direction of motion appears to have been from east to west. About the same time, a severe earthquake was also felt at Smyrna and Scio, and in the Dardanelles.

Miss Ormerod, writing to the *Times* of Saturday last, mentions that bad attacks of the grass-destroying caterpillars of the antler moth are now occurring in some localities in Scotland. She says that in 1884 these caterpillars devastated an area of about ten miles in extent of the mountainous parts of Glamorganshire, and in 1885 spread over an area of about seven by five miles in Selkirkshire, N.B. The district infested at present is that in which the voles not long ago did so much damage, and Prof. Wallace reports that the caterpillars are doing even more mischief than the voles.

Thunderstorms again occurred in nearly all parts of Great Britain on the 6th inst., and were reported at places during several subsequent days; the disturbance appears to have been caused by a shallow barometric depression advancing northwards from the south-west of France. The thunderstorms were again preceded by abnormally high temperatures, especially over the eastern and southern parts of England, where the thermometer rose above 85°, while at Rochefort, in France, the maximum temperature in the shade rose to 99° on the 5th. Some very heavy falls of rain have also been reported, the total in two days amounting to about three inches in the south-west of Ireland, and quantities of considerably over an inch in twenty-four hours fell in Scotland and the south of England. The average rainfall since the beginning of the year has now been about reached, or exceeded, in all districts except the midland parts of England; in Scotland the average has been exceeded by about five inches.

At a Council meeting of the Pharmaceutical Society of Great Britain, last week, Mr. Martindale moved the following resolution:—"That after the first day of January, 1895, a practical knowledge of the metric system of weights and measures shall be required of all candidates for the Minor examination in the subjects of prescriptions and practical dispensing, and that the Board of Examiners be instructed to require from candidates a general knowledge of posology in terms of the metric as well as the British system of weights and measures as defined by the British Pharmacopœia, 1885; and in practical dispensing 'to weigh, measure, and compound medicines' by the metric as well as the British system of weights and measures." After some discussion the resolution was altered to the effect that the Board of Examiners should be requested to consider the advisability of acquiring a practical knowledge of the metric system of weights and measures for the Minor examination. In this form it was carried.

We regret to note that the recently issued report of the Council of the Marine Biological Association states that there is no immediate prospect of a satisfactory boat being obtained by the Association: the question is purely a financial one, and its solution is only to be found in the generosity of public companies or private individuals. The Council points out that it is impossible that a sea-going boat can be purchased out of income, so long as the revenue of the Association is so small. During the past year the work of collection has been largely carried out by means of hired vessels, a method both expensive and unsatisfactory. As to scientific investigations, we read that, during the past year, both Mr. Cunningham and Mr. Holt continued their inquiries into the various questions relating to the maturity of food-fish which were so prominent last year before the House of Commons Select Committee on Sea Fisheries, and upon which much information is still required. More important, perhaps, is the fact that Mr. Cunningham has finally settled by direct experiment the much-debated question of the identity of the egg of the pilchard. He has been able to rear the larvæ of plaice, hatched and fertilised in the aquarium at Plymouth, to the age of thirty-seven days; no flat-fish larvæ had previously been reared in confinement from the ovum to this age, and the result is of great economic value.

The German Fisheries Association offers prizes of 800, 1000, and 600 marks, respectively, for the best works on the following subjects:—(1) Simple, trustworthy, and generally applicable methods for the determination of the gases oxygen, carbonic acid, and nitrogen found in natural waters, or at least of the first two, special importance being attached to methods independent of the higher resources of the chemical laboratory. Competitors to send in before June 1, 1895. (2) Investigations concerning the pathological and anatomical effects upon fishes of the following bodies found in drain-waters:—Free acids, free bases, especially lime, ammonia, soda, and the soluble carbonates of potash and soda; free bleaching gases, such as chlorine and sulphurous acid. Further, the determination of the symptoms of suffocation from these causes. Partial and even negative answers are not excluded. Representatives of the Salmonidæ and Cyprinidæ families are recommended for investigation. Papers to be sent in before November 1, 1896. (3) The development and conditions of life of the water fungus *Leptomitus lacteus*, and its appearance and disappearance in polluted waters. Papers to be sent in before November 1, 1895. All papers for the competition are to be sent in registered envelopes to the General Secretary, Prof. Dr. Weigelt, Berlin, S.W., Zimmerstrasse 90, 91. They may be written in German, French, or English, and are to be provided with a motto and with the name and address of the author in a sealed envelope bearing the same motto. The object of the Association is to throw light on the pollution of natural waters by animal and industrial refuse. The withdrawal of the gases mentioned, which have an intimate relation to the amount of putrifying matter, is difficult to prove. The symptoms of death due to pollution by free acids and other poisons are not as yet very well known. Sugar and starch factories send drain-waters into the rivers, which offer ample sustenance to the white river algæ, especially *Leptomitus lacteus*. These may be regarded as having a purifying effect, but the decomposition of the dead floating masses gives rise to further pollution. An examination of the habits of this plant appears, therefore, highly desirable in the interests of the inland fisheries. The judges are Drs. Fleischer, König, Tiemann, Hermann, Nitsche, Virchow, Halwa, Kirchner, Magnus, and Weigelt.

AN investigation by Prof. W. J. Sollas, F.R.S., "On the Relation of the Granite to the Gabbro of Barnavave, Carlingford" (*Trans.* Royal Irish Academy, vol. xxx. part xii. 1894), has added facts of considerable importance to what was previously known about the mountain groups of Carlingford and Slieve Gullion, which rise from the centre of the Palæozoic tract of the counties of Lough and Armagh, and represent the remains of extinct volcanoes of the Tertiary period. From an examination of the district, and a study of rock-sections from it, the following statements are deduced:—(1) The gabbro of the Carlingford district is older than the granite which penetrates it. (2) The gabbro was already completely solid, traversed by contraction joints, and, probably, fractured by earth movements before the injection of granophyric material. (3) The granophyric material was in a state of great fluidity at the time of its intrusion. The granophyric dykes are in no case contemporary veins. The results of the investigation suggest to Prof. Sollas some reflections on the difficult question of the "differentiation of originally homogeneous igneous magmas." In his opinion, "much more attention must be given to the investigation of the details of the now prevalent differentiation hypothesis before it can be regarded as established on a firm basis." In fact, the importance of this paper as a contribution to physical geology is liable to be overlooked, owing to the topographical nature of its title; but it soon becomes apparent to the reader that the close intermingling of rocks of different composition which has taken place at Barnavave, is not likely to be an exceptional occurrence. The proofs of microscopic penetration of the gabbro by the granite, until a bulk-analysis of any specimen would be most misleading, are interesting to all geologists, and practically open a new field of observation. A severe blow is struck at the whole theory of "segregation veins," or "contemporary veins," which has perhaps been maintained too academically and without complete confirmation in natural exposures. It is worth noting that this memoir is issued separately by the Royal Irish Academy, like all published in their *Transactions*.

IN a paper published in the *Electrotechnische Zeitschrift*, in which he described a new form of gas voltameter, Prof. Kohlrausch expressed his surprise that the gas voltameter was so seldom used for measuring currents. The reason for this state of affairs is probably to be found in that the form of gas voltameter ordinarily in use is both inaccurate and troublesome to use. A new form of gas voltameter has recently been devised by Herr H. A. Naber, of Amsterdam, which embodies several improvements. The burette in which the gas evolved (either hydrogen or oxygen) is collected, can be turned about a vertical axis, so as to bring its lower end over the electrode, and thus start or stop the collection of gas at any given time without breaking the current passing through the voltameter. By means of an auxiliary vessel into which air can be driven, the level of the liquid inside and outside the burette can be made the same, so that there is no correction to be applied to the barometric pressure in order to find the pressure under which the gas is measured. The burette is fitted with a tap, so that the oxygen or hydrogen evolved can be passed into another vessel and collected. The whole of the apparatus is constructed of glass, except, of course, the electrodes, which are of platinum, and are so arranged that the two gases evolved can never possibly mix, and thus cause an explosion, if by any chance the platinum of the electrodes becomes exposed to this mixture of gases.

A NEW form of automatic steering compass has been invented by Lieut. Bersier, of the French Navy, and a very full description is published in *La Nature* for June 25. The difficulty with any form of automatic compass is that any arrangement by which the compass card makes or breaks a mechanical contact when the course deviates from a straight line will interfere with the free set of the needle. Lieut. Bersier, in his compass, uses a spark from a Ruhmkorff coil, which passes between a metal point on the edge of the compass-card and one of two semicircular metal plates fixed to and insulated from the sides of the compass bowl. These metal plates are connected to two small electromagnets, and when the electric current which forms the spark passes, it closes the circuit of a small motor which actuates the steering gear. If the spark passes to one plate the motor works in one direction, while if the spark passes to the other plate the motor works in the reverse direction; so that it is only when the point on the card is half-way between the two metal plates that the rudder is amidships. It is said that the new compass has been tried in the French Navy for several months past, and has given entire satisfaction, which, considering the very delicate and complicated nature of the mechanism employed, is very remarkable. The new form of compass can be made to automatically register the course steered, the spark being caused to pierce a band of paper which is moved by clockwork.

IN a short paper communicated to the Johns Hopkins University *Circular*, Mr. A. S. Mackenzie describes some experiments he has conducted to test the validity of the Newtonian law of attraction for crystalline and isotropic masses at small distances. In discussing the elastic solid theory of refraction in physical optics, it is often customary to introduce an optical density which may be different in different directions. In uniaxal crystals there are two such directions, and in the case of Iceland spar the square roots of the densities are as 1·486 to 1·658. Thus the question arises, does this property depend upon the distribution of the mass with reference to the optic axis? and if so, could a crystal attract a particle in a manner dependent upon the position of the particle with reference to the optic axes of the crystal, so that it would act as if it were of greater mass (and therefore density) in one direction than in another? It is to elucidate this point that the author has been conducting a series of experiments, using for this purpose a form of apparatus which, at any rate as far as the magnitude and suspension of the attracted masses are concerned, resembles that used by Prof. Boys. The apparatus, however, is designed for relative rather than absolute measurements. Although the greatest divergence between any two results only amounted to 1 part in 200, no difference in the attraction of a crystalline mass along, and at right angles to, the axis was discovered. A second set of experiments was undertaken in which the attracting masses were isotropic, but in which the distances between the attracting and attracted masses was varied, with a view of testing the law of the inverse square of the distance. The form of apparatus used seems particularly ill-suited to test this point, as the distances between the centres of the masses are very hard to measure. The author, however, says these distances could be measured to within $\frac{1}{10}$ mm., and he finds that while the deflections as calculated, assuming the correctness of the inverse square law for distances of about 7·4, 5·5 and 3·6 cm. between the centres of the large and small masses were as 1 : 2·05 : 5·25, while the observed deflections were as 1 : 2·04 : 5·24. So that the Newtonian law has been found to be true for the attractions of non-isotropic, and for istropic masses at distances apart as small as 3 or 4 cm.

IN the *Modern Medicine and Bacteriological Review* for May, attention is called to a subject which is attracting special interest just now amongst bacteriologists—the existence of sub-varieties of microbes of specific species. We have frequently referred in these notes, directly and indirectly, to the polymorphism exhibited by one and the same variety of micro-organism when submitted to different conditions of environment, &c., whilst Prof. Percy Frankland has repeatedly shown how the power of fermenting various solutions may not only be imparted to particular microbes by suitable training, but also removed from them. M. Péré has recently shown that there exist many sub-varieties of the bacillus *coli communis*, and Dr. Sanarelli has demonstrated the same in a series of investigations, conducted under Prof. Metchnikoff, for the typhoid bacillus, whilst the list of pseudo and other cholera vibrios is fast becoming unmanageable. The desirability of a due recognition of the fickleness of microbes to prescribed forms, &c., in the diagnosis of disease, where the bacteriological evidence is regarded of first importance, is obvious to all; whilst at the same time it is but one of the difficulties which a larger horizon has placed in the path of the bewildered bacteriologist. The other microbial notes are mainly on subjects already reviewed in these columns, whilst the medical articles are too technical to admit of reference here.

An interesting account of hereditary malformation of the hands and feet is contributed by Drs. W. Ramsay Smith and J. Stewart Norwell to the *British Medical Journal*. In the subjects examined, the malformations in the hands affected the middle and ring fingers. These fingers were webbed to the tips, and the bones were disposed in an extraordinary manner. For instance, on the left hand the tip of the middle finger looked as if it were twisted in front of the ring finger, while the nails, which in the right hand were in the same plane, formed in the left a well-marked angle with one another. Each foot of the subjects had six toes. The second and third toes were webbed almost to the first interphalangeal joints, and the first and sixth toes up to the nail, while the fourth toe was comparatively free. It is not so much the striking abnormalities that are interesting, however, as the persistency and consistency with which the malformation has affected several generations. Taking back the history of the case as far as they could investigate it, the authors found that twenty-one out of twenty-eight of the family were malformed. An important point in this record is that malformation of the hands was always associated with malformation of the feet. In no instance was there a malformation of the hands alone or of the feet alone; and the malformation, as far as could be ascertained, showed very little variation. Another point is that it seemed to go very much in the female line. It is also remarkable that the wife of one of the subjects had been married previously, and had borne three children by her first husband, nevertheless all the children of the second husband inherited the malformation possessed by him.

Messrs. Blackie and Son have published the third part of Prof. F. W. Oliver's translation of Prof. Kerner's "Natural History of Plants."

Messrs. Williams and Norgate have issued a list of new scientific works published in German, French, and other foreign languages. The list is No. 59 of their scientific series of foreign book circulars.

We have received an advance copy of the eleventh annual report presented to the Chemical Section of the American Association for the Advancement of Science, by the Committee on indexing chemical literature. The report consists of a descriptive list of bibliographies published during last year.

Some very interesting reminiscences of the late Rev. Leonard Blomefield, together with a portrait of him, are given by Mr. H. H. Winwood in the *Proceedings* of the Bath Natural History and Antiquarian Field Club (vol. iii. No. 1). Mr. Blomefield was the founder of the Club, in 1855, and took the warmest interest in its work up to the time of his death in September last.

Part ii. of volume lvii. of the *Journal* of the Royal Statistical Society has just been published. Mr. Charles Booth's paper, "Statistics of Pauperism in Old Age," and the discussion on it, as submitted at the meeting of the Society in March, is contained in this number. The paper forms the first part of a volume since published by Messrs. Macmillan. Two other papers are included in the *Journal*, viz. "Conditions and Prospects of Popular Education in India," by Mr. J. A. Baines, and "Modes of Census-Taking in the British Dominions," by Mr. R. H. Hooker.

We stated some time ago that the United States Hydrographic Office was collecting information with the view of publishing a monthly Pilot Chart of the North Pacific Ocean. The first chart, for the month of July, has now been issued, and contains, among other useful information, data showing the calms and prevailing winds, the currents, and mean isobars drawn for Greenwich noon, for that month. The chart is at present far from complete, because of the limited number of observations in unfrequented portions of the ocean; nevertheless it is a good beginning, and no doubt the appeal made to observers to co-operate in the work will eventually enable the hydrographer to fill in the details where they are now wanting.

Every student of physics knows Deschanel's "Natural Philosophy," by Prof. J. D. Everett, F.R.S. For many years this treatise, and that by Ganot, have been the standard works for classes in elementary physics, and the thirteenth edition, just published by Messrs. Blackie and Son, will enable this position to be maintained for some time to come. It is well known that the work is not merely a translation; in fact, Deschanel's "Traité de Physique" only forms a basis upon which Prof. Everett has constructed an invaluable text-book. So many are the additions to the new edition that three pages of the volume are taken up with the enumeration of them. The work has been entirely recast, much of the old matter has been rearranged, and new matter has been largely introduced. Part II. contains a new chapter on Thermodynamics, in which free use is made of the methods of the Differential Calculus. An explanation of entropy, Dewar's experiments, and Van der Waal's theory with respect to the departure of gases from Boyle's law, are among the many additions to this part. Two new chapters have been added to Part III. (Electricity and Magnetism), and much of the antiquated matter has been omitted. Very extensive changes have also been made in the optical portion of Part IV., and a new chapter has been introduced dealing with systems of co-axal lenses. These judicious revisions and expansions have resulted in the production of a work which bears the same relation to physics of to-day that the original treatise did to the state of physical knowledge at the time of publication. The work may, therefore, be expected to be just as successful in the future as it has been in the past.

The nature of the explosive decomposition of the ammonium and mercury salts of diazoimide, N_3H, forms the subject of a communication to the *Annales de Chimie et de Physique*, by MM. Berthelot and Vieille. The ammonium salt, N_3NH_4, was obtained in large, brilliant, transparent crystals by the method of Curtius, the action of ammonia upon diazohippuramide suspended in alcohol and recrystallisation from water. The crystals may be handled without much danger of explosion if due care is taken. They sublime at the ordinary temperature *in vacuo*. The pressure produced during their explosion has been determined in a small steel cylinder provided with piston and registering apparatus; a similar cylinder of copper was burst by the violence of the explosion. The pressure produced was found to be equal to that of one of the gunpowders recently tested by M. Berthelot, but the combustion appears to be a relatively slow one; the temperature of deflagration is about 1350–1400°. Hence the ammonium salt of diazoimide is a remarkable explosive on account both of the force developed during explosion and of its low temperature of deflagration. The products of the decomposition are ammonia, hydrogen and nitrogen. The ammonia was actually liquefied in the cylinder. The temperature is not sufficiently high to dissociate ammonia, so that there is first a decomposition into ammonia and diazoimide and then a subsequent decomposition of the latter into its elements. This probably accounts for the extreme force of the explosion, the energy which would otherwise have been absorbed in effecting the dissociation of the ammonia being available in the explosion. The mercurous salt of diazoimide, N_6Hg_2, was obtained by precipitating a dilute aqueous solution of the ammonium salt with mercurous nitrate. The precipitate requires very careful washing and drying, owing to its highly explosive character. Its explosive decomposition is extremely rapid, analogous to that of fulminate of mercury, and the temperature of deflagration high, about 2700°. The mercuric salt, N_6Hg, may be conveniently obtained from the mercurous salt by decomposing it with sulphuric acid, and treating the solution of diazoimide thus prepared with freshly precipitated yellow mercuric oxide. The greater portion of the salt separates as a white precipitate, but it is somewhat soluble in cold water, and very considerably soluble in hot water, from which long acicular crystals are deposited on cooling. It is the most dangerously explosive of the salts investigated, and the experiments have unfortunately had to be abandoned on account of serious accidents to M. Berthelot's assistants. It is much more sensitive and therefore more dangerous than fulminate of mercury, and explodes when least expected and in a most violent manner. It furnishes the same volume of gaseous products of decomposition as fulminate of mercury.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. Conrad W. Cooke; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Wheeler; a Cheetah (*Cynaelurus jubatus*) from Somali-land, presented by Mr. William Mure; four Hedgehogs (*Erinaceus europaeus*), British, presented by Mr. F. C. Smith; two Senegal Touracous (*Corythaix persa*) from West Africa, presented by Miss E. B. Redwar; a —— Falcon (*Falco*, sp. inc.) captured at sea, presented by Mr. Arthur L. Sclater; four —— Anolises (*Anolis*, sp. inc.) from North America, presented by the Southern Curio Company; a Crowned Lemur (*Lemur coronatus*) from Madagascar, three —— Opossums (*Didelphys*, sp. inc.) from South America, deposited; two Obsolete Tinamous (*Crypturus obsoletus*) from Brazil; a Smooth Snake (*Coronella laevis*) from Austria, purchased; three Indian Cobras (*Naia tripudians*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF THE ORION NEBULA.—Two papers on the spectrum of the nebula in Orion are contained in the current number of *Astronomy and Astro-Physics*, one by Prof. J. E. Keeler, and the other by Prof. W. W. Campbell. The former observer photographed the spectrum of the nebula many times during last winter. A comparison, of the photographic and visual observations of nebular lines, with dark lines in the spectra of the Orion stars, indicates that an intimate relation exists between the two. "Indeed," says Prof. Keeler, "taking into account the relative intensities of the lines, the spectrum of Rigel may almost be regarded as the nebular spectrum reversed." Spectroscopists will remember that Dr. Huggins obtained an anomalous spectrum of the Orion nebula in 1889, his photograph showing a large number of fine lines apparently connected with the spectra of the trapezium stars, while the hydrogen lines H_δ and H_ϵ were absent. Prof. Keeler has tried to obtain the same result by photographing the spectrum in the same way as Dr. Huggins, but without success. He shows that "contrary to the belief which has been held up to the present time, the trapezium stars have spectra marked by strong absorption bands; they have not the direct connection with the nebula that would be indicated by a bright-line spectrum, but are in fact on precisely the same footing (spectroscopically) as other stars in the constellation of Orion. While their relation to the nebula is more certain than ever, they can no longer be regarded as necessarily situated *in* the nebula, but within indefinite limits they may be placed anywhere in the line of sight." Finally, with regard to the appearances that have led to the belief that the nebular lines are bright in these stars, Prof. Keeler believes that they are of physiological and photographic origin, and do not actually exist. It is pointed out that these conclusions have an important bearing on theories of stellar development.

Prof. Campbell's paper, which is continued from the May number, deals with the spectrum of the Orion nebula and other well-known nebulæ. In it Prof. Campbell brings together all his spectroscopic observations of nebulæ. Like Prof. Keeler, he was unable to confirm Dr. Huggins' observation of the absence of certain hydrogen lines in the spectrum of the Orion nebula. His photographs also show that the spectra of the trapezium stars all conform to the Orion type, and contain numerous dark lines, but no bright lines. By tabulating the observations published up to the date of the paper, it is shown that of the twenty-five bright lines known to exist in the spectrum of the Orion nebula, at least nineteen are definitely matched by dark lines in the Orion stars, and at least fifteen by dark lines in the six faint stars situated in the dense parts of the nebula. Including his own observations, Prof. Campbell finds that thirty-six bright lines have been observed in the spectra of the seven nebulæ examined by him. He has tabulated all the lines that have had their positions determined either from photographs or by direct observation.

THE NEBULOUS CHARACTER OF NOVA AURIGÆ.—The question of the telescopic appearance of Nova Aurigæ is again brought up in *Astronomische Nachrichten*, No. 3238. Prof. E. E. Barnard, at the end of a communication on micrometrical observations of the object, made with the 36-inch telescope of the Lick Observatory, says that when he examined the star on August 19, 1892, it appeared to be densely nebulous, and that since then it has not appreciably changed. He has made a very careful examination of the star in order to test whether the nebulosity was due to instrumental defects or not, and the result of his investigation is the conclusion that—"When the Nova is in the best possible focus it is hazy and surrounded for 5″ or 6″ with a decided nebulosity. . . . How much of this nebulosity is due to the peculiarity of the spectrum of the Nova, I am not able to tell. But from my experience with nebulæ I would unhesitatingly say that the Nova is distinctly and unquestionably nebulous." This testimony, coming from such an experienced observer as Prof. Barnard, is very important. An inspection of the micrometrical observations made at the Lick Observatory, failed to show any marked periodic variation of the star's position, such as might be due to parallax. The object must therefore be at an enormous distance from us.

A series of observations of the relative position of Nova Aurigæ and a comparison star of magnitude 10·2, is also communicated to the same number of the *Astronomische Nachrichten* by F. Renz, of the Pulkowa Observatory. The observations extend from September 1892 to March 1894. The series shows no perceptible variation in the relative positions of the two stars. As regards the suspected nebulosity, Dr. Renz found that it disappeared on pulling out the eyepiece by about 3·6 mm., thus indicating that the nebular appearance was due to a want of definition produced by the different refrangibility of the light emitted by the Nova. He thinks that the object has never appeared so nebulous as it was in September 1892, and he suggests that this may be accounted for by the fact that the hydrogen line at λ 486 μμ (F) and that at λ 495 μμ have diminished in intensity.

THE APIS PERIOD OF THE ANCIENT EGYPTIANS.—The Apis Period of the ancient Egyptians formed the subject of a recent paper read before the Vienna Academy by Dr. E. Mahler. The author showed that this 25-year period could no be related to the duration of life of an Apis, since many different periods are recorded for that. But by reducing the dates of the enthronement of Apis as given by Brugsch and Lepsius in the Egyptian reckoning to the Julian chronology on the basis of the fixed Sirius year, the significant fact was discovered that such enthronement always took place on the day of the full moon. Since Apis is known to be the visible representation of Osiris, and the latter is identified with the full moon, it is reasonable to suppose that the Apis-period of $9125 = 25 \times 365$ days was purely astronomical, and that the name was derived from its connection with the full moon and Osiris.

OBSERVATIONS OF THE PLANET MARS.—A telegram transmitted by Prof. Pickering to Prof. Krueger, and printed in *Astr. Nach.* No. 3241, reads as follows:—"Holden telegraphs: Bright projection of Mars terminator like that previously observed at Lick Observatory and seen several mornings, best seen June 28 near Polar Cap, Ganges seen double."

THE JACKSON-HARMSWORTH POLAR EXPEDITION.

THE private Polar Expedition led by Mr. F. G. Jackson, and financed by Mr. A. C. Harmsworth, sails from the Thames to-day, July 12, on board the steam-whaler *Windward*, for Franz Josef Land, calling *en route* at Archangel.

Many of the equipments of the expedition were exhibited to a select party at an "at home" given by Mr. and Mrs. Harmsworth at the Grafton Galleries on Friday evening, and on Monday last a number of visitors were shown over the ship in the Shadwell Basin, when the special arrangements for the expedition were more fully explained.

The staff which has been finally selected by Mr. Jackson to accompany him on his projected land journey in the far north includes the following:—Mr. Albert Armitage, second in command, a young officer of the P. and O. Company's service, who is a practical navigator and trained in astronomical and magnetic observations; Dr. Kettlitz, medical officer; Captain Schlosshauer, a merchant skipper; Mr. Fisher, curator of the Nottingham Museum, as scientific collector; Mr. Burgess, who has had some previous Arctic experience, and will act as cook; Mr. Childs, who undertakes mineralogical work and photography; and Mr. Dunsford, who, like Mr. Jackson and Mr. Armitage, has a knowledge of surveying. Some friends of the explorers sail with the party, intending to return from Archangel.

Several previous expeditions have acquired some knowledge of the natural conditions of Franz Josef Land, and it is confidently expected that game, in the shape of bears, seals, and birds, will be abundant. Accordingly a complete outfit of sporting guns, rifles, harpoons, &c., is being taken. The expedition is, however, fully provisioned for four years with the most highly condensed and thoroughly preserved foods obtainable. Much reliance is placed on the fresh bear and seal meat, expected to be shot, for the prevention of scurvy, but Mr. Jackson also proposes to use port wine as a specific. The use of alcohol and tobacco, which has recently been entirely discarded in Arctic work, is one of the peculiar and probably not unpopular features of the present attempt on the Pole.

The arrangements for travelling include boats for crossing open water. One of aluminium, measuring 18 feet by 5 feet, weighs only 150 lbs., and can carry twenty people; it is made in three sections for convenience of transport on sledges, and each section will float by itself. A similar copper boat, weighing about 200 lbs., is also carried, and three light wooden Norwegian boats. A fast steam-launch, appropriately named the *Markham*, is expected to be of service if it is found possible to proceed from the base for some distance by sea, or up Austria Sound.

Eighteen sledges of exceptionally light and strong construction, each calculated to carry 1000 lbs. weight if necessary, are taken; these are to be drawn by Siberian dogs or ponies. There are three collapsible tents, and suits of Samoyed clothing for use in winter, the cumbrous-looking garb of these Siberian nomads being considered better adapted for rough work in bad weather than the tighter-fitting costume of the Eskimo pattern. The scientific instruments carried are perhaps the finest that have ever been taken into the far north, the extensive use of aluminium ensuring a lightness and strength never before attained in Arctic exploration.

After landing the exploring party in Franz Josef Land about the end of August, the *Windward* will return to England, if possible, and sail again next year with fresh supplies.

The whole cost of the expedition is estimated at £25,000.

ANNUAL REPORT OF THE PARIS OBSERVATORY.

ON the 3rd of March of this year, M. Tisserand presented his report to the Council of the Observatory regarding the state of the Observatory during the past year. In his preliminary remarks he refers briefly to the work in course of execution. Under the direction of Le Verrier, great attention was concentrated on the meridian service, which comprises observations of the sun, moon, planets, asteroids, and the revision of the catalogue of Lalande. Extra-meridian observations of comets and small planets have been made with the equatorial in the west tower, and M. Wolf has been occupied in astro-physic researches. An important work in hand is that of publishing a catalogue of the Observatory, based on all the values of the meridian observations made from 1837–1881, while special researches on the R.A. of fundamental stars have been undertaken, and on the declinations, after methods proposed by M. Lœwy. The equatorial service has been enlarged by the addition of another coudé, which instrument is devoted to the observation of planets, comets, systematic measures of double stars and nebulæ, and will be occupied in future with the study of the most interesting variable stars.

With regard to the work in hand, M. Tisserand says that there is enough "assuré pour plusiers années." In remarking on the great preponderance of meridian work, he refers to its considerable importance in astronomy, furnishing as it does the constants for calculating the positions of planets and stars. Photography, he says, gives the means of determining exactly the positions of small stars on a cliché with relation to a certain number—say a dozen—of reference stars; but the positions of these last-mentioned ought to be measured by meridian instruments.

The movement relative to the lengthening of the railroad has been making great headway, and already the means of protection suggested by the Council have been commenced, notably that of the *mur d'isolement* constructed near the tunnel.

Let us take a rapid survey of the work done with each of the separate instruments as reported by the head of each department.

Large Meridian Circle.—Besides general transits observed, it was attempted to correct the catalogue of polar distances of fundamental stars, in continuing zenith distance measures of stars with the adopted latitude. A series of sixty stars, six times observed, showed that the corrections agreed very satisfactorily among themselves, and harmonised well with those furnished by the normal catalogue of M. Auwers.

Simultaneous observations have also been made to correct the ephemerides of the *Connaissance des Temps* and the latitude, while active researches have been started for finding out the causes of the inequalities. With reference to the "flexion horizontale," the instrument has remained firm, the mean value given by the collimators being $-0''.68$, those for the three preceding years being $-0''.54$, $-0''.73$, and $-0''.66$.

Meridian Instrument, Gambey.—The work started in May 1890, of correcting catalogue R.A.'s of fundamental stars, has been continued, and the corrections found are "faibles et bien concordantes," as shown from the following few values:—

Stars.	1890. s.	1891. s.	1892. s.
θ Virginis	+0·03	+0·03	+0·02
25 Canes Venatici ...	−0·03	−0·12	−0·14
m Virginis	+0·07	+0·06	+0·03
T Virginis	+0·09	+0·06	+0·04
Arcturus	+0·07	+0·05	+0·04

Circle of Gambey.—Employed exclusively for researches on the variation of latitude; 127 nadir distances of polaris were measured, of which 101 were direct, and 26 by reflection.

Cercle Méridien du Jardin.—During the earlier months this instrument was used for the determination of polar distances of fundamental stars and for latitude, by methods of M. Lœwy. A minute determination of the inclination of the horizontal thread of the instrument was also made, and also the influence of personal equations in the cases of stars near the pole, M.

Kenan having installed in front of the eyepiece a prism which reversed the direction of apparent movement of the stars, either in right ascension or declination.

The "Supplément à l'Histoire Céleste de Lalande" is undergoing revision, and the positions of 2250 stars are required to be re-observed, each three times by meridian observations. Since April 1893, sixty series, comprising about 1000 stars of the catalogue, have been obtained.

The [illegible] of the meridian observations made during the year shows that the instruments were by no means idle, no less than 17,248 observations having been made. The *résumé* of the planets observed during the same period gives the total number as 556.

Équatoriaux Coudés.—The large equatorial has been receiving several alterations and additions, and it is hoped to maintain the position of a fixed or movable star on the same part of a photographic plate with an approximation of 0"·2 nearly. The small coudé has been the means of effecting the complete measurements of 186 double stars, besides some observations of minor planets, comets, occultations, &c.

The Equatorial in the West Tower.—This instrument is under the direction of M. Bigourdan, who, with M. Faye, were away observing the total eclipse of the sun at Sénégal. During their stay there, fifteen lunar culminations for longitude and four series of observations for latitude were made, besides meteorological observations and four independent determinations of the relative intensity of gravity. The solar observations, among other things, consisted in observing the four contacts, and searching round the limb of the sun for any small bodies that might be visible.

The observations made with the equatorial above referred to consisted of measurements of 280 double stars, besides those of comets, occultations, &c.

The equatorial in the east tower, under M. Callandreau's direction, has been devoted chiefly to observations of minor planets.

In the departments where photography is employed, MM. Henry have obtained, among other results, 169 clichés for the catalogue of the *Carte du Ciel*, twenty-nine large clichés of the moon, enlarged directly eighteen times, these latter marking "un progrès très sensible sur les résultats obtenus antérieurement."

The "Bureau des Mesures des Clichés du Catalogue," under Mdlle. Klumpke's supervision, is now supplied with two machines. The total number of stars measured in the twelve months amount to 27,750; of these 26,831 were measures of stars, 343 measures of double stars, and 32 planetary measures.

The meteorological observations and the hour service have been regularly continued, the latter without any failure during the entire year.

In the spectroscopic department, M. Deslandres has been continuing the researches on the sun and stars; but much time was devoted to the preparations for the observations of the total eclipse of the sun last year. The results obtained during the eclipse consisted of twenty-two photographs of the corona. Some of the negatives show luminous jets from the corona extending to a distance of two diameters. The ultra-violet spectrum of the corona has been traced up to the limit of the ordinary solar spectrum, and in addition fifteen lines have been observed in the new region. In the researches concerning the rotation of the corona, it has been found that one of the negatives shows the spectra of two points of the corona, situated at the extremity of an equatorial diameter and 10' from the solar limb, placed side by side. The bright H and K lines of calcium present a slight displacement corresponding to a difference of velocity of 5 to 7·5 kilometres. M. Deslandres admits that the solar corona is animated with a motion of rotation, the angular velocity of which corresponds with that of the sun.

Other spectroscopic work being continued is that of the study of the radial velocities of prominences and stars.

THE CHEMISTRY OF CLEANING.[1]

As a great city grows, and the agglomeration of struggling humanity increases, such questions as the disposal of sewage and other waste matter rise from comparative insignificance into problems of almost insurmountable difficulty; and whilst we are able to put the burden of cleansing our towns upon the urban authorities, the responsibility of keeping our homes and bodies in a condition of at least sanitary cleanliness devolves upon the individual, and a knowledge of the causes of dirt and the methods by which it can be removed, cannot be regarded as devoid of interest, or at any rate utility.

Before we can cleanse, we must have dirt to remove, and this prime factor of our subject naturally must claim our first attention.

Dirt has been variously defined: a great statesman has spoken of it as "matter out of place," poets have christened it the "bloom of ages," whilst more matter-of-fact individuals have been content to look upon it as something which causes an infinite amount of trouble in the household, and leads to the consumption of much soap and water. If, however, we divest our mind of prejudice, and approach the subject of dirt from a scientific point of view, we shall find a silver lining to the grimy cloud, and shall have to admit that a wondrous store of interest is to be found in the dust with which the housemaid wages perpetual war, and which when glued by nature to our skins, requires special methods for its removal.

Observation shows that in our town houses, only a very short interval of time is needed to cause a considerable deposit of dust upon any horizontal surface, whilst vertical surfaces and draperies, especially if their surface be rough, also accumulate a considerable quantity, although of a lighter and more finely divided kind. We also find that this dust is borne to its resting place by the air which penetrates from the outer atmosphere, and that its deposition is caused by the comparative condition of rest insured to it by the absence of wind or violent currents.

The presence of these air-borne particles of solid matter can be made visible in any town by allowing a beam of sunlight or a ray from an electric lantern to pass through the air of a darkened room. If the room be filled with air previously filtered by passing it through cotton wool, the beam of light is invisible until it strikes the opposite wall; but if the air be unfiltered, the path of the beam is mapped out by the suspended matter reflecting and dispersing portions of it, and so becoming visible to the eye as "the motes in the sunbeam."

The heavier the nature of the particles, the more quickly will they settle, with the result that the dust on horizontal surfaces, such as the tops of sideboard, piano, and mantel-board, may be expected to differ somewhat from the lighter form, which has continued to float until contact with vertical surfaces has brought it to rest.

These particles of dust are composed of matters of the most varied nature, and will be found, when collected, to consist partly of mineral and partly of organic substances, namely, siliceous and carbonaceous matters, hair, epidermis from the skin, pieces of vegetable fibre, pollen from various plants and grasses, the sporidiæ of fungi and bacteria.

The heavier portions of the dust are found to contain ground-up siliceous matter, pulverised by traffic in the road; small particles of salt carried inland by winds from the sea, together with sulphate of soda, with other impurities of a local character. If a sample of dust be collected and carefully ignited, the organic matter will be burnt away, and any ammonium salts volatilised, whilst the mineral portion will be unacted upon; and in this way it has been shown that more than one half of the suspended matters in the air are of organic origin, a large portion of this organic matter consisting of germs which are capable of setting up fermentation, disease, and decay.

It is only within the last few years that the importance of the work done by the solid particles of dust floating in the air has been recognised, and it is to Pasteur that we owe the knowledge that these germs set up the various processes of organic decay.

Pasteur collected the lightest portions of dust, which are left floating in the air after the heavier portions have settled down, by gently drawing air through a plug of soluble collodion cotton; and after he had collected sufficient dust in this way, he dissolved the cotton in a mixture of alcohol and ether, and examining the residual particles under the microscope, was able to show the presence of a large and variable number of organisms obtained from the atmosphere.

He also found that solutions of sugar mixed with beer yeast, and left exposed to the air, rapidly decomposed. If, however, the solution was kept in contact with air, that had been previously heated, it would remain unchanged for months, but de-

[1] A lecture delivered at the London Institution, by Prof. Vivian Lewes.

composition was started in a few hours if some of the germs collected from the air were added to it.

If a pot of ordinary paste, after being used, is placed on a shelf for a few days, the surface will be found coated with a fine crop of mould or mildew. On examining this mould under the microscope, it will be seen to somewhat resemble a bed of rushes; after a few more days, some of these rush-like filaments will have developed little pods, not unlike poppy-heads, and after the lapse of another week the pods will have split open, and myriads of seeds or germs will have poured forth into the air to carry on nature's cleansing work, for these germs possess the power of setting up the process of decay, by which the waste matter derived from vegetable sources is once again resolved into the water vapour and carbon dioxide used by nature as the foundation of all organic creations.

Decay and putrefaction are the great factors of change which nature utilises for removing the waste products of animal and vegetable life, and for once more bringing them into a condition in which living things can again assimilate, and use them for building up their tissues and carrying on their functions. Without decay, the dead animal and vegetable matter would remain choking the face of nature, and life would be impossible, because the food of life would be cut off; and it is the almost imperceptible germs floating in the air which start this marvellous natural action, germs so minute that it requires the strongest microscope to detect them, yet so potent that the whole balance of life hangs on their existence.

These facts show us that not only has dust a most marvellous history, but that in it nature has disguised her most important factor for cleaning the face of the earth from waste matter of both mineral and vegetable origin.

The surface soil when mixed with water gives the mud which dirties our boots, and forms clots on the train of our skirts; but this, as well as the dust which has settled in our living rooms, and merely clings mechanically to the surfaces upon which it has deposited, may be removed by such simple physical means as the duster and brush. When dust has found its way into a fabric such as a carpet, it requires considerable force to again dislodge it, and this is applied by means of the broom, but in vigorous sweeping we find that the largest proportion of the dust is driven up into the air, only to resettle once again on other surfaces, so that although we can make the nuisance "move on," we do not in this way remove it, and experience has taught our servants that wet tea-leaves scattered on the carpet before sweeping lessen this evil In some cases, instead of using this method, it has been argued that it must be the moisture which acts in preventing the raising of the dust, and the carpet has been sprinkled with water. This converts the dust into mud, which remains fixed in the fabric whilst the sweeping is going on, but as soon as the water has evaporated from it, again reasserts its right of rising as dust.

When, however, wet tea-leaves, damp sawdust, or even moistened sand is scattered over the surface to be swept, the dust when dislodged adheres to the moistened substance and is removed. In choosing moist bodies for this purpose, the only points to consider are that they must have no staining action on the carpet, must not be too wet, and must not be so finely grained as to sink into the fabric, nor so clinging as to resist easy removal by the broom.

It is manifest, however, that the mechanically held dirt which we have been considering, differs very considerably from the dirt on our skins, and on linen in contact with our bodies, which although derived from the same sources as the dust on the furniture, resists any ordinary mechanical process for its removal, and rinsing dirty hands or linen in cold water has but little cleaning effect, whilst if the hands are afterwards dried in the usual way, a transfer of a portion of dirt to the towel takes place.

If we carefully notice the portions of our skin and shirt which become most soiled, we at once observe that it is where the skin is exposed to air, whilst the linen, which is in contact with both air and skin, becomes dirty more quickly than when exposed to either alone.

The part played by the atmosphere is made clear by the facts which we have already been considering, but the action of the skin introduces a new and most important factor. For the healthy carrying on of the functions of life, nothing exceeds in importance the skin with which our body is covered. We may live for days without giving our stomach any work to do, the liver may cease action for several days before death ensues, but it is impossible to survive for the same length of time if the functions of the skin are entirely stopped.

The skin not only plays an important part in throwing off and getting rid of waste matter from the system, but it is also credited with being an important auxiliary to our lungs, and experiments have clearly shown that if the skin of animals be coated in such a way as to completely stop its action, a very few hours will bring about death. Indeed the experiment has been once accidentally tried on a human being, a child gilded all over to represent a statue having died in a few hours; all the symptoms pointing to suffocation as being the cause of death.

If we examine the structure of the skin, we find that it is built up of two distinct layers, an outer skin called the cuticle or epidermis, and an inner termed the cutis or dermis. A third layer intermediate between these two, used to be looked upon as a third skin, but more recently has been recognised as being only a transition form of the outer skin.

The cuticle or outer skin consists of several fine layers of scales which gradually assume a more rounded and granular form the deeper one gets into the cuticle. These rounded granules form the middle skin of the old observers, and as the outer portion of the cuticle roughens and scales off as scurf, these granules gradually flatten and form the new surface to the outer skin, and we differ therefore from other scaly reptiles by being continually in a condition of renewing our skin, whilst most reptiles and fish cast their scaly covering in on operation.

No nerves or blood-vessels find their way into this outer skin, as may be seen when it becomes detached from the inner skin in the formation of a blister, the outer portion of which is devoid of sensation.

The lower or true skin varies in thickness, being thicker in the palm of the hand and sole of the foot, where most resistance is needed.

When we look at the skin of the hand, we notice delicate grooves in it, which examined through a magnifying glass are seen to be pierced with small orifices, and if the hand be warm, minute shining drops of perspiration will be seen issuing from them.

The glands for the secretion of the perspiration are set in the lower side of the inner skin, and are in connection with the capillary network of blood-vessels, which cover the surface of the body. The gland or duct which conducts the perspiration to the surface of the skin is about a quarter of an inch in length, and is straight in the true skin, but becomes spiral whilst traversing the outer skin. Over 3500 of these small ducts have been found to exist in a single square inch of the skin, and it has been computed that the aggregate length of the sudoriferous ducts in the body of an ordinary-sized man is about twenty-eight miles.

These little glands and ducts perform the important function of throwing off the moisture produced during the combustion of waste tissue, by the blood-borne oxygen of the body, and secrete about 23 ounces of perspiration in the twenty-four hours, which under ordinary conditions evaporates, without our noticing it, into the air, but under conditions of considerable exertion or unusual heat, accumulates as beads of perspiration.

The throwing off of the perspiration and its evaporation on the skin, is a beautiful natural contrivance for regulating the temperature of the body, as the conversion of the perspiration into vapour renders latent an enormous amount of heat, which being principally derived from the body keeps it in a comparative state of coolness, even when subjected to high temperatures.

That this is so, is proved by the fact that a bath heated to 120° F. (=49° C.) is almost unbearable, because the evaporation from the surface of the skin is checked, whilst it is perfectly possible for a person with the skin fully exposed to go into an oven and remain there for some time at a temperature of 325° F. or 162°·8 C., at which temperature a beef-steak can be cooked, and it can be clearly noticed in a Turkish bath, that although there is a feeling of oppression at first, the temperature of the hot room can readily be borne as soon as perspiration begins to flow.

In the 23 ounces of liquid so secreted in the course of the twenty-four hours, there will be found rather more than an ounce of solid matter, which is left when the liquid portion of the perspiration evaporates, and tends to clog the pores of the skin, and it is the removal of this by the morning tub and rough towel, which is responsible for a considerable portion of the refreshing influence of the British bath.

Besides these sudoriferous glands, however, there is a second set, called the sebaceous glands, the ducts of which are spiral, and open generally into little pits, out of which the fine hairs which stud the skin grow, and these glands secrete an oily or waxy substance, which nourishes the hair, and also keeps the outer skin smooth and pliant. This waxy substance is developed in largest quantity inside the ear, where it serves to protect the more delicate portions of that organ, and next to the ear, these glands are found most abundantly on the face and other portions of the body which are exposed to external influences and friction.

It is the presence of this oily secretion which holds the dirt glued to the skin, and being also rubbed off on the inside of the wristbands and collars of our shirts, causes these portions of our linen to become the most soiled. We may look upon this form of dirt, therefore, as being glued on to the surface by oleaginous materials, which being insoluble in water resist any mere rinsing, and the most important function of our cleansing materials is to provide a solvent which shall be able to loosen the oil, and so allow of the removal of dirt from the skin.

The skin, however, is not the only source of oily matter, and in all fibres of animal origin more or less fat is to be found, which although not in sufficient quantity to play any very important part in the fixation of dirt, still adds its iota to the general result.

We notice, moreover, that the air of a big town has a far greater dirtying effect than country air, this being partly due to the fact that the number of solid particles per cubic foot of atmosphere are greatly reduced, but chiefly because country air does not contain certain products of incomplete combustion, which are to be found in all large towns.

In London we annually consume some six million tons of bituminous coals, and if we examine the smoke which escapes up our chimney during the imperfect combustion which the coals undergo in our fire-grates, we find that not only will that smoke contain small particles of unconsumed carbon in the form of blacks or soot, but also a considerable quantity of the vapour of condensible hydrocarbon oils, which depositing on the surface of the solid particles of floating dirt, gives them an enhanced power of clinging to any surface with which they come in contact.

If we have a heavy fall of snow in London, as the snow melts it leaves a black deposit, which is formed of the solid particles with which the snow has come in contact in its passage through the air, and a recent analysis of a deposit of this character, collected on the glass roof of an orchid house at Chelsea, gives a very good idea of the constituents of these solid impurities.

Carbon	39·00	per cent.
Hydrocarbons	12·30	,,
Organic bases	1·20	,,
Sulphuric acid	4·33	,,
Hydrochloric acid	1·33	,,
Ammonia	1·37	,,
Metallic iron and magnetic oxide .	2·63	,,
Other mineral matter, chiefly silica and ferric oxide	31·24	,,
Water	not determined.	

Hydrocarbon oils of this character are not as a rule affected by the solvents which we utilise for loosening the dirt which is held to our skin by animal grease; but there is no doubt that the dirtying influence of town air is greatly increased by their presence.

If we take any grease of vegetable or animal origin, we find that it can be dissolved in liquids containing free alkalies, this term being applied to the compounds formed by water with the soluble metallic oxides, which, when dissolved in water, give solutions having a soap-like taste, affecting the colour of vegetable extracts, such as that obtained by the red cabbage, and possessing the power of neutralising the acidulous properties of the compounds we call acids.

If we take two metals discovered by Sir Humphrey Davy in 1807, potassium and sodium, and expose them to dry pure air, they rapidly become converted into a white powder by absorbing oxygen from the atmosphere, and form compounds which we term respectively oxide of sodium and oxide of potassium. These oxides, when dissolved in water, enter into combination with a portion of it, producing sodic hydrate and potassic hydrate, two substances which have pre-eminently the properties which we term alkaline, and which exert a strong solvent action upon all forms of animal and vegetable grease.

These solutions exercise a wonderful power of cleansing upon the grease-bound particles of dirt which veil our skin, but so strong is their solvent power upon animal membrane, that not only do they dissolve fatty matter, but also the cuticle itself, so that they are manifestly unfitted for removing dirt from a tender skin, and we are forced to look further afield for a grease solvent.

If instead of dissolving our sodic and potassic oxide in water, we had left them exposed to ordinary air, we should have found that they gradually attracted from the atmosphere a gas called carbon dioxide, which exists in all air to the extent of 4 parts in 10,000, and that by combining with this gas they became converted into sodic and potassic carbonates, bodies which we call salts, and which, although not so violent in their action upon the skin, will retain to a certain extent their solvent action on fatty matters.

The carbonates of sodium and potassium are found in the ashes of many vegetable and animal substances, and in the earliest records which have been discovered, we find mention of the cleansing power of wood ashes, the ashes of certain marine plants, sea-weed, and "natron," which is an alkaline efflorescence from some kinds of soil; nor has the use of ashes for this purpose entirely died out at the present time.

It was only in 1884, that during some structural alterations in Rome, an old tomb was broken into, and the ashes which it contained removed by one of the workmen, who conveyed them home to his wife, as an offering towards the next washing-day, whilst a few days later the antiquarians were horrified to discover that they were the remains of the Emperor Galba, cremated some eighteen centuries before, which had been put to such practical use.

As early as A.D. 69, however, we find that the elder Pliny mentions another form of cleansing material made from tallow and ashes, the components most recommended being goat's suet and the ash of beechwood; whilst the ruins of Pompeii were found to contain a fairly perfect soap factory.

Although soap and Christianity date from the same period, it was only at the commencement of this century that the classical researches of Chevreul on the constitution of fats, gave the key to the reactions taking place during its formation, whilst even at the present time we probably only know a true explanation of part of the actions which lead to its cleansing effect upon the skin.

If we take sulphuric acid diluted with water, we find that it has certain well-marked characteristics, which leave no room for doubting its acidulous nature, and if we pour a few drops of it into the violet-coloured solution obtained by boiling sliced red cabbage in water, the violet solution at once becomes bright red. On repeating this experiment with the violet cabbage solution, and a few drops of sodic hydrate solution, we obtain a vivid green colour, and now on mixing the solution rendered red by the acid, and the second one turned green by the alkaline base, we once more obtain the original violet colour, and on examining the solution can find no trace of either acid or alkali, but can distinguish the presence of a compound called sodic sulphate, which can be obtained in the crystalline form by concentrating the solution, and such a compound formed by the union of an acid and a base, we are in the habit of calling a salt. During the combination of the sulphuric acid and sodic hydrate to form sodic sulphate, we also had water being formed, which, like the neutral salt, had no action upon our coloured solution. If we had carefully weighed our sulphuric acid and the sodic hydrate, we should have found that it is only in certain definite proportions that they unite to give a solution without effect on the vegetable colouring matter, and we might sum up our experiments on the combination of these two substances as follows:—

Acid.		Base.		A salt.		Water.
Sulphuric acid, 98 parts by weight.	+	Sodic hydrate, 80 parts by weight.	=	Sodic sulphate, 142 parts by weight.	+	36 parts by weight.

And if we take crystals of sodic sulphate, and dissolve them in water, we can decompose them once more into sulphuric acid and sodic hydrate by the aid of galvanic electricity.

My aim in this experiment has been to impress upon you that a salt is a compound formed by the union of an acid and a base, and one of Chevreul's greatest discoveries was that in tallow—the fat of oxen or sheep—you had a salt of organic origin, from which by decomposing the tallow with heated steam, you could obtain the sweet viscous liquid "glycerine," which played the part of base in the compound, and two acidulous compounds—one a lustrous white wax, called stearic acid, and the other an oil called oleic acid.

Now a salt can have its base replaced by another base. If I take two solutions, the one containing sulphate of copper, and the other chloride of iron, and add to each sodic hydrate, decomposition takes place in each case, sodic sulphate is left in solution, and the hydrates of copper and iron being insoluble in water, separate out as precipitates.

In the same way, if we add sodic hydrate to tallow, glycerine separates out, and two salts—sodic oleate and sodic stearate—are formed, a process which we call saponification, as the two sodium salts are "soaps."

It is not necessary to use tallow; any vegetable or animal fat or oil will give reactions of a similar character, and it may be broadly stated that soap is formed by the action of sodic or potassic hydrate upon fats or oils which contain fatty acids.

Organic salt.		Base.		Salt.		
Tallow	+	Sodic hydrate	=	Soap	+	Glycerine.

It is only potassic and sodic hydrates which can be used for ordinary soap-making, as the soaps formed by the combination of other metallic hydrates with the fatty acids are insoluble in water, and therefore useless for detergent purposes.

The soap formed by using sodic hydrate has the property of setting hard, and all the ordinary forms of washing-soap contain sodium as the base; the potash soaps are far softer, and do not set, the soft soap used for scrubbing and cleansing in many manufacturing processes, and also a few toilet creams and shaving pastes, being of this character.

It would occupy far too much time, and would, moreover, be outside the scope of this lecture, to go into the details of the manufacturing methods by which soap is made on the large scale, and if I give a rough idea of the general processes employed, it will be sufficient for the purpose.

Carbonate of soda is first converted into hydrate by dissolving it in water, and then boiling with quicklime. Quicklime consists of calcic oxide, and this, when put into the vat containing the sodic carbonate in solution, combines with water, forming calcic hydrate, which then reacts with the sodic carbonate, forming calcic carbonate or chalk, which being insoluble sinks as a mud to the bottom of the vessel, whilst sodic hydrate remains in solution.

$$\left.\begin{array}{l}\text{Calcic hydrate}\\ \text{Sodic carbonate}\end{array}\right\} = \left\{\begin{array}{l}\text{Sodic hydrate}\\ \text{Calcic carbonate.}\end{array}\right.$$

Of late years the soap-boilers have to a great extent bought the sodic hydrate direct from the manufacturer, and so have avoided this operation.

The solution of sodic hydrate, called caustic ley, is made in different strengths, and tallow is first boiled with a weak ley, and as the conversion into soap proceeds, so stronger leys are used until the whole of the fatty matter has been saponified.

If a strong ley had been used at first, the soap as it formed being insoluble in strong alkalies would have coated the surface of the fat and prevented its complete conversion.

If at the end of the saponification process, the alkaline solution is sufficiently strong, the soap will on standing separate as a fluid layer on the surface of the spent ley, which contains the glycerine set free during the saponification, but in any case separation can be rapidly brought about by adding salt to the liquid, when the soap being insoluble in salt water or brine, separates out and is removed and placed in moulds to harden.

The block of soap so cast is then cut first into slabs, and then again into bars.

A soap made in this way with tallow or lard as the fatty matter, would be "white curd," whilst if yellow bar is required, rosin is added to the mixture of ley and soap after most of the fat has saponified.

When rosin is boiled with alkaline solutions, a compound is formed by the direct union of the resinous acids with the alkali, which strongly resembles ordinary soap, so that the yellow soap is really a mixture of fatty and rosin soap, and when the ingredients are of great purity, the product goes by the name of "Primrose" soap. Bar soaps so made on a large scale are, as a rule, the stock from which the various forms of toilet soap are made by processes intended to render them more attractive for personal use, but generally the consumer gets far better value for his money, and far less injury to his skin, by using a good "white curd" or "Primrose" soap than by employing a high-priced toilet soap, whilst cheap toilet soaps, especially cheap transparent soaps, should be studiously avoided.

The demand made by consumers for cheap soaps, which in many cases are sold retail at prices considerably below the wholesale market price for a true soap, has given rise to the introduction of highly watered soaps, caused to set hard by the addition during manufacture of sodic sulphate, which enables the manufacturer to make a so-called soap often containing less than 20 per cent. of true soap.

Any person desiring to obtain the fullest particulars as to the manufacturing details of the soap trade, cannot do better than consult Dr. C. R. Alder Wright's admirable treatise upon the subject.

Having got our soap, the next point is to try and gain an idea of the way in which it acts as a detergent.

Supposing we are fortunate enough to have a sample of pure neutral soap, we find that on dissolving some of it in water, it undergoes a partial decomposition into alkali, and fatty acid, this action being called the hydrolysis of soap.

The small quantity of alkali so set free, attacks the fatty matter which glues the dirt to the skin, and by dissolving it loosens and enables the water to wash off the particles of dirt.

If this were the only action, however, soap would have no advantage over soda, a solution of which would equally well perform this part of the operation. As the soap decomposes and the alkali removes the grease and dirt, the fatty acid liberated simultaneously from the soap comes in contact with the newly-cleansed skin, and not only softens and smooths it, but also neutralises any trace of free alkali, and so prevents irritation and reddening of the cuticle.

These are probably the main actions by which soap cleanses, but other causes also play a subsidiary part. We know that a solution of soap causes a lather when agitated, this being due to the cohesive power given to the particles of which the liquid is built up by the presence of the soap, a phenomenon which also enables us to blow bubbles with the soap solution on account of the strength of the fine film of liquid, a property which is not found in water alone.

The power of cohesion which the soap solution possesses is in all probability an important factor in removing the particles of dirt from the skin at the moment that they are loosened by the action of the alkali. Prof. W. Stanley Jevons suggested yet a fourth way in which the soap solution might act; when finely divided clay is suspended in water, the microscope reveals the fact that the minute particles are in rapid movement, and hence settle but slowly in the liquid. This movement he christened pedetic action, and he observed that the addition of soap or silicate of soda—often used in soap—to the liquid, enormously increased this agitation of the particles, which would tend to aid the breaking away of the dirt particles the moment they were set free.

Many soaps, even among the varieties intended for the toilet, contain a considerable excess of free alkali, which being greater than the liberated fatty acids can neutralise, cause most painful irritation of the skin, as is testified to by the smarting which annoys the chin after the use of certain shaving soaps; and every lady knows that an alkaline soap, when used for washing the hair, renders it harsh and brittle, and destroys the gloss, but in both cases a rapid rinse with water, containing a few drops of vinegar, will neutralise the free alkali and prevent much of the mischief.

We have now dealt with our grease solvents and dirt looseners, but without the aid of water they would be useless; and experience teaches us that the source of the water used for cleansing, has a great deal to do with its efficiency whether used with or without soap.

As the new-born rain-drops fall from the breaking clouds, they are practically pure water, containing at most traces of gaseous impurities which the mist has dissolved from the upper strata of air whilst journeying in the form of cloud, and where the rain is collected in the open country, it gives us the purest form of natural water, healthful to drink, because it is highly aerated, and free from all impurity, organic and inorganic, and delightful to wash in because of its softness and the ease with which the soap gives a lather.

In towns, however, a very different state of things exists, as the rain in falling washes the air from a large proportion of the suspended organic matters inseparable from a crowded city, and also from the unburnt particles of carbon, which incomplete combustion allows to escape from our chimneys; and charged with these, it still collects more dirt of various kinds from the roofs of our houses, and finally finds its way into our water-butts as the semi-putrid sludge which often causes the true-bred cockney to wonder "if this so-called purest form of natural water is so foul, what on earth must the other forms of water be like?" If in the country the rain water is collected and stored in suitable reservoirs, then we have the most perfect water that can be obtained for washing and cleansing purposes.

In some kinds of water collected under what we might consider ideal circumstances, we find "a something" which acts as a check upon the cleansing action of the soap.

In Attica, close to Atheus, on the slopes of Mount Pentilicus, the Emperor Hadrian built some huge marble underground aqueducts to collect and lead the rain water down as a supply for Athens, the whole water-shed consisting of marble; this mountain being justly celebrated as the source from which the finest statuary marble is obtained. Here, falling through the clear southern air on to a collecting ground formed of the material which all ages have considered the most suitable for baths and reservoirs, one would expect the water to be like the pure rain water, absolutely free from dissolved solid impurities, and one of the best waters of its kind for washing purposes; yet not only does it waste a large amount of soap before a lather is obtained, but if we examine the channels through which it has for centuries flowed down to the valley, we find that it has formed a heavy deposit, which collecting unchecked through long ages, has all but choked up the once spacious passages. A piece of this deposit I have obtained through the kindness of a friend, and on analysis it proves to be:—

Calcic carbonate	96·81
Silica	0·49
Organic matter	1·40
Moisture	1·30
	100·00

It is, in fact, a natural incrustation deposited by the water, and a similar action is seen in the formation of stalactites in many caverns, through the roof of which water charged with certain calcareous compounds has slowly found its way.

In the passage of the rain through the air small quantities of carbon dioxide or carbonic acid gas are dissolved from the atmosphere, whilst in slowly percolating through the surface soil on which it has fallen the water is brought in contact in the pores of the soil with far larger volumes of this gas, which is being continually generated there by the decomposing vegetation and other organic matter in a state of decay. Under these circumstances the water becomes highly charged with the gas, and sinks on through the ground until it comes in contact with some impermeable strata through which it cannot penetrate, and here it collects until a sufficient head of water has been formed for it to force its way along the strata to the surface of the earth, where it now appears as a spring, and during this passage through the earth it has dissolved everything that will yield to its own solvent action or to the activity of the carbon dioxide, which dissolved in water forms the weak carbonic acid, a compound which will dissolve many substances insoluble in the water itself, such as calcic carbonate, occurring in the soil as marble, limestone, or chalk, and also the carbonates of iron and magnesium. If we examine a spring water, we shall find that its dissolved impurities can be divided into two classes: for instance, taking the Kent water supplied at Greenwich, and obtained from deep wells in the chalk, we find its saline constituents in grains per gallon are:—

Calcic carbonate	16·30
Calcic sulphate	5·37
Magnesic sulphate	0·93
Magnesic nitrate	1·20
Sodic chloride	2·64
Sodic nitrate	1·21
Silica, alumina, &c.	0·97

And of these the calcic sulphate, magnesium, and sodium salts are dissolved by the solvent action of the water in the same way that sugar would be, whilst the chief impurity, calcic carbonate, is scarcely at all soluble in the water itself, 16,000 parts of pure water only dissolving one part of the carbonate, but is readily soluble in the carbonic acid, in the water which converts it into soluble calcic bicarbonate.

In the household, waters are roughly classified as hard or soft waters, and the property of hardness manifests itself, as a rule, to the householder by its action upon soap, and also by the amount of "fur" which it causes in the kettle, these actions being due to calcic bicarbonate, calcic sulphate, and the magnesium salts present in it, all of which act upon soap and cause it to curd instead of forming a lather by converting the soluble sodic oleate and stearate into insoluble lime salts, whilst the bicarbonate by decomposing and depositing "chalk" causes the fur.

A more careful examination, however, reveals the fact that this property of hardness owes its origin to two different causes, for if we boil water until all the bicarbonate is broken up and the calcic carbonate deposited, the clear water left behind it is still hard, though to a far less extent, and will still decompose a certain proportion of soap. The hardness which can be got rid of by boiling is due to bicarbonate of lime, and sometimes also bicarbonate of magnesia, and is called "temporary hardness," whilst the hardness left after boiling the water is due to calcic sulphate and the soluble magnesium sulphate, chloride and nitrate, and is called "permanent hardness."

The relative hardness of waters is estimated by the amount of soap they will destroy, *i.e.* convert from the form of soluble sodic oleate and stearate into the condition of insoluble oleates and stearates of lime, and one grain of calcic carbonate or its equivalent in sulphate or salts of magnesia dissolved in a gallon of water, is said to equal 1° of hardness.

The sample of Kent water of which an analysis has been given, contains 23·6 grains of these salts, and would be said to have nearly 24 hardness, 7·5 of which would be permanent and 16·3 temporary.

When it is considered that 1° of hardness in water will waste 10 grains of soap per gallon of water used, we become aware of the economic importance of the kind of water employed in the household, a gallon of the Kent water, for instance, using up 236 grains or nearly half an ounce of soap before any becomes available to form a lather and exert a cleansing action upon the skin.

Glasgow used to have a hard water service, and when this was discontinued and the soft Loch Katrine water was supplied in its place, it made a difference of several thousands a year in the money expended in soap.

From these facts it is manifest that a soft water supply is an important factor in cheapening our cleansing processes, a pure rain water being the best attainable, whilst surface and river water are as a rule softer than spring water.

I have now discussed the chemistry of cleaning as fully as the time at my disposal will permit, and I hope the facts I have brought before you will have quickened your interest in soap, soda, and water, and will have helped to impress upon you that without proper processes of cleansing, the health of each unit, and therefore the prosperity of the masses, must suffer deterioration.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The following pass list for the degree of Doctor of Science of London University has been issued:—Experimental Physics: Mr. Edwin Henry Barton. Chemistry: Mr. Bevan Lean, Mr. Thomas Kirke Rose, Mr. Arthur Landauer Stern. Botany: Miss Margaret Jane Benson. Zoology: Mr. Arthur Willey.

Her Majesty's Commissioners for the Exhibition of 1851 have made the following appointments to science research scholarships for the year 1894, on the recommendation of the authorities of the respective Universities and Colleges. The scholarships are of the value of £150 a year, and are tenable for two years (subject to a satisfactory report at the end of the first year) in any University at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country:—Scholar nominated by the University of Edinburgh, John Carruthers Beattie; by the University of Glasgow, James Robert Erskine-Murray; by the University of Aberdeen, William Brown Davidson; by University College, Bristol, Reginald Charles Clinker; by Yorkshire College, Leeds, Frankland Dent; by University College, Liverpool, Alfred James Ewart; by University College, London, David King Morris; by Owens College, Manchester, Julius Frith; by Durham College of Science, Newcastle-on-Tyne, Robert Beattie; by University College, Nottingham, William Beckit Burnie; by Queen's College, Galway, John Alexander M'Clelland; by the University of Toronto, Frank Boteler Kenrick; by Dalhousie University, Halifax, Nova Scotia, Frederick James Alexander M'Kittrick.

THE President and Council of the Royal Society have, upon the recommendation of the Joule Studentship Committee, elected Mr. J. D. Chorlton, of the Owens College, to the first Joule Studentship. This studentship was founded for the purpose of enabling students to carry on certain researches on lines laid down by Dr. Joule, more especially with the view of determining the constants of some of the instruments employed by him, which his representatives can place at the student's disposal.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 31.—"The Root of *Lyginodendron Oldhamium*, Will." By Dr. W. C. Williamson, F.R.S., and Dr. D. H. Scott.

During a re-investigation of the structure of *Lyginodendron*,[1] the results of which the authors hope to lay before the Royal Society on a future occasion, an important fact has come to light, which they place on record without delay.

A carboniferous fossil, with the structure perfectly preserved, has been described in previous memoirs, under the name of *Kaloxylon Hookeri*, Will.[2] The authors have now established the fact that *Kaloxylon* was not an independent plant, but was the root of *Lyginodendron Oldhamium*.

Specimens, presenting in every respect the typical *Kaloxylon* structure, have been found in actual continuity with the stem of *Lyginodendron*, arising from it as lateral appendages. Their structure and mode of origin prove that they were adventitious roots. These organs branched freely, and the authors have found roots and rootlets of all sizes, and at all stages of development.

This discovery enables a complete account to be given of the vegetative organs of *Lyginodendron*, as they are now fully acquainted with the structure, not only of the stem and foliage, but also of the adventitious roots.

June 14.—"On a Method for determining the Thermal Conductivity of Metals, with Applications to Copper, Silver, Gold, and Platinum." By James H. Gray.

The object of this investigation was to obtain a method for determining thermal conductivities of metals, which would not require either elaborate preparations or large quantities of the substances to be tested, and by means of which a test could be made in a few hours.

The essence of the method is to keep one end of a given length of the wire at a constant known temperature, and to measure the rise of temperature of the other end of the wire every minute. If proper precautions be taken to prevent loss by radiation from the sides, the data are obtained for calculating the thermal conductivity.

The wire to be tested is soldered at one end into the bottom of a copper box. The diameters found most convenient were from 2 to 4 mm., the lengths from 4 to 8 cm.

The box is filled with water and supported at its middle by being fitted into an asbestos-lined wooden screen, 24 × 24 cm. 3 mm. length of the other end of the wire is soldered into a solid copper ball, diameter 5·5 cm. In the ball a hole 3 cm. deep is made, so as to admit the bulb and part of the stem of a small and very sensitive thermometer. This thermometer is graduated from 5° C. to 20° C., and can easily be read to within one-fortieth of one degree. The bulb is surrounded by water.

[1] *Cf.* Williamson, "On the Organisation of the Fossil Plants of the Coal Measures," Part IV. *Phil. Trans.* 1873, p. 377; Part XVII. *Phil. Trans* 1890, B. p. 89.

[2] *Cf.* "On the Organisation of the Fossil Plants of the Coal Measures," Part VII *Phil. Trans.* 1876, Part 1, p. 1; Part XIII. *Phil. Trans.* 1887, B. p. 289.

All the probable errors are practically tested by using different lengths or diameters of the wire, and the results obtained in the present investigation indicate that the errors have been eliminated.

In order to make a complete test of a metal it is only necessary to take a wire of 5 or 6 cm. length and solder it firmly, the one end into the bottom of the heating box, the other into the calorimeter ball. The water in the heating box is kept boiling briskly, and readings are taken every half-minute from the thermometer in the ball. These readings are then put upon a curve as ordinates, with the time in minutes as abscissæ. From this curve the rise of temperature per unit time can then be accurately read off, and, the thermal capacity of the ball being already determined, the flow of heat per unit time is obtained.

At the beginning of the experiment the ball is cooled to about 6° or 7° C. below the temperature of the air, and the rise for equal temperatures above and below that of the air taken, the radiation being thus eliminated.

The metal which was chiefly used for the exhaustive tests of the method was copper wire, of diameter 0·21 cm., density 8·85, volume specific (electrical) resistance at about 13° C. 1834 in absolute units.

It must be noted that the found values are the means of the conductivities corresponding to the temperatures at the ends of the wire. When compared with the values obtained by other experimenters, the results of the latter must be taken for the mean of 97° C. and 10° C., that is, 53° C.

For this temperature Ångström gives 0·9208.

Several qualities of copper were tested, as well as pure gold, silver, and platinum, kindly lent for investigation by Messrs. Johnson, Matthey, and Co.

The values are given below:—

Mean Conductivity between Temperatures 10° *C. and* 97° *C.*

	Thermal conductivity in C.G.S. units.	Diameter.
Copper, Specimen 1	0·9594	2·00 mm.
,, ,, 2	0·8883S	2·11 ,,
,, ,, 3	0·8612	3·09 ,,
,, ,, 4 (very impure)	0·3497	2·04 ,,
,, ,, 5 ,,	0·3198	2·04 ,,
Silver (pure)	0·9628	2·02 ,,
Gold ,, ...	0·7464	2·00 ,,
Platinum ,, ...	0·1861	2·00 ,,

"Flame Spectra at High Temperatures. Part III. The Spectroscopic Phenomena and Thermo-Chemistry of the Bessemer Process." By Prof. W. N. Hartley, F.R.S.

The flame issuing from the mouth of a Bessemer converter was first investigated by Sir Henry Roscoe[1] in 1863; by Lielegg,[2] and by Marshall Watts in 1867;[3] by Tunner,[4] J. M. Silliman, Rowan,[5] Von Lichtenfels,[6] Spear Parker,[7] Kupelwieser,[8] Brunner,[9] and Wedding in 1868;[10] also by A. Greiner in 1874.[11]

Up to the present time the precise nature of the spectrum, the cause of its production, its sudden disappearance when decarburisation of the metal takes place, and the connection between the decarburisation of the metal and the extinction of the spectrum have not been satisfactorily explained. According to Roscoe, Lielegg, Kupelwieser, and Spear Parker, the spectrum is characterised by bands of carbon or of carbon monoxide, which disappear when all carbon is burnt out of the metal.

On the other hand, the investigations of Simmler,[12] Brunner, Von Lichtenfels, and Wedding, the spectrum is not due to

[1] Literary and Phil. Soc., Manchester, *Proc.*, vol. 3, p. 57, and *Phil. Mag.*, vol. 34, p. 437.

[2] *Sitzungsberichte Kaiserl. Akademie der Wissenschaften*, Wien, vol. 56, Part ii.

[3] *Phil. Mag.*, vol. 34, p. 437.

[4] *Dingler's Polytech. J.*, vol. 178, p. 465.

[5] *Phil. Mag.*, vol. 41, p. 1.

[6] *Dingler's Polytech. J.*, vol. 191, p. 213.

[7] *Chem. News*, vol. 23, p. 25.

[8] *Oesterreichische Zeitschr. fur Berg- und Hütten-Wesen*, No. 8, p. 59, 1868.

[9] *Loc. cit.*, No. 29, p. 227, 1868.

[10] *Zeitschrift fur das Berg Hutten- und Salinen-Wesen*, vol. 27, p. 117, 1869.

[11] *Revue Universelle*, vol. 35, p. 623.

[12] *Zeitschr. fur Analytische Chemie*, 1862.

carbon (Roscoe) or to carbon monoxide (Lielegg and Kupelwieser), but to manganese and other elements in the pig-iron.

The very careful examination of these spectra by Watts and his comparison of them with that of the Bessemer flame led to the conclusion that it was not the spectrum of carbon in any form nor of manganese, but that of manganic oxide.

Owing to the courtesy of Mr. F. W. Webb, the engineer of the Locomotive Department of the London and North-Western Railway, and of Mr. E. P. Martin, the manager of the Dowlais Ironworks, observations have been made at Crewe and at Dowlais during the past year. Ninety spectra were photographed, about fifty of which were available for study.

Ninety-two lines were identified with lines in the solar spectrum, with lines in Kayser and Runge's map of the arc spectrum of iron, and in spectra from steel and ferric oxide heated in the oxyhydrogen flame.

The Constitution of the Bessemer Spectrum.

The spectrum is a complex one which exhibits differences in constitution during different periods of the "blow," and even during different intervals in the same period. As originally observed by Watts, the spectrum differs in different works, the difference being due to temperature and to the composition of the metal blown.

During the first period.	The lines of the alkali metals, sodium, potassium and lithium, are seen unreversed on a bright continuous spectrum caused by carbon monoxide. The C line of hydrogen and apparently the F line were seen reversed during a snowstorm.
During the second period. The "boil."	Bands of manganese are prominent, overlying the continuous spectrum of carbon monoxide. There are lines of carbon monoxide, manganese, and iron, also those of the alkali metals.
During the third period. The "fining stage."	The spectrum is the same as the foregoing, but the lines of iron are not so strong and not quite so well defined. Some of the short lines disappear. The lines of the alkali metals are visible.

The alkali metals do not show themselves in the Bessemer flame until a layer of slag has been formed, and the temperature has risen sufficiently high for these basic constituents to be vapourised. At the temperature of the "boil" or second period, both metallic manganese and iron are freely vapourised in a current of carbon monoxide, which, in a highly heated state, rushes out of the bath of molten metal. The evidence of this is the large number of bands of manganese and lines of iron in the spectrum.

When the metal blown contains but little manganese, the manganese spectrum in the flame does not arise from that substance being contained in the bath of metal, it must be vapourised from the slag. That this is so has been proved by photographs of the spectrum from samples of slag obtained from the Crewe works. This explains the fact observed by Brunner, namely, that when a converter is being heated with coke after it has been used, but not relined, the spectra of the Bessemer flame makes its appearance; manifestly it comes from the adhering slag.

The luminosity of the flame during the "boil" is due, not merely to the combustion of highly heated carbonic oxide, but also to the presence of the vapours of iron and manganese in the gas.

The disappearance of the manganese spectrum at the end of the "fining stage," or third period, is primarily due to a reduction in the quantity of heated carbon monoxide escaping from the converter, which arises from the diminished quantity of carbon in the metal. When the last traces of carbon are gone, so that air may escape through the metal, the blast instantly oxidises any manganese, either in the metal or in the atmosphere of the converter, and, furthermore, oxidises some of the iron. The temperature must then fall with great rapidity.

The entire spectroscopic phenomena of the "blow" are undoubtedly determined by the chemical composition of the molten iron, and of the gases and metallic vapours within the converter, the temperature of the metal and that of the issuing gases.

The Temperature of the Bessemer Flame.

The probable temperature of the Bessemer flame at the finish is that produced by the combustion in cold air of carbonic oxide heated to about 1580° C., that is to say, to the temperature which, according to Le Chatelier (*Comptes Rendus*, vol. cxiv. p. 670) is that of the bath of molten metal from which the gas has proceeded. The bath of metal acts simultaneously as a means of heating the blast, producing the gas, and as a furnace, on the regenerative principle, which heats the gas prior to its combustion. The heating effect is therefore cumulative. The temperature, as is well known, can easily rise too rapidly, and the metal has then to be cooled.

If we may judge by the lines and bands belonging to iron and manganese which have been measured in photographed spectra of the Bessemer flame, the temperature must nearly approach that of the oxyhydrogen flame, and may easily attain the melting point of platinum, namely, 1775° C. (Violle).

From thermo-chemical data the heat evolved during the "blow" has been calculated, but the specific heats of cast iron, slag, carbon monoxide, and nitrogen are unknown at temperatures between 1200° C. and 2000° C. If we allow for 50 per cent. of heat developed at high temperatures being lost by radiation or otherwise, then the estimated temperature of the metal in the converter is more than 1900° C.

Le Chatelier (*Comptes Rendus*, vol. cxiv. p. 670) found the steel in the ladle of a Robert converter to be at 1640° C. Reasons are adduced for believing that it was hotter than this at the highest temperature of the "blow."

The Technical Aspect of this Investigation.

The complete termination of the "fining stage" is clearly indicated, but there is no indication by the flame of the composition of the metal within the converter at any previous stage. As the progress of the "blow" is governed by the composition of the metal and its temperature in the converter, and as these cannot be controlled with perfect exactitude during each "blow," it follows that the practice of complete decarburisation [1] is the best course to pursue, the required amount of carbon and manganese being added subsequently in the forms of grey iron, spiegel, or ferro-manganese.

Mathematical Society, June 14.—Mr. A. B. Kempe, F.R.S., President, in the chair.—Abstracts of the following communications were read by the secretary (Mr. R. Tucker).—The solutions of $\sinh\left(\lambda\frac{d}{dx}\right)y = f(x)$, $\cosh\left(\lambda\frac{d}{dx}\right)y = f(x)$, λ a constant, by Mr. F. H. Jackson.—A theorem in inequalities, by Mr. A. R. Johnson. This was a theorem which in a natural way fills up the gap between the A.M. and the G.M. of a number of positive quantities.—Some properties of a circle, by Mr. R. Tucker.—Note on four special circles of inversion of a system of "generalised Brocard" circles of a plane triangle, by Mr. J. Griffiths.—On the order of the eliminant of two or more equations, by Dr. R. Lachlan. In analytical work it is often important to know what will be the order of the eliminant of two equations containing several variables when one of them is eliminated. This question can in general be answered even when it is not easy to perform the elimination. A discussion of the question is given in Serret's "Cours d'Algèbre Supérieure," and is said to be due to Minding. But a simpler method would seem to be arrived at by geometrical considerations. Thus, suppose that it is required to find the order of the eliminant in y when x is eliminated from any two equations,

$$f_1(x, y) = 0 \text{ and } f_2(x, y) = 0.$$

Let a third variable, z, be introduced, so that the equations may be written in the homogeneous forms,

$$\phi_1(x, y, z) = 0 \text{ and } \phi_2(x, y, z) = 0,$$

and let the degrees of these equations be m and n. When these equations are regarded as representing curves, the eliminant will represent the lines connecting the point $y = 0$, $z = 0$ to the points common to the two curves. Hence, the order of the eliminant will be at most mn, because the curves will intersect in that number of points. But a little consideration will show that it will not in general be necessary to take into account the points common to the two curves which lie on the lines $y = 0$, $z = 0$. Similarly, if it is required to eliminate x and y from three equations containing x, y, and z, let a fourth variable, w, be introduced, so as to make the equations homogeneous. Then

[1] The words "carburising" and "decarburising" are to be preferred to "carbonising" and "decarbonising" when applied to metals, because these expressions were those originally used in the older works on metallurgy, and they avoid confusion with the other signification of the word "carbonising."

the order of the eliminant will be the number of common points of the surfaces, less the number of common points which lie in the two planes $z = 0$, $w = 0$. In the paper several examples are considered. It will suffice to mention here the case which led to these investigations. Consider two equations of the form

$$\frac{a_1 x_1}{\alpha_1 + \theta} + \frac{a_2 x_2}{\alpha_2 + \theta} + \frac{a_3 x_3}{\alpha_3 + \theta} = 1.$$

These equations may be written in the homogeneous form

$$\frac{a_1 x_1 \phi}{\alpha_1 \psi + \theta} + \frac{a_2 x_2 \phi}{\alpha_2 \psi + \theta} + \frac{a_3 x_3 \phi}{\alpha_3 \psi + \theta} = 1,$$

and thus represent curves of the third order. But the curves have evidently three common points on the line $\phi = 0$; and a common node (with different tangents) at the point $\theta = 0$, $\psi = 0$. Hence the degree of the eliminant of the given equations is

$$9 - 3 - 4 = 2.$$

More generally, the eliminant of two equations of the form

$$u_n + u_{n-1} + \ldots + u_0 = 0,$$

$$v_m + v_{m-1} + \ldots + v_0 = 0,$$

where u_i and v_i are homogeneous expressions of the ith degree in

$$\frac{x_1}{\alpha_1 + \theta}, \frac{x_2}{\alpha_2 + \theta}, \ldots, \frac{x_r}{\alpha_r + \theta},$$

is shown to be of degree $(r - 1)mn$ in the variables $x_1, x_2, \ldots x_r$. —Solvable cases of the motion of a top or gyrostat, by Prof. A. G. Greenhill, F.R.S. When the sum of the parameters of the two elliptic integrals of the third kind, whose poles correspond to the highest and lowest position of the axis of the top, is an aliquot part of the associated elliptic function periods of the form $K + fK'i$, where f is a proper fraction, then Abel's theory of Pseudo-Elliptic Integrals can be utilised to construct an algebraical solution of the motion, provided that in the general case a secular term pt is associated with the azimuth ψ of the axis. Denoting by θ the angle between the axis of the top and its highest position, and supposing θ to oscillate between α and β, $\alpha > \theta > \beta$, then the dynamical equations to be satisfied are of the form

$$\tfrac{1}{2} A \left(\frac{d\theta}{dt}\right)^2 + \tfrac{1}{2} A \sin^2\theta \left(\frac{d\psi}{dt}\right)^2 = Wgh\,(d - \cos\theta),$$

$$A \sin^2\theta \frac{d\psi}{dt} + Cr\cos\theta = G;$$

equivalent to, with $n^2 = Wgh/A$,

$$\sin\theta \frac{d\theta}{dt} = n\sqrt{2}\sqrt{(\cosh\gamma - \cos\theta \,.\, \cos\beta - \cos\theta \,.\, \cos\theta - \cos\alpha)},$$

$$\sin^2\theta \frac{d\psi}{d\theta} = \frac{\dfrac{G - Cr\cos\theta}{\sqrt{(2AWgh)}}}{\sqrt{(\cosh\gamma - \cos\theta \,.\, \cos\beta - \cos\theta \,.\, \cos\theta - \cos\alpha)}};$$

and it is found that the constants in the problem can be expressed in terms of two arbitrary constants m and c.

In the simplest case, $f = \frac{1}{2}$, the motion of the axis, or of a fixed point on it, will be given by the equation

$$\sin^2\theta e^{2(\psi - pt)i} = (\cos\theta - D)\sqrt{(\cosh\gamma - \cos\theta \,.\, \cos\beta - \cos\theta)} + i(E\cos\theta - F)\sqrt{(\cos\theta - \cos\alpha)},$$

where

$$\cos\alpha = \frac{m^2 - 1 - c - c^2}{\sqrt{M}},$$

$$\cos\beta = \frac{m^2 - 1 - c + c^2}{\sqrt{M}},$$

$$\cosh\gamma = \frac{m^2 + 1 + 3c + c^2}{\sqrt{M}},$$

$$M = (m^2 - 1 + c + c^2)^2 + 8(m + 1)(c + c^2).$$

$$D = \frac{3m^2 + 4m + 1 - c - c^2}{\sqrt{M}}, \quad E = \frac{(2m + 1)\sqrt{2}}{\sqrt[4]{M}},$$

$$F = \frac{2m^3 + 3m^2 + 2(1 + c + c^2)m + 1 + 3c + 3c^2}{M^{\frac{3}{4}}},$$

$$\frac{p}{n} = \frac{2m + 1}{2\sqrt[4]{M}}, \quad \frac{G^2}{2AWgh} = \frac{2m^2}{\sqrt{M}}, \quad \frac{C^2r^2}{2AWgh}$$

$$= 2\frac{m^6 - 2(1 - a)m^4 + (1 - 6a + a^2)m^2 - 4(a - a^2)m + 4a^2}{M^{\frac{3}{2}}}$$

where $a = c + c^2$.

The modulus k of the associated elliptic functions is given by $k = c/(1 + c)$, so that the period of the axis between its highest and lowest position is $\frac{\sqrt[4]{M}}{(1 + c)\sqrt{2}}$ times the period when the body makes plane oscillations, swinging through an angle $4\sin^{-1}c/(1 + c)$.

By putting $m = -\frac{1}{2}$, the secular term pt is made to disappear, and the path of a point on the axis of the top is a closed curve with four branches; this curve has four cusps if $c = \frac{1}{2}$, and it has four loops if $c > \frac{1}{2}$.

The term Cr can be made to disappear by determining a in terms of m by the solution of a quadratic equation, and the motion is that of a spherical pendulum; but it is not possible now to make p vanish. In the next case of $f = \frac{1}{3}$ the motion of the axis is given by an equation of the form

$$\sin^3\theta e^{3(\psi - pt)i} = (\cos^2\theta - D\cos\theta + D')\sqrt{(\cosh\gamma - \cos\theta \,.\, \cos\theta - \cos\alpha)}. + i(E\cos^2\theta - F\cos\theta + F')\sqrt{(\cos\beta - \cos\theta)}$$

and

$$\cos\alpha = \frac{m^2 - 1 + 4c - 5c^2 + 0 + c^4}{\sqrt{M}},$$

$$\cos\beta = \frac{m^2 - 1 + 4c - 5c^2 + 4c^3 - c^4}{\sqrt{M}},$$

$$\cosh\gamma = \frac{m^2 + 1 + 0 - 5c^2 + 4c^3 - c^4}{\sqrt{M}},$$

$$M = (m^2 - 1 + 8c - 15c^2 + 8c^3 - c^4)^2 + 8(1 - c)^2(2c - c^2)(1 - 2c)(m + 1 - 3c + c^2),$$

$$k^2 = \frac{2c^3 - c^4}{(1 - c)^3(1 + c)}, \quad \frac{p}{n} = \frac{3m + (1 - 2c)(2 - c)}{3\sqrt[4]{M}}$$

$$E = \frac{3m + (1 - 2c)(2 - c)}{\sqrt[4]{M}}\sqrt{2} \ldots$$

D, D′, E, E′ being readily found by verification. In this case the secular term pt is destroyed by taking $m = -\frac{1}{3}(1 - 2c)(2 - c)$, and a point in the axis now describes a curve with six loops. The case of $f = \frac{2}{3}$ can similarly be made to give a curve with three loops, the general state of motion being given by an equation of the form

$$\sin^3\theta e^{3(\psi - pt)i} = (\cos^2\theta - D\cos\theta + D')\sqrt{(\cos\beta - \cos\theta \,.\, \cos\theta - \cos\alpha)} + i(E\cos^2\theta - F\cos\theta + F')\sqrt{(\cosh\gamma - \cos\theta)}.$$

A similar procedure will serve for

$$f = \frac{1}{4}, \frac{3}{4}, \frac{1, 2, 3, 4}{5}, \text{\&c.};$$

the results are of rapidly increasing complexity, but the constants D, E, ... are readily determined when p is known, E being the simple multiple $\mu\sqrt{2}$ of p/n, while

$$\frac{p}{n} = \frac{\mu m + \rho}{\mu\sqrt[4]{M}},$$

where

$$\tfrac{1}{2}\int \frac{\rho(Pu - Pv) + \mu P'v}{Pu - Pv}\,du$$

is the pseudo-elliptic integral corresponding to a parameter v, which is a μth part of a period. The Rev. F. J. Smith, F.R.S., of Oxford, has constructed an apparatus by which the preceding theory can be tested, and the agreement between the predicted and experimental results is very satisfactory.—Impromptu communications were made by Dr. J. Larmor, F.R.S. (on the wave surface), and Dr. M. J. M. Hill, F.R.S. (on Monge's solution of a differential equation).—At the special meeting, held on the same evening, for considering certain resolutions relating to the incorporation of the Society under the Companies Act 1867, authority was given to the Council to carry out the incorporation.

PARIS.

Academy of Sciences, July 2.—M. Lœwy in the chair.—Researches on phenylhydrazine. Action of oxygen and of water; formation of salts, by M. Berthelot. Oxygen reacts on a solution of phenylhydrazine hydrochloride, giving off a volume of nitrogen equal to that of the oxygen absorbed, and yielding an uncrystallisable oily compound answering to the reactions of diphenylhydrazine. Pure anhydrous phenylhydrazine heated at 100° with oxygen in sealed vessels yields about half as much again nitrogen. Phenylhydrazine forms a crystalline hydrate melting at 24° C. and having the composition $2C_6H_8N_2 . H_2O$. Thermal data are given for the formation of the hydrate and some of the salts of this base.—Impurities of commercial aluminium, by M. Henri Moissan.—Preparation of a crystallised aluminium carbide, by M. Henri Moissan. A carbide of aluminium forming fine yellow transparent crystals is described. It has the composition C_3Al_4, and slowly decomposes water at the ordinary temperature with the formation of methane.—On the place of production and the mechanism of the murmurings in tubes through which pass currents of air, by M. A. Chauveau. The murmurings are the effect of the transmission of sounds originated by vibrating fluid veins which form at the orifices or at the entrance of dilatations of the tubes. —The use of the potato for feeding cattle—production of meat, by M. Aimé Girard. The results of an extended investigation show that the potato is much superior to beetroot as a food-material for cattle and sheep, and can be used economically with remarkable results as a normal meat-producing forage.—A note by M. Armand Gautier accompanying the presentation of his work, "The Chemistry of the Living Cell."—On the geographical distribution of Cyrtandreæ, by M. E. Drake del Castillo.—On the algebraical integration of differential linear equations, by M. Paul Painlevé.—On a class of polynomials decomposable into linear factors. An extract from a letter to M. Appell, by M. Moutard.—Experimental researches on the conditions of employment and forms of boats used for haulage, by M. J. B. de Mas.—On the elasticity of torsion of an oscillating wire, by MM. G. Berson and H. Bouasse.—On the calorific radiations comprised in the luminous part of the spectrum, by M. Aymonnet.—Reception of sounds, by M. Henri Gilbault.—On enharmonic gamuts, by M. A. de Berthe. —On an application of cathode rays to the study of variable magnetic fields, by M. Albert Hess. An apparatus is employed in which the cathode rays are generated in a Geissler tube and received on a photographic film. Being given that deviations of the rays are due to modifications of the state of tension of the ether under the influence of the magnetic field, the cathode rays form an index without inertia capable of registering the variations of intensity of a magnetic field with a speed only limited by the sensitiveness of the photographic film.—Determination of the form of periodic currents as a function of the time by means of the electrochemical inscription method, by M. P. Janet.—A transformer of monophase into triphase currents, by M. Désiré Korda.—Researches on the action of the acid molybdates of sodium and ammonium on the rotatory power of rhamnose, by M. D. Gernez. Small additions of molybdate determine a relatively great increase of the observed rotation. A maximum effect is produced by the addition of $\frac{6.75}{24}$ of the molecular weight. Greater quantities produce no further appreciable change. The maximum effect is produced by quantities of the molybdates equal to those found to give maximum effects in the cases of mannitol, sorbitol, and persitol.—On the change of sign of the rotatory power, by M. Albert Colson. The author concludes that, from the experimental evidence given, (1) there exist compounds having a rotatory power very variable with the temperature, even to the extent of changing sign, as in the case of isobutylamyl oxide; (2) in certain cases these great variations are caused by alterations in the state of chemical equilibrium.—On the line spectrum of sulphur and on its detection in metallic compounds, by M. A. de Gramont.—New researches on the bromo-boracites, by MM. G. Rousseau and H. Allaire. A description is given of the preparation and properties of compounds of magnesium, zinc, cadmium, manganese, cobalt, and nickel of the general type $6MO . 8B_2O_3 . MBr_2$.—Influence of pressure on the combination of hydrogen and selenium, by M. H. Pélabon. The dissociation theory indicates that the pressure should have no influence on the ratio of hydrogen to hydrogen selenide produced, as there is no alteration of volume in the reaction. The experimental numbers obtained sensibly agree with this conclusion, better as the temperature is higher. The augmentation of pressure increases very slightly the quantity of hydrogen selenide produced at a certain temperature, more as the temperature remains lower.—On a reaction of aldehydes. Differentiation of aldoses and ketoses. By MM. A. Villiers and M. Fayolle. Fuchsine decolourised by sulphurous acid may be used to discriminate between aldoses and ketoses, the former giving when present in sufficient quantity the aldehyde reaction, though less intensely than ordinary aldehyde.—On the substitution of alcoholic radicals combined with carbon or with nitrogen, by M. C. Matignon. A claim for originality as against MM. Stohmann and Langbein.—Remarks on the preceding note, by M. Berthelot.—On piceine, a glucoside from the leaves of *Pinus picea*, by M. Tanret. The glucoside has been resolved into glucose and piceol, $C_8H_8O_2$. The latter substance is described as a monotomic phenol.—On the presence of hydrogen and ethylene in the residual nitrogen from blood, by M. L. de Saint-Martin.—Action of sulphuric acid on camphene, by MM. G. Bouchardat and J. Lafont. The products are (1) the mixed ether of borneol and inactive camphene; (2) borneol sulphuric acid; and (3) polymerides of camphene.—On the bromo-derivatives of tetrachlorethylene, by M. A. Besson.—On some new organo-metallic combinations, by M. G. Perier. Anhydrous aluminium chloride forms, with ketones and similar bodies, compounds of the type $R_2 . Al_2Cl_6$. This article demonstrates the existence of similar compounds with amines, amides, and their substitution products.—On the formation of succinic acid and glycerine in alcoholic fermentation, by M. J. Effront. —The influence of chlorides on nitrification, by MM. J. Crochetelle and J. Dumont.—A new case of commensalism: association of *Aspidosiphon* with coral polyps and a bivalve mollusc, by M. E. L. Bouvier.—Transformation of the aortic arches in the frog, by M. S. Jourdain.—On the respiration of leaves, by M. L. Maquenne.—The mechanism of movements incited in *Berberis*, by M. Gustave Chauveaud.—The "brûlure" of vine-leaves produced by *Exobasidium vitis*, by MM. Prillieux and Delacroix.—On a new disease of wheat caused by Chytridineæ, by M. A. Prunet.—"Brunissure" in Algeria, by M. F. Debray.—On the earthquake of Locrides (Greece) in April 1894, by M. Socrate A. Papavasiliore.—Potatoes as food for milch-cows, by M. Ch. Cornevin.—The vegetation of vines treated by submersion, by M. A. Muntz.—On the determination of the agricultural value of several natural phosphates, by M. G. Paturel.—Currents and winds on the coast of the Landes of Gascony, by M. Hautreux.

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THURSDAY, JULY 19, 1894.

ANCIENT ASTRONOMY.

Recherches sur l'histoire de l'Astronomie Ancienne. Par Paul Tannery. (Paris: Gauthier-Villars et Fils, 1893.)

THE author's previous work, "Pour l'Histoire de la Science hellène," in which early Greek scientific ideas are treated of from the time of Thales to that of Empedocles, and which first appeared in fragments in the pages of the *Revue Philosophique*, leads the reader to open the present with high expectations, which its perusal will assuredly not disappoint. It in no degree trenches upon the ground occupied by the former; but its main object is to furnish an analysis of the Almagest, more accurate and complete than those given by previous writers, and also to discuss the views of those who may fairly be called the precursors of Ptolemy, and especially of Hipparchus. On this latter point M. Tannery's researches have led him to conclusions somewhat different from those which have been generally entertained. The part played by Hipparchus in the progress of astronomy he considers to have been singularly exaggerated, and the ground to have been prepared rather by the earlier writers of the Alexandrian school, particularly by Apollonius of Perga, in the invention of geometrical and trigonometrical methods, and the first systematic combination of recent with earlier Chaldean observations. To illustrate clearly his meaning, he affirms that, without these previous works, Hipparchus would have been unable to accomplish the greater part of that which has made his name immortal; whereas without that of Hipparchus, Ptolemy would have been able in great measure to have composed his Almagest; it would have been undoubtedly much more imperfect and less accurate in many numerical details, but "l'ensemble ne présenterait pas un caractère très notablement différent."

The work begins with an etymological discussion (certainly conducted on historical principles) of the origin of the words (*i.e.* of their Greek equivalents) "astronomy" and "astrology." The former is the older of the two, and is found in Plato and in Aristophanes; the substitution of "astrology" was made by Aristotle. Hipparchus preferred the term mathematician to astronomer or astrologer; and following in his wake, Ptolemy called his great work (for which we usually use the Arabic designation "Almagest") the mathematical composition. It may be interesting to remember that though in modern times the expressions astronomy and astrology returned into use (at first with the same meaning, but the latter became degraded by exclusive application to absurd and superstitious attempts, in the manner of the Chaldeans and Egyptians, to predict future events by supposed planetary influences), yet Flamsteed's favourite way of designating himself was as M.R., for "mathematicus regius." M. Tannery thinks that the term ἀστρονόμος preceded that of ἀστρονομία, and that it strictly signified one who distributed the stars into groups, or, as we call them, constellations. With regard to the well-known passage in Homer, speaking of the Bear that alone has no part in the baths of the ocean, he takes the poet to include under that name all the stars within the circle of perpetual apparition. The knowledge of the distribution of the stars in the visible firmament was obviously of use in navigation; the extension of this astronomy to reasoning on their motions, for which the expression astrology was afterwards logically preferred by Aristotle, was, we are told by Xenophon, discouraged by Socrates; but the language of the historian rather points to the works of Eudoxus of Cnidus, which appeared subsequently to the time of Socrates.

M. Tannery takes occasion to allude to the famous story or legend of the number of the year in the Metonic Cycle taking its name from its being graven in golden letters on a public square in Athens; whereas Boeckh has proved that the cycle in question was not brought into use there until the reform of Calippus, a century after the time of Meton, and Aristophanes in more than one passage ridicules the disorders of the calendar in his own time.

In his second chapter, M. Tannery treats of the progress made in the science which acquired the name of astrology (but for which modern science prefers the more ancient term astronomy, to avoid confusion with what Kepler called its hair-brained sister, though we refuse to recognise any relationship, and it was felt to be too much trouble always to call the other judicial astrology) during what may be considered the Athenian period, for thither came Eudoxus, who founded the school of Cyzicus and introduced the use of the instrument called the ἀράχνη, identical in principle with the astrolabe, the invention of which was long falsely attributed to the Arabs; and there also Calippus conferred with Aristotle. But Alexandria was destined to take the place of Athens as the principal seat of Greek learning. It was, however, to the second period of its prosperity, under the Roman domination, that the astronomical glory of Alexandria culminated in the hands of Claudius Ptolemy, whose work may be said to comprise all that was known of astronomy until the era of Copernicus and Tycho, soon to be followed by that of Kepler and Galileo. Meanwhile one of the islands on the coast of Asia Minor, on which, according to the Greek proverb, the sun always shone, so that it may be presumed that the stars also frequently did at night, had been the scene of the scientific labours of Hipparchus, probably the best known amongst the ancient astronomers. Mr. Chambers calls him "the Newton of Greece," but it is evident that M. Tannery does not share that view at any rate. The illustrious Bithynian is usually considered, he says, "comme un génie absolument hors de pair"; but without desiring in any way to depreciate his very important contributions to science, he adds, "L'importance de son rôle est en tout cas assez grande pour que ce ne soit pas lui faire injure que d'essayer de le ramener à des proportions un peu plus humaines. Il a possédé, sans contredit, les qualités essentielles à un astronome; habile et patient observateur, calculateur émérite, il fut également doué de la sagacité qui conduit aux découvertes capitales et de la puissance de déduction qui permet d'enchainer les vérités nouvellement acquises dans un système solidement construit. Eut-il, au même degré, le génie de l'invention mathématique? C'est ce qui semble pouvoir être mis en doute."

The author proceeds to show that in many of the advances usually attributed to Hipparchus, especially those in which mathematical acumen was requisite, he had been preceded by others, though undoubtedly his store of observations was of great value to his successors, and in practical methods he made many and important inventions. "Trigonometry," we read in the article on Ptolemy in the Encyclopædia Britannica, "was created by Hipparchus for the use of astronomers." M. Tannery gives reasons for believing that his qualifications were not of a kind to enable him to make discoveries of this nature, whilst as for the systematic development of the hypothesis of epicycles and eccentrics to represent the celestial movements (which, since the time of Kepler, "n'est plus que l'objet d'un dédain qu'à vrai dire, elle ne mérite guère en elle-même"), the testimony of antiquity attributes this to the great geometer, Apollonius of Perga. Even in the systematic utilisation by Hipparchus of the ancient Chaldean observations of eclipses, he had probably to a great extent been anticipated by Conon of Samos, best known as the friend of Archimedes, and for his ingenious flattery of the Egyptian queen by raising her hair to the heavens as the constellation Coma Berenices. Seneca, it is true, speaks of Conon's use of Egyptian observations; but this was in all probability an error for Chaldean, brought about by the astronomer's residence in Egypt. It would seem, in fact, that Hipparchus should rather be compared to Flamsteed than Newton amongst the moderns. M. Tannery goes on to dwell upon the mathematical importance of the work of Apollonius, who was probably the same as the astronomer of that name who also lived under Ptolemy Philopator, and was called Epsilon on account of his researches on the theory of the moon; the old ordinary form of that letter resembling a crescent.

Geminus and Cleomedes (whose native places are unknown), Theon of Smyrna, the elder Pliny, are passed in review; but the principal part of the work before us respects, as before said, the great composition of Ptolemy, of which a very complete and interesting account is given. The ancient astronomer who, unknown to Copernicus (as it appears only from a work of Archimedes inaccessible to him), had anticipated him in the theory of the earth's motion, was Aristarchus of Samos. But, however worthy of admiration this may be, "on ne doit nullement exagérer le tort que subit la science astronomique par le fait qu Hipparque et Ptolémée ont maintenu le système géocentrique. Au point de vue mécanique et physique, la conception héliocentrique réalisait un immense progrès; au point de vue géometrique, que la science des anciens n'a pas dé passé pour les astres, cette conception ne présentait aucun avantage réel." The position and work of Copernicus is so often little understood, that it may be well here to quote further M. Tannery's language:—

"Le véritable titre de gloire de Copernic est peut-être moins d'avoir réprouvé le système d'Aristarque que d'avoir en même temps, mais à la suite d'un travail considérable et tout-à-fait indépendant de ce système, simplifié extrêmement les hypothèses relatives aux épicycles et excentriques, tout en conservant les mêmes principes géométriques que les anciens pour l'explication des mouvements des planetes."

The space at our disposal renders it quite impossible to do more than offer some indications of the contents of a work of which we may well say with Osiander of that of Copernicus, "eme, lege, fruere." But we may be permitted to express our concurrence with its closing remark:—"En tout cas, on ne pourra se refuser à admettre cette vérité que *la science ne se développe que lorsqu'elle est cultivée pour elle-même;* voilà sans doute la plus solide conclusion que l'on puisse tirer de son histoire."

There are several interesting appendixes, particularly those on the trigonometry of the ancients, on the great year of Josephus, on the conjectural opinions of the ancients concerning the distances of the planets from the earth, and one (by M. Carra de Vaux) on the celestial spheres of the Persian astronomer Nasir-Eddin Attûsi (born at Tûs in Khorasan, A.D. 1200), with a translation of part of his work. But there is not, what there certainly should be, a general index to the whole. W. T. L.

SCOTTISH LAND-NAMES.

Scottish Land-names. By Sir Herbert Maxwell, Bart., M.P. (Edinburgh and London: W. Blackwood and Sons, 1894.)

THIS book is practically a collection of a course of lectures called the "Rhind Lectures in Archæology," published "just as they were delivered." Sir Herbert Maxwell has done well to print them, by way of furnishing material for future workers, amongst which we may hope that he may himself make one.

The book furnishes a large number of notes and suggestions; and good work might be done by some philological scholar, who would go over the suggested etymologies, and verify them one by one. It is tolerably certain that some of them will not stand any very rigid test; whilst others will, no doubt, be found to be quite correct.

The author clearly recognises the great principle upon which all such investigations must be conducted. We must in every case try to find out the earliest written form in some charter or deed; and it will then often be found that such early form wholly contradicts the suggestion which the modern name presents.

"From a charter of the same king (William the Lion) it is evident that Granton, near Edinburgh, is not, as it appears, Grant's-town, like Grantown-on-Spey; for it is written *grendun*, the Anglo-Saxon *grene dun*—green hill." Similarly, we may remark, we find in England such names as Grendon and Grindon.

After laying down this all-important principle, it is not a little surprising to find, at the end of the work, an index of place-names, with etymologies, in which not a hint is given of the authority upon which each explanation rests. Thus "the Braid Hills" is explained from the Gaelic *braghad* (braad), the breast; and, of course, if there is documentary evidence for it, there is no more to be said. But if not, it is by no means clear why *braid* may not be the ordinary Lowland-Scotch word for "broad." In every such case, we have a right to expect that the evidence should in some way be given; precisely as, in Bardsley's book on Surnames, the whole value of the work really resides in the copious lists of references which are given at the end of it.

We have noted a considerable number of other points on which we desire further information. The remarks on the pronunciation (which is rightly said to be of great importance) are frequently bewildering. It may be well to point out two typical instances, for the bettering of the book in a future issue.

"Broad-ford in Skye retains the full sound of the Norse *breidr fjördr*, broad firth" (p. 84). This is precisely the thing which it does not do. *Broad* is not Norse, but Southern English; and *ford* suggests the word *ford* rather than *firth*.

"*Völlr*, a field, generally becomes *wall* in composition, as Dingwall in Ross-shire" (p. 89). Here "becomes" really means "is represented by"; for, as a fact, the form *wall* shows a far older stem, in which the *w* has not yet become *v*, and the *a* has not yet been treated with the *u*-umlaut. In other words, it would be far more correct to say, conversely, that the old stem *wall* has become *völlr* in the nominative case of the modern Icelandic word.

One thing, at any rate, must go. And that is, the extraordinary definition of *umlaut* on p. 39. "The law of *umlaut*, as the German philologers call it, whereby the vowel-sound in one syllable is altered by the vowel-sound in a syllable following (all fairly well so far, but mark the sequel), as *husband* and *nostril* stand for *house-band* and *nose-thrill*." Certainly, no German philologer ever said anything of the kind. The *u* in husband and the *o* in *nostril* are not examples of *umlaut* at all, for they do not depend in the least upon the vowels *a* or *i* in the second syllable. They simply exhibit examples of vowel-shortening before a collection of consonants, which is a different thing altogether. This is indeed a sentence to induce doubt in the author's methods.

Nevertheless, the book has its place and use. The collection of examples is a thing to be thankful for; and we heartily commend the author for attempting it. But, oh! that he had produced his authorities in every possible case, and had told us where the guesses come in!

OUR BOOK SHELF.

Systematic Survey of the Organic Colouring Matters. By Drs. G. Schultz and P. Julius. Translated and edited, with extensive additions, by Arthur G. Green. (London: Macmillan and Co., 1894.)

THE German edition of this standard work of reference has already been reviewed in these columns (vol. xlvi. p. 313). The translator and editor has done good service in rendering the work more available to English technologists by adding a preliminary section on the raw materials used in the industry, as well as by giving prominence in the tables to English patents. In these particulars the present edition differs from the German, and its value from the English point of view is thereby greatly enhanced. The work is also brought up to date, as all the later discoveries are tabulated. The total number of colouring matters now recorded is 454, as against 392 in the last German edition (1891). Even while Mr. Green was preparing the translation new products were being introduced, and no less than twenty-two new compounds have had to be added in an appendix. Another valuable addition to the English edition is the synoptical table for the qualitative analysis of artificial colouring matters, which was published by the translator last year in the *Journal* of the Society of Chemical Industry, and which is reprinted at the end of the volume.

One reflection which occurs in looking through the tables is the very unfair action of our patent laws upon English manufacturers. Most of the new discoveries are patented by German, French, or Swiss firms in this country, but the patentees do not make the products here—their patents simply blockade the industry in Britain, without giving our manufacturers any benefit. On the other hand, it is well known how stringent is the attitude, especially of the German Patent Office, in granting patents to foreign inventors. But this is a side issue, suggested only by the large number of references to English patents in the tables before us. Of these tables and of the work as a whole we have only to say that it will be welcomed by manufacturers and students as the latest and most complete synopsis of the organic colouring matters that has hitherto been drawn up.

R. M.

A Handbook to the Marsupialia and Monotremata. By Richard Lydekker, B.A., F.G.S. (London: W. H. Allen and Co., 1894.)

MR. LYDEKKER'S capacity for book-making seems to be unlimited. Zoological science is indebted to him for the diffusion of accurate knowledge on the fowl of the air, and "every living thing that creepeth upon the earth" and moves in the sea, from the days when the icthyosaurus disported itself in the Jurassic ocean to the present enlightened age. He is not, however, a brilliant writer, and all his works possess a sameness of diction, the dead level of which becomes oppressive after a time. The volume under review is a "popular monograph," in which the Marsupials and Monotremes are taken in order and have their characters, distribution, and habits detailed in a more or less attractive manner. These interesting mammals are dealt with one after another, and their characteristics are described in a way that strongly reminds us of the verbal expositions of the guide of a menagerie. The thirty-eight excellently coloured plates, with which the book is embellished, help to render the analogy more realistic. This monotony, however, is probably unavoidable in a work having the scope of Mr. Lydekker's handbook, and, in fairness to him, we must say that he has struck a good compromise between zoological treatises bristling with technical details, and works designed for the profoundly ignorant. It is almost unnecessary to say that the book is thoroughly up-to-date as regards recently discovered species, one of the most interesting of these being the remarkable Marsupial Mole described by Dr. Stirling a few years ago. With the exception of the matter relating to a few species, the book is founded upon Mr. Oldfield Thomas's "Catalogue of the Marsupialia and Monotremata in the Collection of the British Museum" (1888), with the addition of some notes on fossil species of these Orders. Mr. Lydekker has made an admirable and handy abridgment of this "indispensable compendium," and his work, though stodgy in places, will well serve the purpose of a popular book of reference on Australian mammals.

Climbing in the British Isles—England. By W. P. Haskett Smith, M.A. Pp. 162. (London: Longmans, Green, and Co., 1894.)

MOUNTAINEERING is a passion. Men who have climbed, rarely, if ever, get rid of the unrestful instinct to scale unconquered peaks and wriggle through unexplored "chimneys." This love of climbing has been growing in England for some years past, and Mr. Haskett Smith's book will certainly assist in extending it still more. The book is the first of a series describing the climbs available in the British Isles, two complementary volumes, dealing respectively with Wales and Scotland, being in preparation. It is not, of course, suggested that hill-climbing in these islands is the same as mountaineering in the

Alps, but it is rightly held that the man who goes through a course of training among the crags of Cumberland qualifies himself to tackle the giants of the Alps or Caucasus. Beginning with the tors on Dartmoor, the would-be Alpinist can pass by easy stages to such climbs as those of Deep Gill, Mickledoor and Napes Needle, and then complete his course of instruction on the Alps. For convenience of reference, all the headings are arranged in alphabetical order. It is easy, therefore, to turn up information about hills or rocks which afford climbs, and to find the meaning of technical terms and expressions. It would have been an advantage, however, if Mr. Smith had given a list of climbs in the order of difficulty, for beginners would then know exactly where to commence their mountaineering education. The book is illustrated with twenty-three sketches by Mr. Ellis Carr, and five plans. It will doubtless increase the number of climbers, and the many admonitions it contains ought to keep down the mortality from what someone has called the "greasy pole" exercise.

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.*]

Trituberculy and Polybuny.

IT is a matter of regret to me that so clear-headed a naturalist as Dr. Forsyth Major should have misunderstood what I thought to be clear intelligible language.

In his letter (NATURE, May 31) Dr. Forsyth Major declares that, in my paper on the Stonesfield mammalia, I stated that he has expressed views in his paper on Squirrels (*P. Z. S.* 1893) the very reverse of those recorded by him in that paper. All that I have said about Dr. Major, whose paper I read after writing mine, is "Dr. Forsyth Major does not favour this view," viz. that all the various forms of lower molars of Ditrematous mammals can be derived from the tubercular-sectorial type. I shall be glad if Dr. Forsyth Major will either state that he *does* favour this view, or withdraw his charge of misrepresentation.

Again, I think, Dr. Major has misunderstood my words when he proceeds to declare that I have made "some obviously contradictory statements" in my paper on the Stonesfield mammalia, and in my letter to NATURE of May 3. The object of my remarks on the primitive mammalian tooth in my paper, was to show that that part of the "tritubercular theory" (as lately set forth by Profs. Cope and Osborn) which seeks to explain the tubercular-sectorial tooth as having arisen—within the mammalian phylum—from a single cone through a triconodont stage is beset with weaknesses and improbabilities which render it untenable. The view there expressed that the Pro-mammalian molars "were of an indefinite multituberculate pattern," or, in other words (used in my letter), that they were "provided with many cusps not placed in one line," is *not* inconsistent with the admission that the common ancestors of the Marsupials and Placentals—and even (if we accept Prof. Osborn's latest statement) of the so-called "multituberculata"—may have already developed tubercular-sectorial lower molars, and perhaps tritubercular upper molars. Dr. Forsyth Major, whose careful observations deserve great consideration, has argued, in his letter of May 31, very forcibly against this "working hypothesis." I think it only right to say that the views expressed by him are identical with those which have been urged on me privately, and also expressed in lectures, by Prof. Lankester, under whose direction I made my investigation of the Stonesfield jaws.

The theory I support, then, merely comes to this: that many-cusped teeth of indefinite pattern (such as those of Ornithorhynchus?) gave rise to tubercular-sectorial lower and, perhaps, tritubercular upper teeth, some of which in turn gave rise to many-cusped teeth of definite serially tuberculated pattern (Polymastodon, &c.). Prof. Osborn declared that he had evidence of the latter step. The one mistake to which I plead guilty is that of having apparently endorsed in my letter Prof. Osborn's view on this latter point. In reality I wished to be understood as admitting temporarily—and until further evidence comes to hand—a statement which I was not in a position to combat by the use of my own observations.

Oxford, June 4. E. S. GOODRICH.

A Review Reviewed.

I AM rather astonished at the criticism of my use of the term mineraliser in my book on the "Economic Geology of the United States," made by a reviewer in a recent number of NATURE. Surely the sanction of the Century, Webster, and Worcester dictionaries, besides several scientific works, should be considered as warranting my use of the term, unless some very serious objection can be urged.

Since I am writing on the subject, I may say what perhaps should have been said in my preface, that the mineralogical part of the book, to which exception is taken by the reviewer, was not intended to teach mineralogy, but to call attention to a new aspect of the subject—the economic. The students for whom the book was mainly written, those at Cornell University, have, when they begin the study of economic geology, already studied determinative mineralogy and blowpipe analysis, and they have also studied rock-forming minerals from the geological standpoint. Here is the third standpoint, and experience in teaching shows that the plan is not superfluous.

Objection is also made to the absence of illustrations. But this is intentional, for I believe the class-room is the place for these. There we can use large illustrations, lantern-slides, and original maps and sections, which are vastly better than text-book diagrams.

I wish also to make an acknowledgment. As the reviewer points out, and as others have done before him, the chapter on mining terms and methods is weak and in places inaccurate. It was a serious error on my part (for which the book has suffered) not to have submitted this chapter, upon which I have only second-hand knowledge, to some specialist for revision. At present the only thing that can be done is to promise the elimination of the objectionable parts in a second edition, if one is called for. RALPH S. TARR.

Cornell University, Ithaca, N.Y., June 29.

I WILL reply *seriatim* to the various points of Prof. Tarr's letter.

(1) *Term "Mineraliser."*—I still think the word objectionable in the sense used by Prof. Tarr. To most people it probably conveys the idea of something which converts or helps to convert another substance into a mineral. How can sulphur be said to "mineralise" silver by combining with it? Both the elements already exist as minerals in nature; and one might just as well say that the silver mineralised the sulphur.

(2) *Mineralogical part of the book.*—Prof. Tarr states that the object of this part of the book is not to teach mineralogy, but to call the attention of students to the economic side of the question; but this is no excuse for loose and careless writing, instances of which are far too numerous. We read on page 16: "When a metal is combined with silica (SiO_2), a silicate is formed." "Ores considered from the economic standpoint occur in beds or in veins" (p. 17); this would lead the student to infer that no other modes of occurrence are known. Iron pyrite "grades into copper pyrite, but when there is much copper present the colour becomes more golden" (p. 18) "Grade" as a neuter verb does not appear in my edition of Webster, but it probably is intended to mean "gradually passes into." This reading is confirmed on page 22, where we find "copper pyrites, which is in reality a sulphide of iron and copper combined, the proportion varying from an exceedingly cupriferous variety (chalcopyrite) to pure iron pyrites." Limonite is spoken of as "the rust of hematite" (p. 19). Tin ore "is found both as tinstone, in coarse granites or pegmatites, and as stream-tin" (p. 25). Is not stream-tin a form of tinstone, and may not tin ore be found in *fine-grained* granite and in slate?

Judging from the paragraph on page 20, the author is unaware of the existence of any oxidised ore of nickel. The student does not obtain a correct idea of dolomite by being told that it is carbonate of lime "combined chemically with magnesium" (p. 10). I think that these instances, and others might be quoted, justify my remarks.

(3) *Paucity of illustrations.*—If Prof. Tarr had adhered to

his original intention of merely writing lecture-notes for his class, there would have been some force in his excuse; but when he sends forth his work as "a text-book, with the hope that it may find a wider field," he cuts the ground from under his feet. He must recollect that the majority of his readers will never have the opportunity of seeing his lecture diagrams and lantern-slides. If illustrations are out of place in a text-book, why did the author take the trouble to insert twenty-nine? Surely he is not ashamed of his beautiful and instructive frontispiece.

(4) *Mining chapter.*—After Prof. Tarr's candid confession, I will not say another word likely to cause him pain or annoyance; but will merely express the hope that Professors of Economic Geology, while examining mineral deposits, will take the trouble to notice how they are worked, and so render themselves independent of any second-hand aid when writing upon the art of mining.

THE REVIEWER.

Halo of 90° with Parhelia.

ON July 11 the halo of 90°, intersecting a primary halo of the usual size, but intensely brilliant in colouring, was visible at West Newton, Cumberland, for about four hours—9 a.m. to 1 p.m. The sun shone brilliantly all the time. Light strips and wreaths of cirrus and minute mottled cirro-cumulus marked the upper sky. There were several mock suns, not all equally distinct. The halo of 90°, a very unusual phenomenon, was of a pale grey-blue tint, showing no prismatic colours, except in a very slight degree at the point furthest removed from the sun.

This system of halos formed a splendid sight for about four hours, indicating a vast sheet of ice-crystals. I have observed that parhelia sometimes precede heat, as well as stormy weather.

The intensely vivid colouring of the part of the two (almost concentric) halos, where they intersected above the sun, was most striking.

SAMUEL BARBER.

West Newton, Cumberland, July 11.

P.S.—Four dry days followed, the fifth *wet*.

Rate of the Flight of Birds.

I SHALL be glad if any of your readers can inform me whether the rate of the flight of any birds other than Homing Pigeons has been accurately measured, and what attempts, if any, have been made to employ birds belonging to other families in place of Homing Pigeons.

F. W. HEADLEY.

Haileybury, July 15.

THE UNIVERSITY OF LONDON AND THE REPORT OF THE GRESHAM COMMISSIONERS.

THE University of London is beyond question the Institution most nearly concerned with the recommendations of the Commissioners appointed to consider the draft charter for the proposed Gresham University in London. These proposals, as was pointed out in NATURE in March last (vol. xlix. p. 405), involve the reconstruction of the present University and the formation of a Senate and Convocation having powers differing considerably from those at present possessed by them. Importance would, under any circumstances, attach to the attitude assumed by either body towards the Report, and in the present case it is in no way lessened by the fact that in the charter of 1863 it is ordained that Convocation—that is, those graduates of the University who have attained a certain seniority and paid certain fees—shall have "the power of accepting any new or supplementary charter for the University, or consenting to the surrender of this our charter, or of any new or supplemental charter," the consent of the Senate being also requisite before either acceptance or surrender becomes operative. This power of veto was exercised by Convocation in 1891, when a draft charter proposed by the Senate was rejected by a large majority, and the way made clear for University and King's Colleges to proceed with their petition for a separate University.

The preparation of a scheme for engrafting teaching on the present examining functions of the University of London did not originate with the Senate. To Convocation belongs the distinction of being the first to advocate this enlargement of the scope of the University, and its proposals were embodied in a scheme as long ago as 1886, while in a later scheme submitted to the Commissioners it indicated in still further detail the lines on which in its opinion a solution of the question might be found. The inability of each body to accept the schemes of the other, the chronic division of opinion between the Senate and Convocation on the Teaching University question, did not augur well for a joint assent to any scheme resulting from the labours of the Commissioners appointed in 1892.

This contingency evidently presented itself to a large majority of the Commissioners, since, with a wisdom which seems likely to be justified by events, they have gone beyond the terms of reference, which contemplated "the establishment under charter of an efficient Teaching University for London," and say that "in view of the failure of previous attempts to settle this question, and of the difficulty and delay which must inevitably attend an alteration of the constitution of the University through the action of the University itself, we are of opinion that, in accordance with the precedents followed in other cases of University reform, the changes which we recommend should be effected not by charter, but by legislative authority, and by the appointment of a Commission with statutory powers to settle, in the first instance, arrangements and regulations in general conformity with the recommendations which we are about to submit to your Majesty."

The latest project for the inevitable extension of University education in London was speedily recognised by many as a well-considered and feasible plan for meeting the requirements of the case. Highly desirable as it was that it should be accepted by, and not forced upon, Convocation, yet at first the outlook was anything but bright. The Annual Committee of Convocation—the body of graduates elected every year "to advise Convocation upon any matter affecting the interests of the University"—undertook the preparation of a report on the scheme of the Commissioners for presentation to Convocation. While this was under discussion an interview took place between it and the Committee of the Senate charged with the consideration of the Commissioners' Report, and it may be inferred that exception was taken to the revocation of the veto and to the mode of procedure proposed by the Commissioners, since the Chancellor (Lord Herschell), in the course of his reply, is reported to have said: "If the proposals of the Commissioners were generally considered to be for the public good, and a reasonable solution of the problem that had been referred to them, it would scarcely rest with this University, either through the Senate or through Convocation, to veto the plan; nor should the remodelling of the constitution of a public body, with a view to its further efficiency, be regarded as a penal abrogation of its charter."

Disregarding this statesmanlike view of the situation, the Annual Committee the same evening adopted a Report wholly adverse to the proposals of the Commissioners, and drew up five resolutions which they recommended Convocation to adopt. Space will only permit reference to the first: "That Convocation protests against the withdrawal without its consent of the charter of the University of London as proposed by the Gresham Commission . . . ." and the fourth: "That Convocation therefore, although it would regret the establishment of a second University in London, is of opinion that it would be less disastrous to establish such a University with a distinctive title than to carry into effect the scheme of the Gresham Commissioners." These will sufficiently indicate the Annual Committee's views.

Convocation's method of conducting business, it may be hoped, is peculiar to itself. Although an extraordinary meeting was convened on April 10 "to consider the Report of the Commissioners appointed to consider the draft charter of the proposed Gresham University in London, and also the Report of the Annual Committee thereon," it was debarred from expressing its opinion, either by discussion or vote, on the Commissioners' Report *as a whole*, and directed to confine itself to such matters as arose out of whichever resolution of the five might be under debate. After much fruitless discussion the resolutions proposed by the Annual Committee were unanimously set aside in favour of a motion which, "with a view to the speedy and satisfactory reconstitution of the University," referred "the whole question of the constitution of this University to the Annual Committee with power to nominate members of a Joint Consultative Committee of the Senate and Convocation."

This motion, agreed upon at the close of a protracted meeting and devoid of any express instructions to the effect that delegates should be selected so as to represent interests and not individuals, and that the Commissioners' scheme should form the basis of conference, was no doubt unfortunately worded, but the use to which it might be put was certainly not foreseen at the time of its adoption. In its seconder's opinion, as stated in a letter to the *Times*, "should such a Committee arrive at a workable result, this may be embodied in a new charter which may be accepted without resort to a Statutory Commission, such as the Annual Committee objected to," in other words, the Consultative Committee might be the means of indefinitely postponing the settlement of the question of University reform. And the Annual Committee, having failed to carry its resolutions, must have taken much the same view, since its delegates were, with one exception—that of a theologian—chosen entirely from its own body, while on points of order raised by two of its members in connection with the motion, discussion on the Commissioners' Report at the ordinary meeting of Convocation on May 8 was again prevented, although a notice of motion expressing general approval of the scheme was allowed to appear on the *agenda*.

Tactics such as these not infrequently meet with the reward they deserve. University reform in London has waited too long for an obstructive and dilatory attitude, whether arising out of questions of "dignity" or of inability to take a broad view of the problem, on the part of a few, to be tolerable, and fortunate it is that a salutary change has taken place in Convocation itself. A movement in favour of the Gresham scheme took definite shape a few days after the extraordinary meeting on April 10; a Committee of Graduates was formed and a circular sent out to elicit from members of Convocation an expression of general approval of its provisions, and a direct vote in Convocation on the scheme being prevented, its adherents took the only course open to them, turned out the old Annual Committee on May 8, and replaced it by one almost wholly favourable to the Commissioners' proposals. Although not a direct vote in favour of the scheme, it has with good reason been regarded as tantamount to this, since the meeting which elected the new Annual Committee would certainly have expressed general approval of the Report had not the motion to this effect been ruled out of order by the chairman.

Since May 8, events have moved rapidly. The delegates appointed by the late Annual Committee, with one exception, resigned their seats on the Joint Consultative Committee as a result of the vote adverse to themselves, and the Joint Consultative Committee with its endless opportunities for delay has been shelved. The circular issued by the Committee of Graduates just mentioned obtained 856 replies, many of them from the best known and most influential members of Convocation, expressing "general approval of the Commissioners' Report"; and this fact with a list of signatories was embodied in a memorial praying the Senate to "use all its influence to induce the Government to appoint a Statutory Commission forthwith." At its meeting on June 13, the Senate, happy in its opportunity, passed almost unanimously a resolution in which general approval of the proposals of the Commissioners was expressed, and instructions given to its special Committee to consider suggestions for the terms of reference to the Statutory Commission. A fortnight later the Annual Committee and other invited graduates met the Special Committee of the Senate in conference, and on behalf of the former it was urged "that it is desirable to memorialise Government to take immediate steps for the appointment of a Statutory Commission to frame statutes in general accordance with the Report of the Gresham Commission, with full power to make such modifications as they may see fit, after conference with Convocation and other bodies affected." Further, four delegates from the Annual Committee attended the meeting on June 30, of representatives from nearly all the institutions which, according to the Commissioners' proposals, will form constituent colleges of the reorganised University, and concurred in the resolution of similar character, which, as reported in NATURE (this vol., p. 227), was passed unanimously by those having the right to vote as delegates. And now the welcome news has transpired that at its meeting on July 11 the Senate passed a resolution urging the immediate appointment of a Statutory Commission with power to modify details of the Gresham Commissioners' scheme if judged expedient after conference with the bodies concerned, and that copies of the resolution were forwarded to the Lord Chancellor, the Lord President and the Vice-President of the Council, and the Home Secretary.

The unexpected, therefore, has happened. In every way in which it has been permitted to do so, Convocation, like the Senate, has expressed general approval of the Commissioners' proposals, and the University of London instead of being placed, by divided counsels, in a position deplorable to all friends of higher education in London, is now at the head of the movement for a University worthy of the greatest city of the world. Now that extensive approval of the Report by the great majority of the institutions concerned has satisfied the condition laid down by the Home Secretary as one to be complied with before action could be taken by the Government, it may be hoped that before Parliament is prorogued an Act appointing the Statutory Commission will be added to the legislative achievements of the Session.

W. Palmer Wynne.

THE OXFORD MEETING OF THE BRITISH ASSOCIATION.

Since the last account of the preparations for the meeting of the British Association on August 8 appeared in these columns, the local arrangements have made steady progress, and the arrangements for the Sectional and other meeting rooms are nearly complete. It may be well to explain that only a few of the Sectional meeting rooms can be darkened for the use of a lantern. It has been found impracticable to darken the large writing rooms in the Examination Schools in which Sections E and F will meet: and the same may be said of Hertford College Hall (Section C) and Keble College Hall (Section F). The Clarendon Laboratory Theatre (Section A), the Anatomical Theatre and Laboratory (Sections D and H), and the Physiology Theatre, are provided with dark blinds; and the large Lecture Theatre in the Museum will be available for meetings of Sections in which the lime-light is indispensable. The dates and hours at which this room will be available must be settled by the Recorders of Sections during the meeting.

The arrangements for excursions in the neighbourhood are now complete. The list is not as long as has been the case in some recent meetings, as the localities of general interest which are accessible from Oxford are few in number. On the Saturday afternoon parties will be taken to Dorchester and Wallingford, to Abingdon, to Blenheim Palace and Woodstock, and to the Roman remains at Silchester, and Prof. Green will take a geological party through Fawler to the classical grounds of Stonesfield. On the Thursday, whole day excursions are arranged for Windsor and Eton, Warwick and Stratford-on-Avon, Compton Wynyates, Broughton and Wroxton, Reading, and the Great Western Railway Works at Swindon.

The total number of those who have up to the present signified their intention of attending the meeting amounts to a little over 1500. As the Sheldonian Theatre, on the most liberal estimate, will not accommodate more than 1800 persons, and as it is very probable that the number of applicants for places will be greater than this, members and associates are recommended to apply for places in the Theatre for the President's address and evening lectures as early as possible. The allotment of seats will begin on Monday, August 6.

Up to the time of writing, but little information has been received respecting the work of the various Sections. In Section D (Biology) the President, Prof. J. Bayley Balfour, will deal in his address with the aspects of forestry in Great Britain, and among other papers which will be read to the Section, Prof. Ray Lankester will make a communication on chlorophyll in the animal kingdom, Prof. A. A. W. Hubrecht will read a paper on the Didermic blastocyst, and Mr. J. T. Cunningham on the specific and generic characters of the Pleuronectidæ.

In Section E the President, Captain W. J. L. Wharton, R.N., will deal in his address with our present knowledge of the physical conditions of the sea. And among other papers which will be read at the meeting are the following:—Colonel Godwin Austen, on Bhotan; Mr. Osbert H. Howorth, on the Sierra Madre of Mexico; Miss Baildon, on a visit to New Guinea; Mr. D. G. Hogarth, on a recent journey in Asia Minor; Mr. W. H. Cozens Hardy, on Montenegro and Albania; Dr. H. Schlichter, on the natural wealth of British East Africa; Mr. G. G. Chisholm, on the orthography of Place-names; Mr. J. Theodore Bent, on Hadramut; Mr. A. Montefiore, on the equipment of the Jackson-Harmsworth Arctic Expedition; Mr. H. N. Dickson, on the physical condition of the North Sea; M. A. Delbecque, on the lakes of France, and Dr. H. R. Mill, on the geography of the English lakes. The proceedings of the other sections will be announced as soon as they are communicated.

THE BIOLOGICAL INSTITUTION IN BERGEN, NORWAY.

LAST autumn a biological institution was opened in Bergen. It forms part of the museum, the library and collection of which the students are at liberty to use.

The building is of wood, two storeys high. On the ground floor there is one large hall surrounded on three sides by aquaria, which are open to the public on payment of a small entrance fee. Then there is the pump-room, and other rooms, one of which is used for experiments in hatching, and in the others the collected matter is examined and studied, and the dredges and other instruments are kept. There are two hatching apparatus, each containing eight hatching-boxes. A hatching apparatus for fresh water is much required, so that the biological questions in connection with the salmon-fishing may be worked out.

Fig. 1 is the plan of the ground floor.

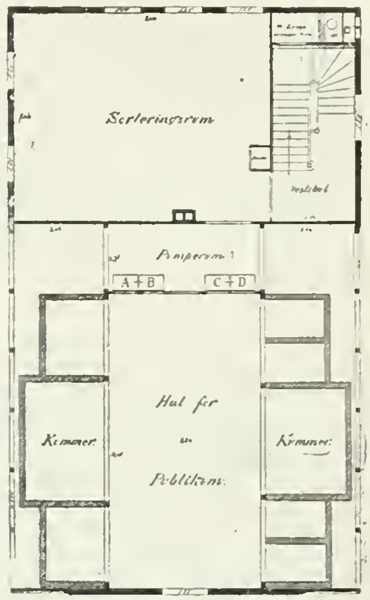


FIG. 1.—Ground floor

The first floor is set apart for scientific work, and consists of two large rooms, the smaller of which is used for chemical work, and is furnished with all necessary apparatus.

The larger room has four windows on each side; those on the east are separated by wooden partitions, curtained off from the rest of the room, thus forming four small work-rooms, each of which is furnished with a microscope and writing-table and other conveniences for the work of one person. In front of the windows on the west side, there are tables (L, M, N, O, Fig. 2).

Altogether ten work-tables are provided in the institute. In the middle of the larger room there is a long low sink (E, F, G, H, Fig. 2), which has a small channel in the middle connected with a waste-pipe. On each side of this sink, but raised slightly above it, there is a shelf running the whole length of it, and wide enough to hold the small experimental aquaria, which consist of glass bowls. Above the shelves are pipes from the sea-water reservoir, with numerous taps, thus supplying flowing water when necessary.

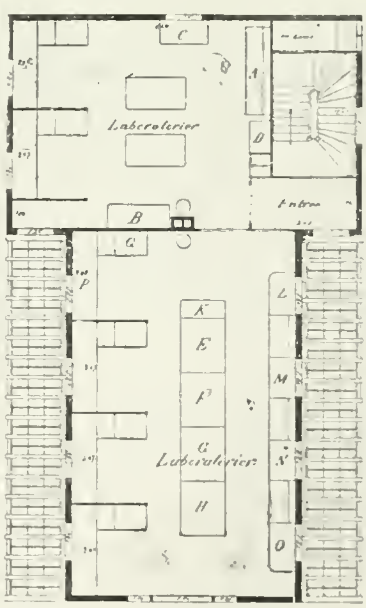


FIG. 2.—First floor.

The sea-water supply is conveyed to the pump-room by means of a long pipe from the middle of the Paddefjords, at a depth of ten metres; from here it is pumped up to the reservoir, which is on the top storey, whence it supplies the laboratories.

The fauna is very rich; the flora has not yet been much studied.

The biological institution is for foreign as well as Norwegian students. The monthly cost for the use of one of the work-tables is twenty-five kronen. This includes the necessary reagents, the free use of all the apparatus and the museum, also the use of the boat, with the men, for private explorations, and liberty to take part in the weekly steamer excursions to the distant parts of the fjords.

The institution is open every day all the year round; the fjords are never quite frozen, and at the coldest time the temperature is never more than a few degrees from zero.

The institution is under the supervision of Herren Dr. A. Appellöf, G. A. Hansen, and T. Brunchorst. It is almost entirely supported by voluntary contributions. A certain sum, however, is granted by the State, which unfortunately is not sufficient to permit the institution to have a resident zoologist; but as the Norwegian Government is always so liberal in matters of a scientific nature, it is hoped that the required amount will soon be granted.

PROFESSOR DR. FISCHER.

By the death of Prof. Dr. Fischer, which took place on May 17 last, the Königliche Preussische Geodätische Institut and the Central-bureau der Internationalen Erdmessung lose a very ardent and devoted chief who has done much, not only to keep up the high standard of these institutions, but to bring them, if possible, to a higher grade of perfection.

Born in the year 1836, on December 10, at Deutsch-Leippe, near Grottkau, in Schlesien. Amand Fischer began his first studies at the Mathias-Gymnasium in Breslau, occupying his attention, among other things, with mathematics and science (*Astr. Nach* Bd. 135, No 3235); he graduated in 1866, the subject of his dissertation being the Comet III. of 1860. In the following year he entered in the Central-bureau der Mitteleuropäischen Gradmessung, and two years later in the Königliche Preussische Geodätische Institut, in which he commenced his great activity, which he continued up to the end. From July 1877 he conducted the sections relating to Geodesy.

Among the numerous valuable works brought before the public will be remembered the "Rheinische Dreiecksnetz," in which were a great number of Fischer's measurements, made at the majority of the stations employed. He found occasion also to busy himself with lateral refraction, and he made an interesting contribution on "Lothabweichungen in der Umgebung von Berlin" (1889), which was valuable in the discussion regarding the relation between Geodesy and Geology.

At a somewhat earlier date, in an article that appeared in the *Astr. Nach.* (Bd. 88), entitled "Die Gestalt der Erde und die Pendelmessungen," he brought forward the interesting deduction that the variation, which Ph. Fischer had calculated from the measures of gravity, could be traced back to geological causes, a deduction which agrees very nearly with our present ideas.

The publication of the "Berliner Basisnetzes" (1891) absorbed a great amount of his activity, as he paid special attention to this piece of work. In the measurements made in the Strehlen, Berlin, and Bonn base-lines operations, he took, finally in the capacity of director, a prominent part. We have to thank him, also, for some important thermoelectrical researches on the expansion of the rods used for base-line determinations. (*Astr. Nach.* Bd. 103.) He determined, also, the difference of longitude between Wangeroog and Schillig by means of optical signals, during the time of the operations on the trigonometrical survey of the North Sea islands and the mainland, with the computation of which he busied himself.

We are indebted to him for a great number of astronomical observations made at several stations for the trigonometrical work in which he was employed.

In order to get some idea of his dexterity and care, and more especially of his love for work and his self-sacrifice, one must not only look at the literary side of Fischer's activity, but at that in which his capacity as an observer was a very prominent feature.

Besides a host of numerous friends who mourn his loss, he leaves behind a widow and three children.

NOTES.

The subjects for 1895 for the results of original research, upon which the Royal Society of New South Wales offer their medal and £25, are as follows:—(1) On the Silver Ore Deposits of New South Wales. (2) On the Physiological Action of the Poison of any Australian Snake, Spider, or Tick. (3) On the Chemistry of the Australian Gums and Resins. The communications are to be sent in not later than May 1, 1895. The subjects for 1896 are also announced as follows:—(1) On the Origin of Multiple Hydatids in Man. (2) On the Occurrence of Precious Stones in New South Wales, with a description of the deposits in which they are found. (3) On the Effect of the Australian Climate on the Physical Development of the Australian-born Population. The Society emphasise the condition that the award will not be made for a mere compilation, however meritorious it may be.

The Council of the Royal Society of New South Wales have awarded the prize given by the Hon. Ralph Abercrombie for the best essay on "Southerly Bursters" on the east coast of Australia, to Mr. Henry A. Hunt, second meteorological assistant in the observatory at Sydney. The essay contains the results obtained from a study of all the bursters that visited the east coast from 1863 to 1893, and is illustrated by weather charts, cloud photographs, and diagrams showing the monthly and hourly distribution of these wind storms, as well as diagrams showing instrumental conditions in typical cases.

Manuscripts competing for the De Candolle Prize for 1895, offered by the Geneva Physical and Natural History Society, for the best unpublished monograph of a genus or family of plants, must be sent in by January 15, 1895. They may be written in Latin, French, German, English, or Italian. The value of the prize is 500 francs.

Liverpool is fortunate in having citizens who testify their interest in the scientific welfare of the city by munificent generosity. We have previously noted the endowments, by the Earl of Derby and Mr. George Holt, of chairs in anatomy and pathology at the University College, Liverpool. We now learn, from the *British Medical Journal*, that the Rev. S. A. Thompson Yates has presented the College with the sum of £15,000 in order to build physiological and pathological laboratories.

The Danish Government has undertaken, during the years 1895 and 1896, a deep-sea exploration in the Greenland and Icelandic waters. The expedition will be accompanied by a botanist.

One of the last acts of the late President Carnot, a few hours before his assassination, was to confer on the well-known botanist Dr. Saint-Lager the dignity of Officer of Public Instruction.

Dr. V. Schiffner has sent to the Botanical Institute of the German University of Prag a very large collection of dried plants and spirit-material from Western Java. He is intending also to visit Eastern Java and Sumatra.

The antiquities, ranging from prehistoric down to Roman times, lately discovered by Prof. Flinders Petrie in the temple of Koptos in Upper Egypt, will be exhibited to the public in the Edwards Library, University College, Gower Street, from July 23 to September 1.

THE death is announced of Dr. Adolph Hannover, at Copenhagen, at eighty years of age, and of Dr. J. Hyrtl, of Vienna University, at the age of eighty-four.

THE first annual meeting of the Australasian Institute of Mining Engineers, recently held at Ballarat, Victoria, appears to have been a very successful one. The inaugural meeting of the Institute was held last year at Adelaide, when Sir Henry Ayres, the President of the Legislative Council of South Australia, was chosen as its first president. Among the speeches delivered at that time was a very pointed one by the Hon. James Martin, the head of the engineering firm bearing that name. In the course of his remarks he said: "Science is much needed in mining, for without it mining cannot go along. We have been blundering too much by rule of thumb, which has done much to injure the mining industry and those who are willing to take some risks in mining. It has been the want of knowledge of the men who have been placed as mining managers that has ruined so many concerns. We want to bring science, experience, and knowledge to bear upon mining, so that we will be able to bring wealth from the earth without a waste of labour." Mr. James Stirling, the present president of the Institute, took the "Mineral Wealth of the Colony of Victoria" as the subject of his address at the Ballarat meeting. A variety of papers on mining topics were read and discussed, and visits were made to a number of mines and engineering works. The Institute has accepted an invitation from the Premier of Tasmania to hold the annual meeting in Hobart, Tasmania, next year, at which time the mining exhibition will be open.

UNDER the conductorship of Major Lamorock Flower, a meeting of the Essex Field Club was held last Saturday on the River Lea, the Conservancy Board having placed their steam-barge at the disposal of the club for the occasion. About sixty members embarked at Hertford and steamed down the river as far as Tottenham. Many well-known scientific men were present and gave addresses during the course of the day. Major Flower, after welcoming the party on behalf of the Conservancy Board (to which he is sanitary engineer), gave an account of the river and of his own work in connection with the improvement in its condition. After lunch at Broxbourne, Mr. J. E. Harting read a short paper on Izaak Walton's association with the river, and exhibited a most interesting set of prints in illustration of his remarks. Mr. G. J. Symons, F.R.S., later in the day, gave an account of the watershed, and explained the connection between the rainfall and the water supplied to the river. Mr. Howard Saunders followed with an address on the birds of the Lea Valley, and Mr. T. V. Holmes concluded with a paper on the geology of the district, explaining how the river had in the course of time shifted its bed generally in an easterly direction, leaving gravel deposits to the west often a mile or more from the present stream. As the result of a most enjoyable meeting, it was generally conceded that the river above the intake of the East London Waterworks Company at Ponder's End was in a very good condition, but great regret was expressed at the accumulation of heaps of the most evil-smelling garbage which here and there greeted the party on their way down. This refuse, as Major Flower explained, is brought from London in barges, and is heaped by the river banks under certain legal powers permitted by an Act of Parliament passed in 1868, and which the Conservancy Board has therefore at present no power of preventing; but it is to be hoped that the general advance of sanitary science will soon be such that public opinion will lead to legal restrictions as to the placing of decomposing refuse on the banks of any stream of which the water is used for human consumption.

ACCORDING to press telegrams, the cholera epidemic which has recently appeared at St. Petersburg is assuming an alarming character, being much more severe than that of last year. It is officially reported that 875 cases of cholera, and 294 deaths have occurred in St. Petersburg alone from the 8th inst. up to Saturday last. In Cronstadt, also, the disease has become epidemic, and other parts of Russia are seriously affected. A number of deaths from cholera are reported from the province of Galicia, in Austria-Hungary. Zaleszczki, in Galicia, has been declared to be a centre of the epidemic, and the necessary precautions have been taken to prevent communication with the infected district. Cases of cholera have also occurred in Sparta, near Adalia, Asia Minor, in the Prussian part of the Vistula, and at Liège and several surrounding villages, and an isolated case with choleraic symptoms has been notified at Paris.

FURTHER particulars with regard to the earthquake in Turkey last week show that it was of a very serious nature. No official return of the real number of victims has yet been published, but Reuter reports that the death-roll in Stamboul alone is known to exceed two hundred. According to Press telegrams, the damage to property in Constantinople is estimated to amount to £T6,000,000. There is scarcely a street in that city which does not show signs of the destructive effects of the earthquake, many of the old Turkish houses in Stamboul and the suburbs having been completely wrecked. The Grand Bazaar suffered severely. The vaulted roof of the jewellers' arcade fell in, causing a scene of great panic and confusion. Reuter's telegrams state that, at Prinkipo, the Greek Orthodox Church and a large number of houses were destroyed or seriously damaged. On the island of Halki nearly all the houses have been rendered uninhabitable. A portion of the Great Ottoman Naval College also collapsed, six students being killed and several injured. On the island of Antigoni not a house has been left intact, with the exception of the monasteries. At Pera four houses fell in, and many were damaged, the number of victims being five. The village of Galateria, near St. Stephano, has been completely destroyed. The shock was felt in the interior of Anatolia at a distance of 236 miles from Constantinople. Nearly all the railway stations have been damaged, and the town of Jalova, in the Gulf of Ismidt, has been almost totally destroyed. During the first shock at the island of Halki and the village of St. Stephano the sea retired over 200 yards, leaving many boats and vessels high and dry. The waters then returned with such force and violence that they overflowed the quay, hurling the boats on to the shore far above sea-level, and causing great damage. It is reported that shocks continue to be felt at intervals, but the movements of the ground are barely perceptible. The point from which the surface disturbances proceeded is said to be in the Sea of Marmora, somewhere between Jolava on the Asiatic side, and Stephano on the European side.

A PRIVATE telegram to the Royal Geographical Society has brought bad news of the Wellman polar expedition, the departure of which for Spitzbergen was noticed in NATURE, vol. l. p. 57. The steam-yacht *Saide*, belonging to Captain Townley-Parker, of the Royal Yacht Squadron, called at Danes Island, in the north-east of Spitzbergen, on July 6, and found the geologist of Mr. Wellman's party, Mr. Oyen, alone in charge of the house and stores. The expedition had reached Danes Island safely on May 7, and after landing Mr. Oyen, set out for Seven Islands on the 10th, promising to send back the steamer for Mr. Oyen in a week's time; but she had never returned. The *Saide* at once attempted to go in search of the missing vessel, but was stopped by ice off Hakluyts Head in 80° 10′ N., and compelled to return. No trace of the ship had been seen by the Norwegian walrus-hunters who are cruising off Spitzbergen, and the inevitable conclusion is that she has been beset by the ice and probably foundered. It is hoped that Mr. Wellman and his party of fifteen men had left the vessel and started on their northward journey before this happened; and if that be so, there is no reason why they should not return safely to Danes Island. Spitzbergen is now visited so frequently during the summer months, that little anxiety need be felt as to their return to civilisation should they be able to regain the island; but since the provisions in store are only sufficient to supply eight men for six months, it is important that additional supplies should be sent to provide for emergencies.

We have received from Prof. Guido Cora a copy of a short paper communicated by him to the Italian Geographical Congress of 1892, in which he strongly urges the importance of a more complete and detailed study of the minute geography of Italy, proposing the formation of a special committee to elaborate and carry out the scheme. It is a subject no less pressing in England than in Italy, for to a properly qualified geographer there is no part of the world riper for investigation and more deserving of study than those countries of Europe in which the ground for a solid constructive geography has been laid by complete topographical and geological surveys.

The State of Minas Geraes in Brazil has recently established a Geographical and Geological Commission, entrusted with the rectification of the topographical map and with the geological survey of the State. The first *Boletim* of this Commission has just been published at Rio de Janeiro by Señor A. de Abreu Lacerda, chief engineer. It contains an account of the objects of the Commission, which are to delimit the State and lay down the boundaries of the subordinate political divisions, to determine the nature of the rocks, minerals, and cultivable soils, to fix the altitudes of important places, and to make a triangulation of the State. The work is modelled on that of the United States Coast and Geodetic and Geological Surveys, and there are several Americans engaged on the operations.

The lectures to intending travellers on various aspects of science, given at the Natural History Museum in Paris, continue, and are reported fully in the *Revue Scientifique*. The most recent were on Palæontology, by M. Marcellin Boule, and on "Metrophotography" by M. Laussedat. The latter is particularly interesting, and shows that the use of photography in surveying is a natural development of a method which Beautemps-Beaupré introduced more than fifty years ago. He utilised panoramas sketched by means of a camera lucida at opposite ends of a measured base-line, and by an ingenious arrangement of the two views on a plane-table plotted the map without any calculations. In this method photography simply facilitates the production of the pictures, the rest of the process remaining the same. The calculation of vertical heights from the photographs is simple when the correct relative distances of the objects are laid down on a map, and thus the simple operation of taking a photograph of the same object from two points suffices for the construction at any future time of a contoured map.

From a circular received from Prof. Dr. Coloman Muller, we note that the preliminary arrangements of the Eighth International Congress of Hygiene and Demography, to be held at Budapest from September 1 to 9, 1894, are nearly completed. The Congress promises not only to be a worthy successor of its predecessors, but also to be in some respects superior to them. Up to the present time a total of 725 papers have been notified, of which 593 belong to the Hygienic, and 132 to the Demographic groups of the Congress. Besides this, 26 Governments with 92 delegates, 91 Public Corporations with 163 delegates, 41 Universities with 65 delegates, and last, but not least, 132 learned Societies with 300 delegates, have expressed their intention of being represented at the Congress. The following are among the subjects of promised communications:—Mr. Ernest Hart, on protection against cholera in the Orient, and the hypothesis of its epidemic diffusion; Prof. Dr. E. Leyden (Berlin), on provisions made by large towns for consumptives; Prof. Dr. George Mayr (Strassburg), on statistics and social science; Baurath Herzberg, C.E. (Berlin), the civil engineer's work in hygiene; Prof. E. Levasseur (Paris), the history of Demography; Prof. Dr. E. T. Erisman (Moscow), the struggle with death; Prof. Dr. C. Lombroso (Turin), the criminal.

The Congress of the British Institute of Public Health, to be held in London from July 25 to 31, under the presidency of Prof. W. R. Smith, promises to be an important one. About 1500 delegates have already been appointed, and if two-thirds of the number attend the meetings the organisers at King's College will have a difficulty in accommodating them. The Congress will be divided into five sections as follows:—(A) Preventive Medicine; (B) Chemistry and Climatology; (C) Municipal and Parliamentary; (D) Engineering and Building Construction; (E) Naval and Military Hygiene. Among the subjects which will be brought up for discussion in the first section are:—The mode of spread and methods of prevention of diphtheria; the dissemination of disease by river-water; the self-purification of rivers; and the alleged aerial diffusion of smallpox. In the second section the subjects for discussion include the chemical and bacteriological examination of water; the purification of sewage; and the micro-organisms in sewer air. In Section D discussions have been arranged on electric lighting from the point of view of public health; on a system of softening public water supplies; sewage disposal; and other matters. There will be conferences on "The Housing of the Working Classes" and "The Provision of Isolation Hospitals," and on Saturday, the 28th inst., Prof. E. M. Crookshank will deliver a popular lecture on "Microbes and the Spread of Infectious Diseases." A number of visits will be made to places and institutions of interest from a public health point of view.

In a memorandum on the mitigation and prevention of insect ravages in India, forwarded a short time ago to the Department of Revenue and Agriculture of the Government of India, the Hon. J. Buckingham, C.I.E., pointed out the necessity for a staff of entomologists, and suggested a scheme for the organisation of an entomological department. Though crops to the value of millions of rupees are destroyed annually in India by insect pests, the Government had not until recently seriously set to work to modify these ravages. In the United States, as also in Canada and parts of Australia, the Government has taken up the matter, with the result of the introduction of new methods of treatment which in some cases have effected an enormous saving. The memorandum calls attention to the fact that in the United States, besides entomological advisers attached to individual States, a strong section of entomology is kept up as a branch of the Agricultural Department of the Central Government. Attached to the entomological section are some fourteen trained entomologists, who visit all parts of the country in order to study and report upon destructive insects. The great importance of collecting information personally upon the spot is so fully recognised that the travels of the investigators are not confined to the limits of the United States, but representatives are even occasionally despatched to distant parts of the world. At the time when the memorandum was drawn up, however, all that had been done was to empower one of the officers of the Indian Museum in Calcutta to report upon insects which were submitted by planters, officials, and others, and to publish the results. Doubtless in this way a considerable amount of information has been collected, and the nature of a large number of the more destructive species of blights have been ascertained; but, as the memorandum urged, what was wanted was a specialist free to move about the country, and supported by laboratory assistants in some fixed place. To render the work of practical value, it is essential that it should be carried on continuously from year to year, so that the observations made in one season may be supplemented and verified by those made in the next, and that a record may be kept up of the increase or decrease of particular blights, so that the planting and agricultural community may be warned in time of impending danger. For the sake of Indian agriculture, we are glad to see that the scheme put forward by the Hon. J. Buckingham has been favourably considered. The Government of India has expressed a readiness to appoint two or three entomologists for the benefit of agriculturists throughout the country. It is not, of course, supposed that the appointment of this small staff of entomologists will result in the suppression of every destructive insect; but there can be no doubt that careful local investigations would, in many cases, lead to the development of improved methods of fighting the evil. In connection with the subject of the memorandum, it is worth remark that the Planters' Association of Ceylon have recently made the modest request for one entomologist to study the insects which attack tea and other plants under cultivation there. Dr. Trimen, of the Royal Botanic Gardens, Peradeniya, has, however, informed the Colonial Secretary at Colombo that, while he would support the appointment of an entomological assistant for the Colombo Museum, who would pay special attention to injurious insects, he could not recommend the appointment of an entomologist for the agricultural community alone. Mr. A. Haly, the Director of the Museum, also thinks that a special officer is not needed for the small area covered by Ceylon, and suggests that the case would be fully met by the appointment of an entomological referee.

THE *Illini* informs us of the establishment on the Illinois River, at Havana, of a biological station devoted to the systematic and continuous investigation of the plant and animal life of the waters of that region. This establishment, authorised by the trustees of the University in March, is under the direction of Prof. S. A. Forbes, with Mr. Frank Smith in immediate charge of the work. The field work is done from a cabin boat, chartered for the summer, which carries the seines, dredges, surface nets, plankton apparatus, and other collecting equipment, together with microscopes, reagents for the preservation of specimens, a small working library, a number of special breeding cages for aquatic insects, and a few aquaria. This boat is provided with sleeping accommodation for four men, and with a well-furnished kitchen. In Havana itself are office and laboratory rooms supplied with running water and electric light, and provided with the usual equipment of a biological laboratory, consisting of first-class microscopes, microtomes, biological reagents, &c., and tables for five assistants. The boat is established in Quiver Lake, an elongated bay of the Illinois, two and a half miles above Havana. From the lake and the river, selection has been made of a number of typical situations, and from these, and from Phelps and Thompson lakes, a little distance away, collections of all descriptions are made at regular intervals for a comparative study of the organic life—the relative abundance of the species at different seasons of the year, and the general system of conditions by which it is affected. We understand that this is the first inland aquatic biological station in America manned and equipped for continuous investigation; and the first in the world to undertake the serious study of the biology of a river system.

WE learn from the *Lancet* that an admirably appointed biological station, modelled upon that at Naples, has just been opened at Dröbatt, on the Christiania Fiord, not far from Christiania. It is said that the international element so wisely encouraged in the Neapolitan institution, by which, in return for an annual subsidy, the universities of the world are entitled to avail themselves of its facilities, will also be recognised at the Norwegian station.

THE report for 1893 of Dr. S. Schönland, the Curator of the Albany Museum, Grahamstown, to the Committee of the museum, has been issued. We learn from it that the institution has largely increased in popularity, the number of visitors having been over 22,000, or more than 2000 in excess of those of 1892. Its value as an educational institution has also been widely appreciated. The Committee dwells on the necessity of the appointment of an assistant who would take over the Entomological Department, the work having become too great for the Curator. It is also urged that, as the grant hitherto accorded to the institution by Parliament is insufficient, even with the greatest economy, to meet urgent requirements, a suitable increase will be made. As many as 7660 specimens were added to the collection in the museum during 1893, all of them being of South African origin.

THE changes of plumage in the Red Grouse (*Lagopus mutus*) have long attracted the attention of ornithologists. Mr. W. R. Ogilvie-Grant gives, in *The Annals of Scottish Natural History* for July, an interesting account of these changes, the nature of which he has described in vol. xxii. of the Catalogue of the birds in the British Museum. In that publication it was conclusively shown that both the male and female of the Red Grouse have two distinct moults during the year, but whereas in the male they occur in autumn and winter, in the female they take place in spring and autumn; the former having no distinct spring, and the latter no distinct winter, plumage. These seasonal variations are clearly explained in the paper referred to, and the principal changes, moults, and varieties are illustrated in two beautifully coloured plates, the feathers of each sex being shown separately.

DR. R. HANITSCH, of Liverpool, has done a most useful and, we need scarcely say, laborious piece of work in his revision of the generic nomenclature and classification in Bowerbank's "British Spongiadæ" (Trans. Liv. Biol. Soc., viii. 1894, pp. 173–206). His paper consists of two parts, dealing with the nomenclature and classification respectively. In the first section are given parallel columns of Bowerbank's and the revised nomenclature; and in the second a list of the British sponges described by Bowerbank, classified in accordance with recent research. Definitions of all British genera of Monaxonida are given. *Lissomyxilla*, for the reception of Bowerbank's *Tethea spinosa*, is new. For the most part, however, the author's arrangement is compiled from the revisions and work of Ridley and Dendy, Sollas, Topsent, Von Lendenfeld and Vosmaer.

A NEW form of phonograph of a particularly simple construction has been described before the Electro-chemical Society of Berlin by Herr A. Kœltzow. In this instrument, which in consideration of its low price appears suited to many purposes, at any rate in those countries where patent rights will not prevent its introduction, the cylinder on which the record is made is composed of a hard kind of soap. Each cylinder, which costs about three shillings, admits of being used for recording 250,000 words, since an arrangement allows of the removal of a very thin layer from the surface when this has been covered. Thus the cost of the cylinders for registering any number of words is not more than the cost of the paper which would be required if they were written down.

The village of Gossau, situated about ten kilometres from St. Gall in Switzerland, was recently the scene of a curious electrical phenomenon. This village is lighted by a supply station situated at a distance of twelve kilometres, which supplies the current at high tension to transformers at the village. During a thunderstorm, which lasted several hours, the supply wires were struck by lightning, all the electric lamps being extinguished, while bright sparks passing between the aërial wires lighted up the whole village. These phenomena were particularly brilliant at the chief transformer sub-station, where the sparks continued to pass for more than an hour, and only stopped when the circuit was broken at the generator station.

The current number of *Science Progress* contains a paper by Mr. Chree, the Superintendent of the Kew Observatory. In this paper, which is entitled "The most recent Values of the Magnetic Elements at the Principal Magnetic Observatories of the World," the author points out the importance of the continuous records of the different magnetic elements made at some of the observatories, both for the purpose of applying the correction for secular change to the charts and maps used by travellers by land and sea, and for allowing observers engaged on a magnetic survey to correct their observed results by allowing for any disturbance of the observed element from its mean value at the moment at which the observation was made. The possibility of making this correction depends on the fact that the diurnal change as well as the small irregular disturbances occur simultaneously, and similarly over considerable tracts of country. This fact is very markedly shown by superposing the photographic traces obtained at Kew and Falmouth, when it will be found that every little undulation is faithfully reproduced. The paper also contains a "popular" account of the different observations made, and the methods by which the photographic curves are obtained and the results reduced. A most useful table of the magnetic elements at the different observatories, which we see from an editorial note is to be continued from year to year, is appended. This table contains besides the latitude and longitude of the observatory, the mean declination, dip, horizontal force and vertical force for the last year for which data are available. A very useful addition to the table would be four additional columns giving, where possible, the secular change.

We have received from T. Homén, of the University of Helsingfors, a work entitled *Bodenphysikalische und meteorologische Beobachtungen*, which has been carefully compiled from all available sources, and also from a long series of observations made by the author, with especial reference to night frosts and their effect upon vegetation in the spring and autumn. The observations and conclusions refer more particularly to northern Europe, but will be found of practical use to agriculturists generally. The work is divided into six sections; the first three deal with the temperature and the conductivity of the earth's surface, and at various depths, with different kinds of soil, with the formation of dew, and with evaporation, while the last three chapters deal with the phenomena of night frosts, the methods of their prediction, and a discussion of the various means which may be adopted to prevent or lessen their injury to vegetation. The chapter relating to the conditions under which frosts usually occur is instructive, and shows that they chiefly depend upon the tracks taken by barometric depressions, the positions of areas of high barometer, and on the amount of the radiation from the surface of the earth. The method sometimes adopted of predicting frost from the position of the dew-point in the evening is shown to be very unsafe, especially for ground temperatures. The protection caused by burning wet straw or moss, and so preventing radiation by means of smoke, is fully discussed; but the plan is not likely to come into general use, owing to the large area over which fires have to be lighted, and the probability of the smoke being drifted away by currents of air. The experiments have been made at a considerable cost of labour and money, part of the necessary funds having been contributed by the authorities of the University.

A paper on the "Geology of Torres Straits," from the combined points of view of Profs. A. C. Haddon, W. J. Sollas, F.R.S., and G. A. J. Cole, was read before the Royal Irish Academy two years ago, and has just been published in the Society's *Transactions* (vol. xxx. part XI.). This is the first time that any detailed description has been given of the islands between Queensland and New Guinea. One of the chief conclusions arrived at, from a close study, is that no recent movements of elevation of the shores of Torres Straits have taken place. "As our knowledge grows" (the authors state) "we the more distinctly see in Australia and its islands the ruins of a great southern continent, fractured and submerged, possibly during the great Alpine Himalayan revolutions, and now in process of resurgence, as the vast folds of the earth's crust roll slowly inwards upon the central continental mass."

A copy of Dr. Sykes' report on the cause of the increase of mortality from diphtheria in London, prepared at the instance of the Health Department of the Vestry of St. Pancras, has been sent to us. Dr. Thorne Thorne, who has also drawn up a report on the same subject, concludes that increased school attendance has had a material influence in increasing the spread of diphtheria, and Dr. Sykes regards this conclusion as irresistible. Again, the increase in cases described as diphtheritic may be also due to variation in nomenclature, most forms of infectious sore-throat being now regarded as diphtheria, whereas formerly the term was restricted to typical cases. Dr. Sykes is, however, also of opinion that the variation in nomenclature may very possibly be due to a change of type in disease of the throat, brought about by increased density of population in our great towns, and the effects of increased personal infection consequent upon the greater aggregation in schools. But does this explain why London should be singled out from all our great cities for such a disastrous epidemic of diphtheria as has unfortunately prevailed over such a long and continuous period? Why should not these causes apply with equal force to Glasgow, Manchester, Birmingham, or any of our great centres of industry?

Frank, and afterwards Schloesing and Laurent, showed that soil containing bacteria and algæ can fix free nitrogen in large quantities; their experiments, however, did not decide whether algæ alone are capable of doing this. In order to answer this question Kossowitsch has estimated (*Botanische Zeitung*, May 16, 1894) the amount of nitrogen present in a nutritive soil before and after the growth of pure cultures of two kinds of algæ, *Cystococcus* and *Stichococcus*. In neither case was any sensible increase of nitrogen detected; so that it appears that neither of these algæ alone have the power of fixing free nitrogen. *Cystococcus*, even when mixed with pure cultures of the bacteria which enable the Leguminosæ to assimilate free nitrogen, was found powerless in this direction; whereas a mixture of soil-bacteria and *Cystococcus*, which also contained a small amount of other algæ, had the power of fixing free nitrogen to a large extent. The same author also describes a number of experiments with heterogeneous mixtures of algæ and bacteria, and shows how in each case the capability of fixing free nitrogen is greatly increased by the addition of dextrose to the nutritive substratum. From this and also from the fact that such mixtures of algæ and bacteria which are capable of fixing free nitrogen when exposed to light cannot be shown to assimilate it in the dark, he concludes that although in no case has it been proved that algæ by themselves possess the power of fixing free nitrogen, yet they are in a symbiotic relationship with the nitrogen-fixing bacteria, and he regards it as probable that these latter draw on the assimilation-products of the algæ to supply the carbon they require in growth.

MR. BERNARD QUARITCH, Piccadilly, has issued a new list (No. 143) of the old and valuable books he has for sale. The list contains a number of rare books of travel, and many important works on botany, entomology, and ornithology.

MESSRS. HENRY SOTHERAN AND CO. will shortly issue a second and cheaper edition of Mr. J. G. Millais' "Game Birds, and Shooting Sketches," with illustrations by the author, and a frontispiece by Sir J. E. Millais, Bart.

WE have received a copy of "Bourne's Handy Assurance Manual" for 1894, now edited by Mr. William Schooling. The volume differs from its predecessors in several important respects, and some of the tables in it may be found useful to students of demography.

THE first volume of "The Royal Natural History," edited by Mr. Richard Lydekker, F.R.S., has been published by Messrs. Frederick Warne and Co. It is illustrated with numerous coloured plates and engravings, and forms a desirable addition to any library. We look forward with pleasure to the publication of the remaining volumes of Mr. Lydekker's important work, a work that possesses scientific interest and has a high educational value.

THE frontispiece of the July number of the *Monist* is a portrait of the late Dr. Romanes. Accompanying it and a short obituary notice, are two stanzas from a memorial poem addressed by the deceased investigator to Charles Darwin, and embodied in a volume printed for private circulation. The number also contains, among other matter, a paper entitled "The Non-Euclidean Geometry Inevitable," by Prof. G. B. Halsted; one on "Leonardo da Vinci as a Pioneer in Science," by Mr. W. R. Thayer; and another on "Monism in Arithmetic," by Prof. Hermann Schubert.

IN the *Journal of Botany* for July is "A Tentative List of British *Hieracia*," which affords a remarkable instance of the tendency to "splitting" displayed by botanists who devote themselves to monographing genera or families. Hooker's "Student's Flora" enumerates 10 British species of *Hieracium*, the eighth edition of Babington's "Manual" 33. The present list comprises no less than 103 specific names, besides varieties. Of these species 36 are attributed to two English botanists who have made the genus their special study, Mr. W. R. Linton and Mr. F. J. Hanbury.

AS in previous years, the *Photographic Annual* for 1894, edited by Mr. Henry Sturmey, contains a number of excellent pictures illustrating various systems of photographic and photo-mechanical reproduction. Some of these illustrations are extremely fine. We are specially interested in four figures reproduced from photographs of microscopic objects, obtained by Mr. Frederick Iles in a novel manner. By a method of stereoscopic illumination, not described, he has procured "stereo-micrographs" showing objects in beautiful relief, and which greatly disparage pictures obtained with ordinary illumination. Plant sections, medical sections, crystals, and other translucent objects are found by Mr. Iles to furnish good results. Judging from the photographs reproduced, the method may have important scientific applications. The text of the *Annual* includes records of the progress, during 1893, of photographic chemistry, by Mr. C. H. Bothamley; photographic optics, by Mr. Chapman Jones; and an admirable summary of work in astronomical photography, by Mr. Albert Taylor. The *Annual* also contains the usual complement of articles on practical photography, and information on recent novelties in photographic apparatus, appliances, and processes.

THE first edition of the late Sir Andrew Ramsay's well-known "Physical Geology and Geography of Great Britain" (Edward Stanford) appeared in 1863. Between then and 1878 five editions of the work were issued, and a sixth has just been published. This edition has been prepared by Mr. H. B. Woodward, and his "restoration" has been admirably done. It is a difficult task to enter thoroughly into the spirit in which an investigator like the late renowned geologist indites a book, but Mr. Woodward has allowed his personality to merge into that of the lamented author, and the result is that the work begins a new life in all its original freshness and vigour. More than thirty years ago, Sir Andrew delivered the lectures out of which the book has grown. The object of the course was "to show how simple the geological structure of Great Britain is in its larger features, and how easily that structure may be explained to, and understood by, persons who are not practised geologists." Some of the author's theoretical views have been called into question, but others have served to establish his perspicuity on geological matters. Throughout the book, however, controversial subjects are fairly treated in the light of latter-day evidence. The part in which the greatest changes have been necessary is that referring to Archæan rocks. Considerable changes had to be made in order to bring this section of the book into touch with current opinion. Not only have such necessary emendations been made, but most of the more or less uninteresting details inserted in the fifth edition have been omitted or condensed. Where the author's theories have been entirely controverted, the accepted views have been substituted for them, but opinions still *sub judice* have been left in their original form. Several changes have been made in the excellent little geological map which forms the frontispiece, especially in the northern part of Scotland. All the revision has been in the direction of improvement, and we have no doubt that numerous readers will appreciate the careful manner in which it has been done.

THE additions to the Zoological Society's Gardens during the past week include two Lesser White-nosed Monkeys (*Cercopithecus petaurista*, ♂ ♀), a Campbell's Monkey (*Cercopithecus campbelli*, ♀), a Brush-tailed Porcupine (*Atherura africana*) from West Africa, presented by Mr. W. H. Boyle; a Mona Monkey (*Cercopithecus mona*, ♂) from West Africa, presented by Mr. Charles Gardiner; two —— Tortoises (*Testudo*, sp. inc.) from the Aldabra Island, presented by Rear-Admiral W. R. Kennedy; a Crowned Lemur (*Lemur coronatus*, ♀) from Madagascar, deposited; an Eland (*Oreas canna*, ♂) from South Africa, a Livingston's Eland (*Oreas canna livingstonii*, ♀) from the Transvaal, two Short-toed Hedgehogs (*Erinaceus brachydactylus*) from Somaliland, purchased; a Thar (*Capra jemlaica*), a Japanese Deer (*Cervus sika*, ♀), a Wapiti Deer (*Cervus canadensis*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

VARIATIONS OF LATITUDE.—Since 1885, the fifteen polar stars of which the apparent places are given in the *Connaissance des Temps*, have been regularly observed at Lyons Observatory. The materials thus obtained are used by M. F. Gonnessiat, in the *Bulletin Astronomique* (vol. xi. June and July 1894), for an investigation of the variations of latitude. The calculations show that from one maximum to the next the mean interval is 1·185 years; while the mean interval between two successive minima comes out as 1·178 years. In round numbers, therefore, the variation has a period of 1·18 years, that is, 431 days, which agrees with that found by Mr. Chandler. The mean amplitude of the oscillation is 0"·44. As to the annual variation, M. Gonnessiat is inclined to think that it has no real existence. He points out that one batch of observations discussed by Mr. Chandler, was like those made at Lyons, and hence refraction and errors of delineation introduce apparent annual changes in the results. In the case of observations made in the prime vertical by Horrebow's method, it is argued that refraction would show itself in the results, not only by its effects on the zenith distance of the same star in the course of a year, but also on the same day, when the connection between the groups observed is established. It is further remarked that the intensity of gravity, which determines the phase of the annual term, is far from being constant at any single place, and that its variation with the longitude does not appear to have been established. For these reasons M. Gonnessiat holds that it is necessary to exercise "une certaine réserve à l'égard du second terme de la formule de M. Chandler."

PHOTOGRAPHS OF THE MOON.—At the meeting of the Paris Academy of Sciences on July 9, MM. Lœwy and Puiseux exhibited some marvellous photographs of the moon, obtained by means of the great *coudé* equatorial of the Paris Observatory. In the communication which accompanied the photographs, the advantages of multiplying good lunar photographs were pointed out, and the various methods employed in the work were passed in review. One of the enlargements on paper, shown to the Academy, represented the moon on a scale of 1·80 metres for its diameter, and five lunar pictures on glass were exhibited at the same time. Some years would be required to make a drawing showing all the details visible on one of the plates obtained with an exposure of about a second. The negatives are larger than those obtained with the Lick telescope, and they bear considerable magnification without loss of definition. But such negatives cannot always be obtained. MM. Lœwy and Puiseux say that, of fifty or sixty evenings employed in lunar photography, only four or five gave really first class results. A complete series of negatives, tracing the moon through its phases, has not yet been obtained at Paris, but what has been done has furnished material for experiments in making enlargements. This part of the work is really as important as that of taking the negatives. From the results, MM. Lœwy and Puiseux conclude that a complete lunar atlas of the dimensions proposed by Prof. S. P. Langley can be made by means of the great *coudé* telescope at the Paris Observatory without the expenditure of much time and work. A comparison of the enlargements with previous representations of the same regions shows that real progress has been made. Another great step in advance will have been made when all the phases of the moon have been reproduced photographically in pictures so clearly defined as those just obtained.

FURTHER CONCERNING THE NEW IODINE BASES.

A FURTHER contribution to the chemistry of their recently discovered iodonium bases, by Prof. Victor Meyer and Dr. Hartmann, will be found in the present issue of the *Berichte*. In their two former communications, an account of which will found in NATURE, vol. xlix. pp. 442 and 467, in addition to the free parent base $(C_6H_5)_2I.OH$, descriptions were given of the iodide $(C_6H_5)_2I.I$, the chloride $(C_6H_5)_2I.Cl$, the bromide $(C_6H_5)_2I.Br$, and the pyrochromate $[(C_6H_5)_2I]_2Cr_2O_7$. Several new salts are now described, most of which crystallise well, and several are endowed with properties of a particularly interesting character. The similarity to the salts of thallium becomes even more apparent as the reactions of the derivatives are elaborated. The hydroxide has already been shown to be an easily soluble and an alkaline substance; the carbonate is likewise soluble in water and exhibits an alkaline reaction, and the halogen compounds are similar in colour, solubility, and other physical properties to the corresponding thallium salts.

The *nitrate*, $(C_6H_5)_2I.NO_3$, is obtained as a white crystalline precipitate when a concentrated solution of the free base is neutralised with concentrated nitric acid. It is readily soluble in hot water, and crystallises on cooling in the form of small plates or under particular conditions of concentration in compact spear-like crystals. It melts at 153°–154° to a clear liquid which soon commences to decompose with evolution of gas. When larger quantities are heated they explode with some violence. The nitrate is also produced when the chloride is treated with fuming nitric acid; upon the addition of twice as much water and allowing the liquid to cool, well-formed crystals of the nitrate are deposited.

The *acid sulphate*, $(C_6H_5)_2I.HSO_4$, is produced in solution when a moderately concentrated solution of the base is feebly acidified with concentrated sulphuric acid. Upon evaporation to small bulk over a water-bath and allowing to cool the salt crystallises in compact aggregates. It is so largely soluble in water that it cannot be recrystallised from that liquid, and in order to free the salt from adhering sulphuric acid the crystals are dissolved in the minimum quantity of alcohol and a quantity of ether added, which precipitates the salt in clear colourless crystals. It reacts acid to litmus, and the crystals melt like those of the nitrate at 153°–154° to a clear liquid which decomposes at a higher temperature.

The *acetate*, $(C_6H_5)_2I.OC_2H_3O$, has been obtained under somewhat peculiar circumstances. It was shown in the previous communication that iodobenzene was attacked by caustic soda after agitation of the mixture for some little time, and that the solution, which contained the iodonium base, yielded a white precipitate with acetic acid. This precipitate consists of the impure acetate of the base. If the liquid is filtered immediately after the addition of the acetic acid, when it is quite warm (about 30°) owing to the heat of the reaction, the clear filtrate deposits crystals of the pure acetate, which melt with decomposition at 120°.

The *periodide*, $(C_6H_5)_2I.I.I_2$.—This interesting compound, analogous to the iodine addition products of the alkyl ammonium iodides, is obtained by mixing the iodide of the base with a little alcohol and triturating with an alcoholic solution of iodine. The combination occurs almost instantaneously with production of a brownish-red precipitate, which crystallises from alcohol in magnificent dark red, almost black, and exceptionally lustrous crystals which melt at 138°.

Double salts.—The chloride forms characteristic double salts with mercuric chloride, gold chloride, and platinic chloride. The mercuric chloride compound, $(C_6H_5)_2I.Cl.HgCl_2$, is obtained as a white precipitate upon the addition of corrosive sublimate solution to a solution of the chloride of the base. It crystallises from water in highly refractive colourless needles which melt at 172° with decomposition. The gold salt, $(C_6H_5)_2I.Cl.AuCl_3$, obtained by precipitation with gold chloride, crystallises from hot water in yellow needles melting at 134°–135° with decomposition. The platinochloride, $[(C_6H_5)_2I.Cl]_2PtCl_4$, is obtained by use of chloroplatinic acid as a flesh-coloured precipitate which is very difficultly soluble even in boiling water, and only crystallises from the solution in microscopic needles. Its melting point is 184°–185°, and decomposition occurs upon fusion.

Sulphides.—It was a point of considerable interest to ascertain whether the similarity of the iodonium bases to thallium would be carried as far as the formation of insoluble sulphides. This is indeed found to be the case, and the sulphides are in external appearance most remarkably similar to the freshly precipitated sulphides of lead, thallium, and antimony. When a solution of the free base is mixed with ammonium sulphide a bright orange-red precipitate, very similar to antimony sulphide, is produced. If the experiment is carried out with ice-cold solutions and the product is maintained at 0°, the precipitate is quite stable. If it is performed at the ordinary temperature, however, in a very short time the orange precipitate begins to hiss and seethe, white clouds of vapour are projected out of the liquid, and the solid precipitate rapidly changes to a mobile oil. Analyses and fractional distillations show that the solid orange precipitate is the trisulphide of the base

$$(C_6H_5)_2I.S.S.S.I(C_6H_5)_2,$$

and that this substance decomposes at the ordinary temperature into phenyltrisulphide and iodobenzene.

$$[(C_6H_5)_2I]_2S_3 = 2C_6H_5I + (C_6H_5)_2S_3.$$

The normal sulphide, $(C_6H_5)_2I.S.I(C_6H_5)_2$, has been obtained by the action of sodium sulphide, Na_2S, which precipitates it as a bright yellow precipitate. It rapidly changes at the ordinary temperature, in the same manner as the trisulphide, to a colourless oil consisting of iodobenzene and ordinary phenyl sulphide.

$$[(C_6H_5)_2I]_2S = 2C_6H_5I + (C_6H_5)_2S.$$

Reduction of the free base is brought about by the action of sodium amalgam in the cold, a molecule of the base decomposing into benzene, water, and hydriodic acid, which latter precipitates a second molecule of the base as the insoluble iodide.

$$2(C_6H_5)_2I . OH + 4H = (C_6H_5)_2I . I + 2C_6H_6 + 2H_2O.$$

The solution of the free base precipitates solutions of the salts of the heavy metals exactly like ammonia or the fixed alkaline hydrates.

The physiological action of the chloride of the base has been studied in detail by Dr. Gottlieb, of the Heidelberg Pharmakologisches Institut. The salt has been found to be very poisonous, and its mode of action upon the animal muscles, membranes and nerves, combines the characteristics of the action of lead and thallium salts with those of ammonia and the ammonium bases. A. E. TUTTON.

WOMEN AND SCIENCE.[1]

THIS little volume is to all intents and purposes a charming and eloquent appeal in support of the claims of women to effectual recognition in the scientific world. In reality it purposes only to give in brief outline the lives of half a dozen women who have rendered important service to mathematical science. But although brief the sketches are so clever that the various characters depicted could scarcely appear more living or real, whilst there is not a single dull sentence to be found in the book.

One of the most interesting of the short studies, because so closely connected with the present, is that of the gifted and fascinating Sophie Kowalevski, who only died three years ago, and who commenced her study of mathematics at the age of fourteen, and at eighteen married Kowalevski, "parce qu'il n'était permis qu'aux dames de suivre les Cours des Universités!" On the presentation of three original theses, the University of Gottingen hastened without further examination to confer the degree of Doctor of Philosophy upon her, and later in life she was appointed to a chair of mathematics in Stockholm. But Sophie Kowalevski was not only a gifted mathematician of whom Kronecker declared "l'histoire des mathématiques parlera comme d'une des plus rares investigatrices," but an accomplished *littérateure*, and the author of numerous books, one of which is entitled "Souvenirs sur George Eliot," whilst "Les Souvenirs d'enfance" is described as a fine bit of psychological study worthy of Tolstoi, or of the new "Immortal" Bourget.

The place of imagination in science, so forcibly insisted upon by Mr. Goschen some years ago in his rectorial address at Edinburgh, is beautifully put in a letter to a novelist friend astonished at her pursuing science and letters simultaneously. "People frequently regard mathematics as a dry and barren science. In reality the pursuit of mathematics demands a great deal of imagination, and one of the greatest mathematicians of our century said, with justice, that it is impossible to be a good mathematician without at the same time having a touch of the poet."

Some sixty or seventy years earlier we read of another highly gifted mathematician, Sophie Germain, who at the same time distinguished herself by her contributions to philosophy. M. Rebière tersely summarises her claims to distinction by thus closing his memoir: "Pour construire la tour Eiffel, les ingénieurs ont utilisé l'élasticité des métaux. On a inscrit sur la tour les noms de 72 savants; on a oublié celui d'une fille de génie, la théoricienne de l'élasticité!"

England is represented by Mrs. Somerville in a very bright and sympathetic little notice, whilst Italy sends her contribution in the shape of "la nobile fanciulla" Marie Agnesi, who Pope Benedict XIV. nominated Professor of Mathematics in the University of Bologna, writing—"It is not you who should thank us; on the contrary, it is we who owe all our thanks to you. From the most remote times Bologna has heard of people of your sex occupying its public chairs. It belongs to you to worthily perpetuate the tradition." In commenting upon this distinction M. Rebière cannot resist telling us of some of the numerous women who have at various times held professorial appointments at Bologna. The list is instructive, and we quote it in full, for we cannot afford to admit women as fellows of any of our learned societies even!—"In languages, philosophy, and theology: Priscopia Cornaro, 'maîtresse des arts libéraux'; Clotilde Tambroni, hellenist, who had Mezoffanti as a pupil. In law: Dotta, daughter of Accurse; Biltizia Gozzadini, in connection with whom a pamphlet was published, *De mulierum doctoratu*; the two sisters, Bettina and Novella Calendrini. It appears that Novella was so beautiful, that it was necessary, in order to avoid distracting the students, to draw a slight curtain between her and the audience. In natural science and medicine: Alexandra Gigliani, Maria Petraccini, Anna Manzolini, and Sybille Mérian. The latter, who was a German, went to study insects at Surinam; she published an important work, and left her collections to the School of Bologna. In physics and mathematics: Laure Bassi, who married Dr. Verati, and who whilst teaching physics during forty years was a model wife and mother; the two astronomers, Thérèse et Madeleine Manfredi, sisters of the Director of the Observatory, who published a volume entitled 'Astronomy for Women.'"

The bust of Marie Agnesi was subsequently placed by Cardinal Dumini in his gallery of distinguished Lombards, and on her tomb these words were inscribed: "Fille remarquable par sa piété, sa science et sa bienfaisance."

We are introduced to a very different woman and mathematician in the person of Madame la Marquise du Châtelet, the friend of Voltaire, and whom the Prince Royal of Prussia familiarly addressed as Vénus Newton!

M. Rebière tells us that she had preserved, in spite of her studies, "une certaine frivolité. Son goût pour la parure et les diamants était très vif. Et puis elle riait de si bon cœur aux marionnettes!" But whilst indulging in diamonds and puppet-shows, the Marchioness found time to translate Newton's "Principia" from Latin into French, and produced besides numerous learned memoirs, one of which, "Institutions de Physique," was dedicated to her sons in words which, although written more than a century and a half ago, might have been uttered yesterday—"J'ai toujours pensé que le devoir le plus sacré des hommes était de donner à leurs enfants une éducation qui les empêchât dans un âge plus avancé de regretter leur jeunesse, qui est le seul temps où l'on puisse véritablement s'instruire." We find her returning to the same theme in a little essay, "Traité du bonheur," a curious mixture of feelings reflecting very vividly the varying moods of this remarkable woman:—"Nous n'avons rien à faire en ce monde qu'à nous procurer des sensations agréables," she writes; whilst on another page we read, in an eulogistic commentary on the benefits of study more especially to women—"Quand, par hasard, il s'en trouve quelqu une née avec une âme assez élevée, il ne lui reste que l'étude pour la consoler de toutes les exclusions et de toutes les dépendances auxquelles elle se trouve condamnée par état," M. Rebière does not omit to include amongst his memorable women Hypatia, with whose memoir the volume in fact opens.

In conclusion, M. Rebière devotes a couple of pages to suggestions for the making of a book which we fancy would be with difficulty kept within the modest limit of eighty pages, which the little pamphlet before us embraces. "Un livre à faire" remains, says M. Rebière, in which the influence direct and indirect exerted by women on the progress of science might be recorded, a book catholic enough not only to include the *savantes professionnelles*, but the *simples curieuses* or amateurs in science, amongst which George Sand finds a place, the *collaboratrices*, and finally those whose munificence and public spirit have earned for them the well-deserved title of *les protectrices*, instances of which we in this country have fortunately little difficulty in recalling. But possibly the most eloquent tribute which has ever been paid to any woman, and which might appropriately have found mention in M. Rebière's little volume, is that which was so pathetically inscribed by John Stuart Mill on the first page of his essay on "Liberty."

We are glad to learn that meanwhile M. Rebière is compiling a second and more elaborate volume in which women's relation to science will be discussed, upon which subject M. Rebière asks us to mention that he will gratefully receive any notes and suggestions. G. C. FRANKLAND.

[1] "Les Femmes dans la Science." Conférence faite au cercle Saint-Simon le 24 Février 1894, par A. Rebière. (Paris: Librairie Nony et Cie, 1894.)

THE ELECTRIFICATION OF AIR.[1]

§ 1. THAT air can be electrified either positively or negatively is obvious from the fact that an isolated spherule of pure water, electrified either positively or negatively, can be wholly evaporated in air.[2] Thirty-four years ago it was pointed out by one of us[3] as probable that in ordinary natural atmospheric conditions, the air for some considerable height above the earth's surface is electrified,[4] and that the incessant variations of electrostatic force which he had observed, minute after minute, during calms and light winds, and often under a cloudless sky, were due to motions of large quantities of positively or negatively electrified air in the immediate neighbourhood of the place of observation.

§ 2. It was proved[5] by observations in the Old College of Glasgow University that the air was in general negatively electrified, not only indoors, within the old lecture room[6] of Natural Philosophy, but also in the out-of-doors space of the College Court, open to the sky, though closed around with high buildings, and between it and the top of the College Tower. The Old College was in a somewhat low situation, surrounded by a densely-crowded part of a great city. In the new University buildings, crowning a hill on the western boundary of Glasgow, similar phenomena, though with less general prevalence of negative electricity in the air, have been observed, both indoors, in the large Bute Hall, and in many other smaller rooms, and out-of-doors, in the court, which is somewhat similar to the courts of the Old College, but much larger. It is possible that the negative electricity found thirty years ago in the air of the Old College, may have been due to its situation, surrounded by houses with their fires, and smoking factory chimneys. In the New College much of the prevalence of negative electricity in air within doors has, however, been found to be due to electrification by the burning lamp[7] used with the quadrant electrometer; and more recent observations with electrification by flame absolutely excluded, throw doubt on the old conclusion, that both in town and country negative electrification is the prevailing condition of natural atmospheric air in the lower regions of the atmosphere.

§ 3. The electric ventilation found in the Old College, and described in § 299 of "Electrostatics and Magnetism," according to which air drawn through a chink, less than ½-inch wide, of a slightly open window or door, into a large room, showed the electrification which it had on the other side of the chink, whether that was the natural electrification of the open air, or positive or negative electrification produced by aid of a spirit lamp and electric machine in an adjoining room, has been tried again in the New College with quite corresponding results. It has also been extended to the drawing in of electrified air through a tube to the enclosure represented in Fig. 1 of the present paper; with the result that the water-dropping test indicated in the sketch, amply sufficed to show the electrification, and verify that it was always the same as that of the air outside. When the tube was filled with loosely packed cotton-wool the electrification of the entering air was so nearly annulled as to be insensible to the test.

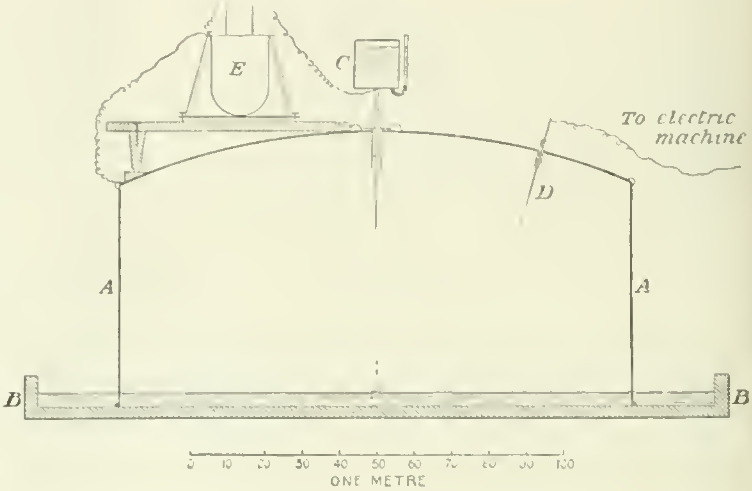


Fig. 1.

§ 4. The object proposed for the experiments described in the present communication was to find if a small unchanged portion of air could be electrified sufficiently to show its electrification by ordinary tests, and could keep its electrification for any considerable time; and to test whether or not dust in the air is essential to whatever of electrification might be observed in such circumstances, or is much concerned in it.

§ 5. The arrangement for the experiments is shown in the diagram, Fig. 1. A A is a large sheet-iron vat inverted on a large wooden tray B B, lined with lead. By filling the tray with water the air is confined in the vat. There are two holes in the top of the vat: one for the water-dropper C, and one for the charging wire D. Both the water-dropper, and the charging wire, ending with a pin-point as sharp as possible, are insulated by solid paraffin, which is surrounded by a metal tube, as shown in half size in Fig. 2. To start with they were supported by pieces of vulcanite embedded in paraffin. But it was found that after the lapse of some days (possibly on account of ozone generated by the incessant brush discharges), the insulation had utterly failed in both of them. The vulcanite pieces were then taken out, and solid paraffin, with the metal guard-tube round it to screen it from electrically influencing the water-dropper, was substituted. This has proved quite satisfactory: the water-dropper, with the flow of water stopped, holds a positive or a negative charge for hours.

§ 6. A quadrant electrometer I (described in "Electrostatics and Magnetism" §§ 346-353) was set up on the top of the vat near the water-dropper, as shown in Fig. 1. It was used with lamp and semi-transparent scale to indicate the difference of potential between the water-dropper and the vat. The sensibility

[1] A Paper by Lord Kelvin, P.R.S., and Mr. Magnus Maclean, read at the Royal Society on May 31.

[2] This demonstrates an affirmative answer to the question, Can a molecule of a gas be charged with electricity? (J. J. Thomson, "Recent Researches in Electricity and Magnetism," § 36, p. 53) and shows that the experiments referred to as pointing to the opposite conclusion are to be explained otherwise.

Since this was written, we find in the *Electrical Review* of May 18, on p. 571, in a lecture by Elihu Thomson, the following:—"It is known that as we leave the surface of the earth and rise in the air, there is an increase of positive potential with respect to the ground. . . . It is not clearly proven that a pure gas, rarefied or not, can receive and convey a charge. If we imagine a charged drop of water suspended in air and evaporating, it follows that, unless the charge be carried off in the vapour, the potential of the drop would rise steadily as its surface diminished, and would become infinite as the drop disappeared, unless the charge were dissipated before the complete drying up of the drop by dispersion of the drop itself, or conveyance of electricity by its vapour. The charge would certainly require to pass somewhere, and might leave the air and vapour charged."

It is quite clear that "must" ought to be substituted for "might" in this last line. Thus the vagueness and doubts expressed in the first part of the quoted statement are annulled by the last three sentences of it.

[3] "Even in fair weather the intensity of the electric force in the air near the earth's surface is perpetually fluctuating. The speaker had often observed it, especially during calms or very light breezes from the east, varying from 40 Daniel's elements per foot to three or four times that amount during a few minutes, and returning again as rapidly to the lower amount. More frequently he had observed variations from about 30 to about 40, and back again, recurring in uncertain periods of perhaps about two minutes. These gradual variations cannot but be produced by electrified masses of air or cloud, floating by the locality of observation."—Lord Kelvin's "Electrostatics and Magnetism," art. xvi. § 282.

[4] The out-of-doors air potential, as tested by a portable electrometer in an open place, or even by a water-dropping nozzle outside, two or three feet from the walls of the lecture room, was generally on these occasions positive, and the earth's surface itself therefore, of course, negative—the common fair weather condition—which I am forced to conclude is due to a paramount influence of positive electricity in higher regions of the air, notwithstanding the negative electricity of the air in the lower stratum near the earth's surface. On the two or three occasions when the in-door atmospheric electricity was found positive, and, therefore, the surface of the floor walls and ceiling negative, the potential outside was certainly positive, and the earth's surface out-of-doors negative, as usual in fine weather."—*Ibid.* § 300.

[5] *Ibid.* Q 2, § 2[illegible]3. [6] *Ibid.* §§ 296-300.

[7] "Electrification of Air by Combustion," Magnus Maclean and Makita Goto, Philosophical Society of Glasgow, November 20, 1889: "Electrification of Air by Water Jet," Magnus Maclean and Makita Goto, *Philosophical Magazine*, August 1890.

of the electrometer was 21 scale divisions (half-millimetres) per volt, and as the scale was 90 centimetres long, difference of potentials up to 43 volts positive or negative, could be read by adjusting the metallic zero to the middle of the scale. A frictional plate-electric machine was used, and by means of it, in connection with the pin-point, the air inside the vat could be electrified either positively or negatively.

§ 7. The vat was fixed in position in the Apparatus Room of the Natural Philosophy Department of the University of Glasgow on December 13, 1893, and for more than three months the air inside was left undisturbed except by discharges from the pin-point through the electrifying wire, and by the spray from the water-dropper. Thus the air was becoming more and more freed of dust day by day. Yet at the end of the four months we found that the air was as easily electrified, either positively or negatively, as it was at the beginning; and that if we electrify it strongly by turning the machine for half an hour, it retains a considerable portion of this electrification for several hours.

§ 8. Observations were taken almost daily since December 13; but the following, taken on February 8, March 12, and April 23, will serve as specimens, the results being shown in each case by a curve. At all these dates the air must have been very free from dust. Both during the charging and during the observations the case of the electrometer and one pair of quadrants are kept metallically connected to the vat. During the charging the water-dropper and the other pair of quadrants were also kept in connection with the vat. Immediately after the charging was stopped the charging-wire was connected metallically to the outside of the vat, and left so with its sharp point unchanged in its position inside the vat during all the observations.

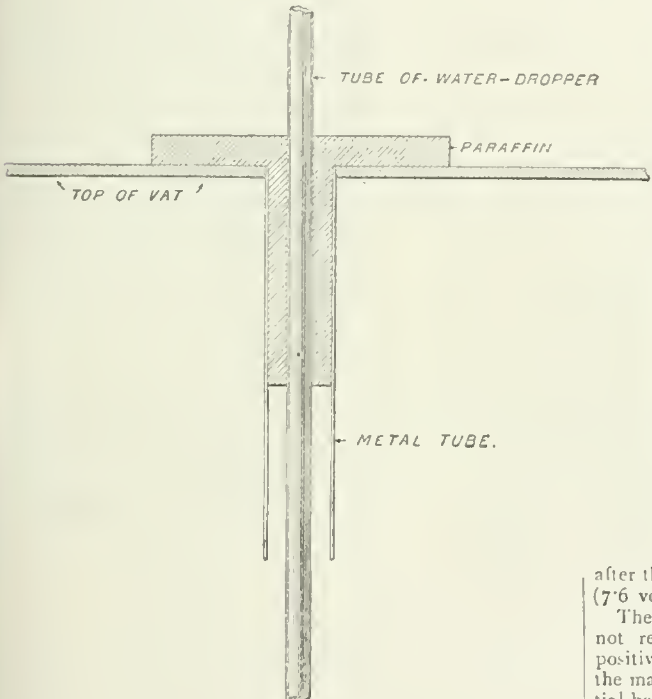


FIG. 2.

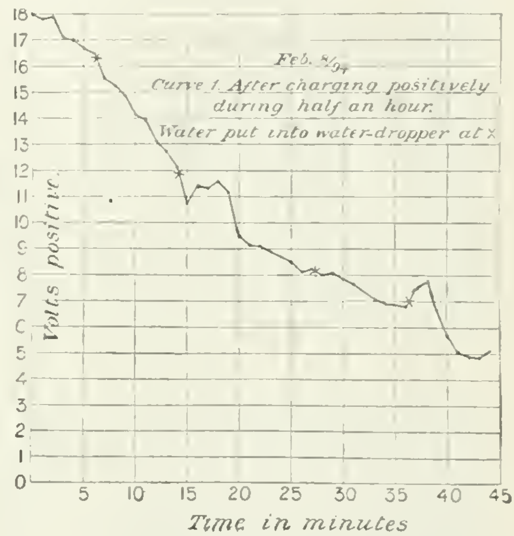
§ 9. *Curve* 1. *February* 8, 1894.—The friction-plate machine was turned positive for half an hour. Ten minutes after the machine stopped the water-dropper was filled and joined to one pair of quadrants of the electrometer, while the other pair was joined to the case of the instrument. The first reading on the curve was taken four minutes afterwards, that is, fourteen minutes after the machine stopped running (18 volts).

Curve 2. *March* 3, 1894.—The friction-plate machine was turned positive for five minutes. The water-dropper was filled and joined to the electrometer immediately after the machine stopped turning. The spot was off the scale, and nine minutes elapsed before it appeared on the scale. The first reading on the curve was taken one minute afterwards, or ten minutes after the machine stopped turning (35·25 volts).

Curve 3. *March* 12, 1894.—A Voss induction machine was joined to the charging wire, and run by an electric motor for four hours nineteen minutes. A test was applied at the beginning of the run to make sure that it was charging negatively; and a similar test when it was disconnected from the charging wire in the vat showed it to be still charging negatively. The water-dropper was joined to the electrometer, and the spot appeared on the scale immediately. The first reading on the curve was taken half a minute after the machine was disconnected (30·65 volts).

Curve 4. *April* 23, 1894.—The friction-plate machine was turned positive for thirty seconds, with water-dropper running and joined to the electrometer. Twenty seconds after the machine stopped the spot appeared on the scale, and the reading one and a half minutes after the machine stopped turning is the first point on the curve (7·3 volts).

Curve 5. *April* 23, 1894.—The friction-plate machine was turned negative for thirty seconds, with the water-dropper running and joined to the electrometer. Ten seconds afterwards the spot appeared on the scale, and the reading seventy seconds



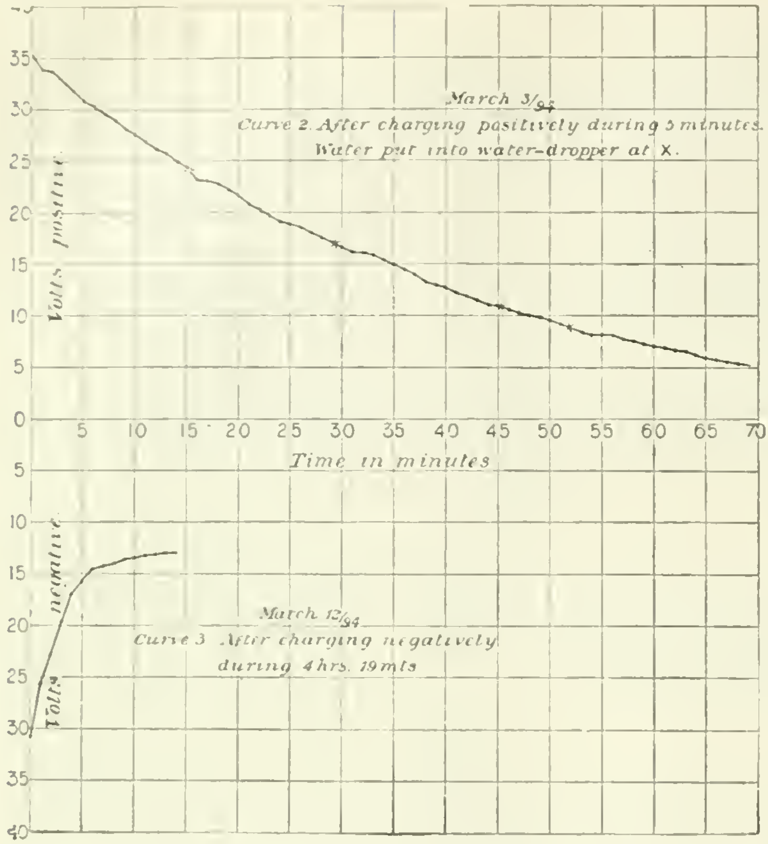
after the machine stopped turning is the first point on the curve (7·6 volts).

The curves show, what we always found, that the air does not retain a negative electrification so long as it retains a positive. We also found, by giving equal numbers of turns to the machine, that the immediately resulting difference of potential between the water-dropper and the vat was greater for the negative than for the positive electrification; though the quantity received from the machine was probably less in the case of the negative electrification, because the negative conductor was less well-insulated than the positive.

§ 10. On March 21, two U-tubes were put in below the edge of the vat, one on either side, so that it might be possible to blow dusty, or smoky, or dustless air into the vat. To one tube was fitted a blowpipe bellows, and by placing it on the top of a box in which brown paper and rosin were burning, the vat was filled with smoky air. Again, several layers of cotton-wool were placed on the mouth of the bellows, so as to get dustless air into the vat. The bellows were worked for several hours on four successive days, and we found no appreciable difference (1) in the ease with which the air could be electrified by discharges from the wire connected to the electric machine, and (2) in the length of time the air retains its electrification.

But it was found that, as had been observed four years ago with the same apparatus,[1] with the water-dropper insulated and connected to the electrometer, and no electrification of any kind to begin with, a negative electrification amounting to four, five, or six volts gradually supervened if the water-dropper was

[1] Maclean and Goto, *Philosophical Magazine*, August 1890.



the equal and opposite quantity on the inner boundary of the enclosing metal; and we therefore have the formula:—

$$V = 4\pi \int_0^a \left(\frac{r^2}{r} - \frac{r^2}{a}\right)\rho\, dr,$$

where V denotes the potential indicated by the water-dropper, a the radius of the spherical hollow, and ρ the electric density of the air at distance r from the centre. Supposing now, for example, ρ to be constant from the surface to the centre (which may be nearly the case after long electrification as performed in our experiments), we find $V = \frac{2}{3}\pi\rho a^2$; whence $\rho = 3V/2\pi a^2$.

To particularise further, suppose the potential to have been 38 volts or 0·127 electrostatic c.g.s. (which is less than the greatest found in our experiments) and take $a = 50$ cm.: we find $\rho = 2{\cdot}4.10^{-5}$. The electrostatic force at distance r from the centre, being $\frac{4}{3}\pi\rho r$, is therefore equal to $10^{-4} r$. Hence a small body electrified with a quantity of electricity equal to that possessed by a cubic centimetre of the air, and placed midway ($r = 25$) between the surface and centre of the enclosure experiences a force equal to $2{\cdot}4.10^{-9}.25$, or 6×10^{-8}, or approximately 6.10^{-5} grammes weight. This is 4·8 per cent. of the force of gravity on a cubic centimetre of air of density 1/800.

§ 14. Hence we see that, on the supposition of electric density uniform throughout the spherical enclosure, each cubic centimetre of air experiences an electrostatic force towards the boundary in simple proportion to distance from the centre, and amounting at the boundary to nearly 10

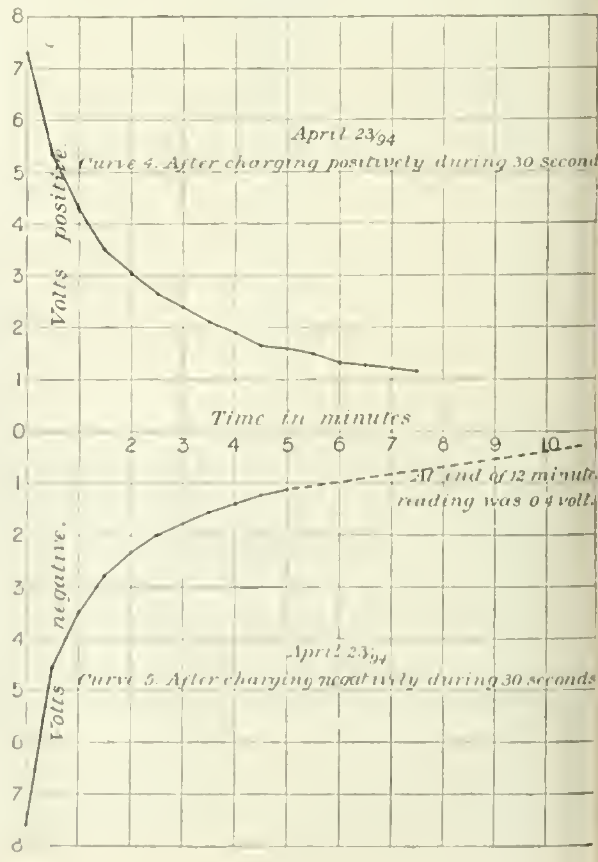
kept running for 60 or 70 minutes, through air which was dusty, or natural, to begin with. It was also found, as in the observations of four years ago, that no electrification of this kind was produced by the dropping of the water through air purified of dust.

The circular bend of the tube of the water-dropper shown in the drawing was made for the purpose of acting as a trap to prevent the natural dusty air of the locality from entering the vat when the water-dropper ran empty.

§ 11. The equilibrum of electrified air within a space enclosed by a fixed bounding surface of conducting material presents an interesting illustration of elementary hydrostatic principles. The condition to be fulfilled is simply that the surfaces of equal electric "volume-density" are surfaces of equal potential, if we assume that the material density of the air at given temperature and pressure is not altered by electrification. This assumption we temporarily make from want of knowledge; but it is quite possible that experiment may prove that it is not accurately true; and it is to be hoped that experimental investigation will be made for answering this very interesting question.

§ 12. For stable equilibrium it is further necessary that the electric density, if not uniform throughout, diminishes from the bounding surface inwards. Hence, if there is a portion of non-electrified air in the enclosure it must be wholly surrounded by electrified air.

§ 13. We may form some idea of the absolute value of the electric density, and of the electrostatic force in different parts of the enclosure, in the electrifications found in our experiments, by considering instead of our vat a spherical enclosure of diameter intermediate between the diameter and depth of the vat which we used. Consider, for example, a spherical space enclosed in metal of 100 cm. diameter, and let the nozzle of the water-dropper be so placed that the stream breaks into drops at the centre of the space. The potential shown by the electrometer connected with it, being the difference between the potentials of the air at the boundary and at the centre, will be the difference of the potentials at the centre due respectively to the total quantity of electricity distributed through the air and



per cent. of the force of gravity upon it; and electric forces of not very dissimilar magnitudes must have acted on the air electrified as it actually was in the non-spherical enclosure used in our experiments. If natural air or cloud, close to the ground or in the lower regions of the earth's atmosphere, is ever, as in all probability it often is, electrified to as great a degree of electric density as we have found it within our experimental vat, the natural electrostatic force in the atmosphere, due as it is, no doubt, to positive electricity in very high regions, must exercise an important ponderomotive force quite comparable in magnitude with that due to difference of temperatures in different positions.

It is interesting to remark that negatively electrified air over negatively electrified ground, and with non-electrified air above it, in an absolute calm, would be in unstable equilibrium; and the negatively electrified air would therefore rise, probably in large masses, through the non-electrified air up to the higher regions, where the positive electrification is supposed to reside. Even with no stronger electrification than that which we have had within our experimental vat, the moving forces would be sufficient to produce instability comparable with that of air warmed by the ground and rising through colder air above.

§ 15. During a thunderstorm the electrification of air, or of air and the watery spherules constituting cloud, need not be enormously stronger than that found in our experiments. This we see by considering that if a uniformly electrified globe of a metre diameter produces a difference of potential of 38 volts between its surface and centre, a globe of a kilometre diameter, electrified to the same electric density, reckoned according to the total electricity in any small volume (electricity of air and of spherules of water, if there are any in it), would produce a difference of potential of 38 million volts between its surface and centre. In a thunderstorm, flashes of lightning show us differences of potentials of millions of volts, but not perhaps of many times 38 million volts, between places of the atmosphere distant from one another by half a kilometre.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Council of the Owens College has, on the recommendation of the Senate, made the following appointments to Fellowships in the College:—Bishop Berkeley—Dr. A. W. Crossley in Chemistry, A. H. Jameson in Engineering; Honorary Research—Wilmot Holt, junr., in Chemistry.

MR. ANDREW J. HERBERTSON, of Edinburgh, has been appointed Lecturer on Geography at the Owens College, Manchester, in succession to Mr. Yule Oldham.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xvi. 3. (Baltimore: July 1894.)—A class of uniform transcendental functions, by Dr. T. Craig (pp. 207–220), gives another mode of forming a certain transcendental function first introduced by M. Picard (*Comptes Rendus*, 1878), and which does not seem to have been subsequently discussed. M. G. Humbert (pp. 221–253), writing "Sur les surfaces de Kummer elliptiques," after mentioning that Cayley's *tetrahedroid* is a particular case of a Kummer surface with six double points, applies himself to the problem of determining whether any other of these surfaces possess similar properties.—Mr. Basset contributes a memoir on the deformation of thin elastic plates and shells (pp. 254–290). The origin of the investigation appears to be the dissatisfaction Mr. Basset has felt with Mr. Love's treatment of the theories of thin plates, shells, and wires in the second volume of his book on "Elasticity."

Jahrbuch der k. k. geolog. Reichsanstalt Wien. Bd. xliii. Heft 3 and 4, March 1894.—Although Graz is one of the few localities in the Central Alps in which palæozoic strata are present containing good fossils, the exact age of these strata and their parallelism with the Silurian and Devonian strata of extra-Alpine regions have remained uncertain. The richly fossiliferous Coral-limestone of the Graz succession was determined as mid-Devonian by Suess, Stache, and others. Hoernes, on the other hand, thought it Lower Devonian. Now, for the first time, the Corals have been made the subject of a detailed study.—Dr. K. A. Penecke contributes a paper to the *Jahrbuch*, "On the Devonian strata of Graz," in which he proves that the "Coral limestone" and the "Calceola horizon" immediately above it are the uppermost bed of the *Lower Devonian* series. The age of the palæozoic strata of Graz ranges, according to Dr. Penecke, from the oldest Silurian to the youngest Devonian, and may possibly include a part of the Lower Coal Measures.—The monograph of the Raibl strata, by Baron von Wöhrmann, marks a considerable advance in our knowledge of Alpine Trias. The author's previous papers on the Raibl fauna in North and South Tyrol, have paved the way for this general paper. All the Raibl facies known in the Alps are described, the species contained in them reviewed, the indications of the geographical conditions discussed, and comparative references made to extra-Alpine seas in the same period. The subject is one of the most complex, but its treatment is searching, concise, and exhaustive. We note, almost with relief, the entire absence of the speculative method and wordy argument too frequently seen of late in matters concerning the Alps.

Bd xliv. Heft 2, June 1894.—"On the newer literature of the Alpine Trias," by Dr. A. Bittner. The personal and polemical tone of this paper renders it somewhat remarkable. By way of reviewing the terminology and literature of the Alpine Trias, Dr. Bittner exposes scathingly the fashion of new name-giving on insufficient grounds, the prejudice and obstinacy with which a name once given is apt to be retained, and the danger to science of subsequent attempts to modify the original meaning of a name, and prop a deservedly falling fabric. The writings of Mojsisovics are those which specially come under the whip. We are told, for example, that in studying "the Cephalopoda of the Hallstadt Limestone," one of the greatest works of Mojsisovics, we must read everywhere—instead of Mediterranean Trias, Alpine Trias; instead of Juvavic horizon, Noric horizon; instead of Noric horizon, Ladinian horizon; the author of the work himself having entirely departed from the geological conceptions for which the names were created! Dr. Bittner's paper is, to say the least, breezy; but, on the principle of the old proverb, "It's an ill wind, &c.," there is no doubt it will have a healthful effect in blowing away some of the cobwebs of tradition from a study which nature had already made so difficult and so fascinating.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 10.—"The Composition of Atmospheres which Extinguish Flame." By Dr. Frank Clowes, Professor of Chemistry, University College, Nottingham.

The statements usually published, as to the proportion of carbon dioxide in air necessary to extinguish a candle flame, vary widely. The present investigation was undertaken with the object of fixing the minimum proportion of carbon dioxide and of nitrogen gas, which, when mingled with air, will extinguish flame; and with the further object of ascertaining also the minimum proportion of each of these gases, which is necessary to extinguish the flames of different combustible substances, including those of certain gases.

The method of experimenting, which was devised, prevented the introduction of errors arising from the incomplete mixture of the gas with the air, from the solubility of carbon dioxide in water, and from the effect of carbonic dioxide produced from the flame during its combustion. The proportions of gas and air in the mixtures used were checked by analysis and were shown to be accurate, and duplicate experiments agreed in their results closely.

A preliminary series of experiments proved that, within the wide limits selected, the extinctive proportion of carbon dioxide was independent of the *size* of the flame of any particular combustible which was introduced into the mixture.

An extended series of experiments was then made to ascertain the minimum extinctive proportion of carbon dioxide for flames of very various description. The results arrived at showed that the flames of very different combustibles which were burnt from wicks, required a strikingly similar proportion of carbon dioxide in the air for their extinction. Thus the percentage of carbon dioxide necessary for the extinction of the flames of the following combustibles were: for absolute alcohol, 14; for methylated alcohol, 13; for paraffin oil, 15; for mixed colza and petroleum, 16; and for a candle, 14.

The extinctive proportions of the gas for the flames of various gases burnt from a jet, on the other hand, showed wide differences. The minimum percentages of carbon dioxide gas in air required for the extinction of the various flames of gases were as follows: for hydrogen, 58; for carbon monoxide, 24; methane, 10; ethylene, 26; and for coal-gas, 33. These numbers show no relation, as they might have been expected to do, to the volume of oxygen necessary for the combustion of the different gases.

A second series of experiments was then undertaken to ascertain the minimum proportion of nitrogen which must be added to the air in order to render it extinctive of the various flames already specified. It was found necessary in every case to add nitrogen in larger proportion than carbon dioxide to the air, in order to secure the extinction of a flame. The superior extinctive power of carbon dioxide over that of nitrogen is probably connected with its higher specific heat, and with its greater density.

Characteristic differences were noticed between the behaviour of wick-fed flames and flames supplied with gas from a jet, during the process of their extinction. The wick-fed flame gradually *diminished* in size until it ultimately dwindled away. The gas-fed flame, on the other hand, rapidly *increased* in dimensions, at the same time becoming more and more pale; and it became so pale at last as to be often visible with difficulty, so that it was not easy to mark the moment of its extinction. Probably the extinction of both classes of flames was primarily due to the lowering of their temperatures. In the case of the wick-fed flames, however, the reduction of their temperature led to the diminution of the supply of gaseous and vapourous fuel to the flame, and the flame ultimately died because it was starved. In the case of gas-fed flame the supply of fuel, being independent of the flame, was maintained, and the flame perished from lowering of temperature only; in its effort to obtain an adequate supply of oxygen in the diluted air, however, it expanded its surface, and it thus undoubtedly hastened the reduction of temperature which led to its extinction.

The very high proportion of carbon dioxide in air which is necessary for the extinction of the hydrogen flame has received an important and interesting application. One of the most serious troubles to which the miner is exposed when using his safety-lamp, is the extinction of its flame by air containing carbon dioxide. In most mines the lamp cannot be relighted with safety, since a naked flame would cause danger in the possible presence of inflammable gas. The loss of the flame therefore implies the necessity of the miner moving in darkness often through a considerable distance to a place where the wick may be relighted without risk. The safety-lamp for delicate and accurate gas-testing, which has been already described by the author (*Roy. Soc. Proc.* vol. lii. p. 486), provides the means of avoiding this inconvenience and possible danger. Without opening this lamp it can be made to burn either an ordinary oil-flame alone, or a hydrogen flame alone, or both these flames may be made to burn side by side. If the miner is approaching a part of the mine in which the proportion of carbon dioxide may be extinctive of his oil-flame, he would turn on the hydrogen-flame as an auxiliary. If the oil-flame becomes extinguished, he has proof that he has entered air containing at least fifteen per cent. of carbon dioxide; but he can withdraw from it with his hydrogen-flame still burning, and in purer air the hydrogen-flame will at once rekindle the wick and give him his illuminating flame once more. Under certain circumstances he might even with safety pass though the foul air, and in a similar way regain his oil flame. It is even possible to arrange the hydrogen-jet so close to the wick, that the oil-flame is more or less perfectly maintained by the hydrogen-flame even in the presence of much carbon dioxide.

The question has been raised whether it is safe to enter air which contains sufficient carbon dioxide to extinguish a candle-flame. This question is usually answered in the negative. But recent experiments made by J. R. Wilson (*Amer. Journ. Pharm.* 50, No. 12), seem to prove that rabbits can breathe for an hour with entire immunity from harm or even discomfort air containing 25 per cent. of admixed carbon dioxide, and that when the air contains 50 per cent. of the gas it is by no means immediately fatal to a rabbit which is immersed in it. Now air containing 15 per cent. of carbon dioxide at once extinguishes an ordinary candle-flame or oil-flame. Hence it appears that air may contain a considerably larger proportion of carbon dioxide than that which is necessary to extinguish the flame of a lamp or candle, and yet be competent to maintain life when it is breathed. This statement is fully supported by experiments made by Dr. Angus Smith, as well as by the experience of miners and others.

The following conclusions may be drawn from the experiments referred to above:—

(1) That the extinction of a flame depends not only upon the *quantity* but also upon the *quality* of the extinctive gas present in the air; carbon dioxide uniformly exerting a more powerfully extinctive effect than nitrogen.

(2) That wick-fed flames burning different combustibles show a remarkable uniformity in the minimum proportion of an extinctive gas in air necessary for their extinction.

(3) That this uniformity is not shown by flames fed by a gas burning from a jet; and no simple relation is apparent in the case of the gas-fed flames between the proportion of oxygen present in the diluted air and the proportion of oxygen requisite for the complete combustion of the gas.

(4) That the hydrogen flame requires for its extinction the presence in air of a very high proportion of extinctive gas; it may therefore be advantageously used as an auxiliary flame for maintaining an oil-flame in the foul air of a mine or other locality.

(5) Since an ordinary candle-flame or oil-flame is extinguished by the presence of about 15 per cent. of carbon dioxide in air, and air containing over 25 per cent. of carbon dioxide has been breathed with perfect safety for more than an hour, the extinction of an ordinary oil- or candle-flame in any particular atmosphere must not be taken as proof that that atmosphere contains so much carbon dioxide as to be dangerous to life when it is breathed.

(6) A more satisfactory indication of the presence of a dangerous proportion of carbon dioxide is furnished by the change of colour of the hydrogen flame from reddish to blue-grey. This change begins when 2 per cent. of carbon dioxide is present in the air; it becomes very pronounced as the proportion of the gas present increases. When 30 per cent. or upwards is present the flame is of a pronounced blue colour and also increases in height with the increased proportion of the gas, to an extent which is easily measured on a scale.

May 31.—"Note on the Possibility of obtaining a Unidirectional Current to Earth from the Mains of an Alternating Current System." By Major P. Cardew.

June 21.—"Degenerations consequent on Experimental Lesions of the Cerebellum." By Dr. J. S. Risien Russell.

The paths which degenerate after ablation of one lateral lobe of the cerebellum, and after extirpation of its middle lobe, are discussed in this paper.

Degenerated fibres are found in all the peduncles on the same side after the former operation, and in the superior peduncle of the opposite side. The position occupied by these degenerated fibres, in this peduncle, is that of fibres which degenerate in both superior peduncles after the cerebellum has been divided into two lateral halves by a mesial incision. The degenerated fibres in the superior peduncle of the side of the lesion decussate in the posterior quadrigeminal region, and pass to the opposite red nucleus and optic thalamus. Those fibres which degenerate in the middle peduncle pass chiefly to the grey matter of the opposite side of the pons. Of the fibres which degenerate in the inferior peduncle, the majority occupy the lateral region of the medulla, becoming more and more scattered as they pass down. These can no longer be said to form a tract below the level of the superior pyramidal decussation; but a few scattered fibres occupy the antero-lateral region of the cervical cord, beyond which none can be traced. Degenerated fibres pass to both inferior olives from this peduncle; but no well-marked tract to the opposite inferior olive was found.

After extirpation of the middle lobe of the cerebellum, degenerated fibres were found in all the peduncles. Those in the superior peduncle decussate in the region of the posterior corpora quadrigemina, and terminate in the opposite red nucleus. The degenerated fibres in the middle peduncle behave much as do those which result from ablation of one lateral lobe of the cerebellum; and the same may be said with regard to the degenerated fibres in the inferior peduncle.

No degeneration was found in the fillet, posterior longitudinal bundles, pyramids, ascending root of the fifth nerve, the roots of the cranial and spinal nerves, and in the spinal cord, forming an antero-lateral tract throughout its whole length.

Physical Society, June 22.—Prof. W. E. Ayrton, F.R.S., Past-President, in the chair.—Captain Abney, before exhibiting his photographs of flames, demonstrated that a candle flame contains solid particles by passing a beam of polarised light though it, the track of the beam through the flame being clearly seen in one direction, whilst in a direction at right angles it was practically invisible. The same thing was also shown by passing the light through a turbid liquid. Photographs of argand and candle flames with pencils of sunlight and electric light passing through, were then exhibited showing similar phenomena. Several series of photographs of flames of candles and various forms of gas-burner taken with diminishing exposures were then shown in order to illustrate the different luminosities at different parts of the flame. Those taken with long exposures showed the bright parts nearly equally white, but as the time of exposure diminished only the most luminous portions were recorded on the plate. From the photographs the author concluded that when used with a slit as a photometric standard the argand burner was unsuitable, for portions of different luminosity come into view when the slit is approached or receded from. The ordinary fish-tail burner was better in this respect. Questions were asked and remarks made by Prof. S. P. Thompson, Prof. Perry, and Mr. Trotter, in reply to which Captain Abney said dropped shutters with slits from one inch to one-sixteenth inch wide had been employed, and some of the exposures were only a few thousandths of a second. The displacement caused when the object was not stationary could easily be allowed for when the velocity of the shutter was known.—Prof. O. Henrici read a paper on an elementary theory of planimeters. Considering the generation of areas by the motion of straight lines, the author defined the sense in which such areas are to be taken. Choosing the positive sense of a line O T of variable length as outwards from the centre O about which it turns, and the positive direction of rotation as counter-clockwise, the following rule for determining the sense of an area was given. Imagine yourself standing at a point P, and looking along the positive sense of O T, whilst it passes over P, then the area near P will be swept out in *a positive sense if O T crosses you from right to left*, otherwise it will be negative. Applying this rule to closed curves of any shape, it was shown that if T goes once round the boundary, any area outside the curve was necessarily swept over as many times in the negative sense as in the positive sense, therefore these areas cancelled, and also that the sense of any part of an area depends on the sense of its boundary. Passing on to the consideration of areas generated by a line (or rod) of fixed length, which moves anyhow in a plane and returns to its initial position, Prof. Henrici showed by taking instantaneous centres, that the same rule regarding the sense of the areas holds, and that the area generated by the rod is equal to the difference between the areas of the two closed curves traced by its ends. In the particular case where one end of the rod moves forwards and backwards along the same path the area swept out by the rod is equal to that of the closed curve traversed by the other end. This is the theory of Amsler's planimeter, for the area of the curve whose boundary is traversed by the tracer is the same as that swept out by the rod carrying the tracer when the pole is outside the closed curve. By resolving small motions of the rod in two component parts, a translation parallel to itself, and a rotation about the point in which the plane of the registering wheel cuts the rod, the author showed that the areas swept out by the translations were registered by the wheel, whilst the sum of those generated during the rotations cancel. Cases where the pole is inside the curve were next considered, and the constant then to be added to the wheel reading determined. Instead of registering the translation by a wheel whose axis is parallel to the rod, a knife-edged wheel which slides and turns freely on an arm perpendicular to the rod would serve the same purpose. This is the principle of Hine and Robertson's planimeter. In the actual instrument, however, the arm is inclined at about 10° to the rod, and is therefore inaccurate. In the "hatchet" planimeter a bent rod terminates at one end in a tracing point, and at the other in a convex knife-edge or "keel," whose plane contains the point. The area of the curve whose boundary is traversed by the point is approximately equal to twice that of the sector included between the initial and final positions of the rod. The approximation results from the fact that the area of the curve traced by the keel is not zero. At the meeting the question of reducing the area of the keel curve was discussed at some length, the author showing that in the case of a curve symmetrical about a line, it was possible to reduce this area practically to zero. Even for unsymmetrical curves one could obtain a symmetrical one of double the area by drawing a line, cutting the curve, and supposing the area turned over about this line. Prof. Perry inquired if the author's conclusion was that the "hatchet" planimeter and the Hine and Robertson instrument were inaccurate? If so, he was at a loss to understand why the latter gave results more nearly correct than Amsler's. Mr. Blakesley pointed out that if both arms of a jointed planimeter be simultaneously moved over curves the total reading should give the sum of the two areas traced out if taken in the proper senses. Mr. A. P. Trotter directed attention to an article by the inventor of the "hatchet" in the current number of *Engineering*. Dr. Macfarlane Gray said he had examined the proof given in *Engineering*, and found no error. He then showed how the Amsler planimeter could be explained in a simple geometrical manner by drawing radial lines through the pole and intersecting the curve. Moving the tracer along these radii added nothing to the area; motion along the arcs was the important component. Mr. O. G. Jones and Prof. Thompson also took part in the discussion.—Mr. F. W. Hill made a communication on the "hatchet" planimeter. In this paper the author takes a point within the area to be measured, and divides the area into elementary triangles with this point as apex. The tracing point of the planimeter is then supposed to start from the apex and trace out one of the triangles. The inclination between the initial and final positions of the "hatchet" is then expressed in terms of the angle at the apex, the radius vector, and the length of the planimeter. By expanding and integrating the expression, it is shown that twice the area between the initial and final position of the planimeter, after tracing all the triangles, is represented by an infinite series of terms, the first of which is the area of the curve, the second is proportional to the moment of inertia of the area about the point, the third proportional to its first moment about the same point. The higher terms are usually small enough to be neglected. Starting the tracer at the centroid of the area causes the third term to disappear, and the second has its minimum value, so that this is the starting-point recommended. The magnitude of the errors caused by neglecting the various terms are discussed in some detail. In the author's opinion, the instrument can never be strictly accurate; but usually the errors are within the limits of observation. Prof. Henrici did not agree with the statement that the instrument was necessarily inaccurate, and thought geometry might aid analysis to find the proper starting-point. For a symmetrical curve he had shown that a point existed, starting from which the area traced by the hatchet end was zero. Dr. Macfarlane Gray thought Prof. Henrici's latter argument was vitiated by his figure not being correctly drawn; but this Prof. Henrici disputed. Mr. O. G. Jones said Prof. Henrici's construction was not obvious, for the cusp curves traced by the "hatchet" end depended on the starting-point. Mr. Yule suggested that by shortening the planimeter it might be possible to bring the third and second terms of Mr. Hill's formula into greater prominence, and, by going round the curve more than once, determine the first and second moments. —A paper on a new integrating apparatus, by Mr. A. Sharp, was taken as read. The paper describes an improved form of harmonic analyser, giving the amplitude and epoch of each constituent term, the mechanism of which is an inversion of that described in a communication made to the Society on April 13. Numerous drawings accompany the paper, showing the various parts in detail. The mechanism is also shown to be applicable for integraphs, and by suitable modification may be employed for mechanically integrating differential equations of various forms. A paper on magnetic shielding by a hollow cylinder, by Prof. Perry, and another on "Clark's cells," by Mr. S. Skinner, were postponed.

Geological Society, June 20.—Dr. Henry Woodward, F.R.S., President, in the chair.—On deep borings at Culford and Winkfield, with notes on those at Ware and Cheshunt, by W. Whitaker, F.R.S., and A. J. Jukes-Browne. Four borings at Culford, Winkfield, Ware, and Cheshunt were described in detail, so far as the specimens examined would permit; these were few in the case of Culford, but many from the other borings. The interest of the Culford boring centred in its striking the Palæozoic floor at the small depth of 637½ feet; but the age of the slaty rocks cannot be determined. Although only 20 miles east of Ely, no Jurassic rocks exist, and the Lower Cretaceous series is only about 32 feet thick, the beds differing greatly from those of Cambridgeshire, but resembling those of the same age in the Richmond boring. The Winkfield boring (3½ miles west-south-west of Windsor) was remarkable for having been successful in obtaining water from the Lower Greensand, and for the great depth (1243 feet) to which it was carried for this purpose, the Gault being unusually thick. The boring at Ware was for the first time described in detail, and former accounts were corrected from specimens preserved by the New River Company. By this means, and with the assistance of Mr. W. Hill, the authors were able to give a fairly complete account of the rocks, and to determine the limits of the divisions of the Upper Cretaceous series. They denied the existence of Lower Greensand at this locality. Of the boring at Cheshunt a complete account was given, based on information and specimens supplied by Mr. J. Francis, the engineer of the New River Company. The paper concluded with a tabular view of all the borings in the East of England, showing the level below ordnance datum at which the Palæozoic floor occurs in each. The President, Prof. Boyd Dawkins, Prof. Judd, and Mr. Topley spoke upon the subject of the paper, and Mr. Whitaker briefly replied.—The Bargate Beds of Surrey and their microscopic contents, by Frederick Chapman. This was an attempt to correlate the Bargate Beds of Guildford and its vicinity with the members of the Lower Greensand as known elsewhere in the south-east of England. Mr. T. Leighton, Prof. Judd, Mr. Whitaker, Dr. G. J. Hinde, Mr. Topley, and Prof. T. Rupert Jones offered some remarks upon the paper.—On deposits from snowdrifts, with special reference to the origin of the loess and the preservation of mammoth-remains, by Charles Davison. When the temperature is several degrees below freezing-point, snow recently fallen is fine and powdery, and is easily drifted by the wind. If a fall of snow has been preceded by dry frosty weather, the interstitial ice in the frozen ground is evaporated, and the dust so formed may be drifted with the snow and deposited in the same places. The snowdrifts as a rule are soon hardened by the action of the sun or wind, and the dust is thus imprisoned in the snow. As the snow decays, by melting and evaporation, a coating of dust is extruded on the surface of the drifts, and, increasing continually in thickness as the snow wastes away, is finally left upon the ground as a layer of mud, which coalesces with that of previous years. The deposit so formed is fine in texture, unstratified, and, as experiments show, mica-flakes included in it are inclined at all angles to the horizon. The author described several such deposits both in this country and in the Arctic regions; and suggested (1) that the loess is such a deposit from snowdrifts, chiefly formed when the climate was much colder, but still very slowly growing; (2) that mammoths suffocated in snowdrifts are subsequently embedded, and their remains preserved in the deposits from them; and (3) that the ground-ice formation of Alaska, &c., is the remains of heavy snowdrifts when the coating of earth attained a thickness greater than that which the summer heat can effectually penetrate. Mr. Davison's theory did not find much support. During the discussion upon it, Mr. Oldham said that he happened to have a personal acquaintance with the deposits left after the melting of snow and with the loess. The former were found in sheltered spots on the ridges of the Himalayas, which are annually covered with snow, but (so far as his experience went) they were denser and more compact than the true loess; they were, in fact, dried muds, while the true loess was a dust. In the hills of the western frontier of India, where loess was largely developed and still in course of formation, the distribution, surface-contour, and constitution showed it to be a wind-blown dust deposit, though it passed into deposits which had been rearranged by water. Part of this lay at altitudes where snow fell each year, but it was equally well and typically developed below the level at which snow usually fell, and where it was not preceded by a long frost nor lasted long enough to form extensive drifts. He did not think that the true loess could originate from the solid matter left by melting snow, and it could certainly be formed without the aid of snow. Prof. Blake, Prof. Boyd Dawkins, and Dr. W. F. Hume also spoke.—Additions to the fauna of the *Olenellust*-zone of the north-west Highlands, by B. N. Peach, F.R.S. New material obtained by the officers of the Geological Survey having been placed in the author's hands, he was enabled to add information concerning the species of *Olenellus* previously described by him (*O. Lapworthi*); he also described a new variety of this species, three new species of the genus, a new subgenus of *Olenellus*, and a form provisionally referred to *Bathynotus*. He discussed certain theoretical points based upon the study of the remains described in the paper, and stated that these make it probable that the dispersal of the Olenellids was from the Old World towards the New. Dr. Hicks and Dr. G. J. Hinde spoke upon the subject.—Questions relating to the formation of coal-seams, including a new theory of them: suggested by field and other observations made during the past decade on both sides of the Atlantic, by W. S. Gresley. A number of new facts were described, and the bearing of these and of previously recorded facts upon the origin of coal was discussed, special reference being made to the Pittsburgh coal. He maintained that the evidence pointed to the formation of coal on the floor of an expanse of water, by vegetable matter sinking down from floating "islands" of vegetation, which may have been of very large size, and enumerated cases of such "islands" or "rafts" of vegetation which have been described as existing in modern times.—Observations regarding the occurrence of anthracite generally with a new theory as to its origin, by the same author. After discussing Dr. J. J. Stevenson's theory of the origin of anthracite, the author described the nature and mode of occurrence of the anthracites of Pennsylvania, and gave his reasons for concluding that the de-bituminisation of coal was not produced by dynamic metamorphism during mountain-building, but rather by previously-applied hydrothermal action. He further discussed the applicability of his theory to other cases of anthracite, including that of South Wales and Ireland. In the discussion that followed, Prof. Boyd Dawkins pointed out that the anthracite-fields of South Wales and of Ireland are exactly in those places where the coal-seams have suffered most from crushing and faulting, and that therefore there is distinctly a connection between the exertion of dynamical force and the anthracitic condition. This also applies to the Irish fields. In some cases a coal-seam can be traced into an anthracite seam. In his opinion the author's views would not explain the presence of anthracite in this country.—The igneous rocks of the neighbourhood of Builth, by Henry Woods.—On the relations of some of the older fragmental rocks in north-west Caernarvonshire, by Prof. T. G. Bonney, F.R.S., and Miss Catherine A. Raisin. In a recent paper on the felsites and conglomerates between Bethesda and Llanllyfni, North Wales, it was argued that, in the well-known sections on either side of Llyn Padarn, a great unconformity separates the rocks into two totally distinct groups. The authors of the present communication discussed at the outset the great physical difficulties involved in this hypothesis; a subject which, in their opinion, was passed over too lightly by the author of that paper. They further affirmed, in the course of a description of the sections, which are most clear and afford the best evidence:—(1) That the strike in both the supposed rock-groups is generally similar. (2) That the same is true of the dips. (3) That very marked identity of lithological characters may be found in rocks on either side of the alleged unconformity, specimens occasionally being practically indistinguishable. (4) That in no case, which has been examined, can any valid evidence be found in favour of the alleged unconformity, and that in the one, which is supposed to to the most satisfactory proof of it, the facts are wholly opposed to this notion. Prof. Blake, Dr. Hicks, and Mr. Whitaker discussed these views, and Prof. Bonney replied.

Royal Microscopical Society, June 20.—Mr. A. W. Bennett in the chair—Dr. J. E. Talmage described his method for mounting and staining the brine shrimp, *Artemia fertilis*.—Dr. W. H. Dallinger called attention to a stereoscopic photomicrograph of injected muscle which had been presented by Dr. W. C. Borden.—Dr. Dallinger exhibited and described a new form of mechanical stage for the microscope, which had been produced by Messrs. Swift. Further remarks were made by the chairman, Messrs. Comber, Swift, More, and Beck.—Mr. J. H. Harvey described a method of mounting opaque objects so that they could be moved in all directions whilst under examination.—Mr. T. Comber read a paper on the unreliability of certain characters generally accepted for specific diagnosis in the Diatomaceæ. A discussion ensued, in which the chairman, Prof. F. J. Bell, and Mr. J. Badcock took part.—Prof. Bell gave a *résumé* of Mr. F. Chapman's sixth paper on the Foraminifera of the Gault of Folkestone.

DUBLIN.

Royal Dublin Society, June 20.—Dr. W. Frazer in the chair.—Dr. Telford Smith and Prof. D. J. Cunningham, F.R.S., gave a lantern demonstration of two microcephalic brains. One of these weighed 352 grammes; the other 559 grammes. The authors contrasted these specimens with the brains of the ape and the quadruped. The cerebrum in each had not passed in its development beyond the quadrupedal stage. The initial growth disturbance must therefore have occurred about the fourth month of fœtal development. With the aborted occipital region there was associated a marked convolutionary disturbance. The arrangement of the gyri and sulci did not correspond with that present at any period of fœtal life. It resembled the simian more than the human type; and what was most remarkable was the mixture of low-ape and high-ape characters. In some respects, therefore, the convolutionary pattern resembled that of a baboon, and in others that of a chimpanzee or an orang. The authors referred to the various theories which had been put forward to account for the condition, and upon the whole seemed to favour that of Karl Vogt, although the arguments they brought forward were of a totally different character. The results at which the authors have arrived will shortly appear in the Society's *Transactions*.

PARIS.

Academy of Sciences, July 9.—M. Lœwy in the chair.—The death of M. Mallard, member of the Mineralogy Section, was announced.—On the photographs of the moon obtained with the great *coudé* equatorial of the Paris Observatory, by MM. Lœwy and Puiseux. (See our Astronomical Column.)—On some of the work done at Nice Observatory, by M. Perrotin. In connection with photographic exploration, the author observes that, in the sky regions examined, (1) the number of new asteroids (magnitudes 7–13) is much less than the number previously known; (2) only in the case of asteroids of the 13th magnitude are more now discovered than had been previously observed; (3) the total number of asteroids increases with decreasing magnitude as far as the 12th mag.—On new derivatives from benzoylbenzoic acid, by MM. A. Haller and A. Guyot.—Experimental production of the contagious peripneumonia of cattle by the aid of cultures. Demonstration of the specific character of *Pneumobacillus liquefaciens bovis*. Note by M. S. Arloing. The author concludes from his results quoted that (1) the virulent agent in contagious peripneumonia is an ordinary microbe, and (2) this microbe is the *Pneumobacillus liquefaciens bovis*.—Comparative researches on the products of the combustion of lighting-gas given by an Argand burner and an Auer burner, by M. N. Gréhant. The combustion products from the Auer burner yielded evidence of the presence of carbonic oxide to the extent of 1 in 2580, those from the Argand burner a trace only, estimated at 1 in 75,000.—Special images of the sun given by the simple rays corresponding to the dark lines of the solar spectrum, by M. H. Deslandres. The author gives the first results of a study of the surface layers of the sun by means of images formed by light from selected parts of the spectrum.—On the calorific radiations included in the luminous part of the spectrum, by M. Aymonnet. The following conclusions are deduced from a study of the spectra given by the Bourbouze and Drummond lamps and by the sun: (1) the eye does not perceive all the radiations between the red and violet; (2) the eye is not acted on by rays intercepted by water; (3) when the medium between the radiant source and the measuring apparatus contains water, there is an imperfect concordance between the distribution of heat and that of light in the same region of the spectrum; (4) the bright lines or bands which we can observe in a spectrum are only those or a part of those which pass through water.—On the polarisation of light diffused by roughened surfaces, by M. A. Lafay.—On the relation between the density of a saline solution and the molecular weight of the dissolved salt, by M. Georges Charpy. The density of a saline solution augments proportionally to the molecular concentration if it be admitted that the molecular weight of water at 0° is about 3×18. The densities of equally concentrated solutions of analogous salts are nearly proportional to their molecular weights.—On a new glucosane, lævoglucosane, by M. Tanret.—Syntheses by means of cyanacetic ether. Phenylcyanacetic ethers, by M. T. Klobb.—On paraphthalodicyanacetic ether, by M. J. Locher.—On pine tar, by M. Adolphe Renard.—The quantitative composition of creosotes from beech and oak, by MM. A. Béhal and E. Choay. Beechwood creosote is richer in guaiacol than that from oak.—Inuring ferments to antiseptics and the influence of this hardening on their chemical work, by M. J. Effront.—The nature of onychomycosis, demonstrated by culture and by inoculations, by M. J. Sabrazès.—On the coexistence of the sternum with the shoulder-girdle and lungs, by M. Alexis Julien. The sternum varies in its composition, form, and texture, in its development and even in its connections. Notwithstanding this great variability, certain constant features may be distinguished. The sternum always coexists with the shoulder-girdle and lungs, that is to say, all vertebrates which have a sternum have also lungs and shoulder-girdles, but the converse is not true.—On the insertion of the membrane of Corti, by MM. Coyne and Canniew.—On the topography of the attached urethra, studied on sections of frozen subjects, by M. L. Testut.—On the measurement of the absorption of water by roots, by M. Henri Lecomte.—On the petrographic nature of the summit of Mont Blanc and the neighbouring rocks, by MM. J. Vallot and L. Duparc.

BERLIN.

Physical Society, June 1.—Prof. du Bois Reymond, President, in the chair.—Prof. König described a repetition of H. Müller's experiments on the part of the retina in which the sensation of light takes its origin, using, however, monochromatic light. Müller, as is well known, had localised it in the rods and cones by observing that the shadows cast by the blood-vessels of the retina execute movements, when the source of light is moved (Purkinje's experiment), which correspond to the distance between the blood-vessels and the layer of rods and cones. Prof. König had repeated the measurements on the normal eye of Dr. Zumft, whose constants he had accurately determined, using four kinds of monochromatic light, namely, that of the lithium line in the red, of the D sodium line, of the thallium line, and of the line F. He found as a result of fifteen separate determinations that the distance of the light-perceiving elements of the retina from the blood-vessels which give the shadows varies with the varying wave-lengths of the different lights, a result which can only be explained on the basis of Young's theory of colour-vision.—Dr. H. du Bois spoke on the changes of resistance of a bismuth spiral in a powerful magnetic field. This change, discovered by Lord Kelvin, had been measured in the case of bismuth in a magnetic field whose maximum strength was 12,000 C.G.S., and the curve of resistance in the field, compared with that of the resistance outside the field, was found to be at first concave upwards and then straight. The resistance in the field of maximum strength was 1·7 of that in zero field. The speaker, using some very powerful electromagnets which he had recently exhibited to the Society, and which gave an intensity of 38,000 C.G.S., had, in conjunction with Dr. Henderson, measured the resistance of spirals of pure bismuth, and found that the curve pursues a further straight-line course, so that the resistance in the field of greatest intensity is three times as great as in a field of zero intensity. The measurement of the resistances in a magnetic field at different temperatures had yielded interesting results. In weak fields a rise of temperature increased the resistance: in stronger fields the effect was less, and became zero in a field of 7000 C.G.S. In still stronger fields the resistance of the warm spiral was less than that of the cold. The experiments have so far been carried on only for temperatures between 0° and 25°, but will be pushed further up to 100°.—Dr. Pringsheim described an ingenious procedure by means of which he had succeeded in obtaining positives of old manuscripts on which old and faint characters were obscured by newer and dark writing. The positives were obtained by a combination of several photographs, and showed only the older and fainter characters in sharp and clear definition.

June 15.—Prof. von Helmholtz, President, in the chair.—Prof. von Bezold gave an address in memory of Prof. A. Kundt, the Vice-President of the Society, recently deceased, in which he dwelt upon his scientific labours, and in particular upon his distinguished efforts as a teacher.

NEW SOUTH WALES.

Royal Society, May 2.—Prof. Anderson Stuart delivered the presidential address. He gave a detailed account of the poison of *Ornithorhynchus paradoxus* and of the poison of the "Bush-tick," and alluded to that of the Australian varieties of the spider-genus *Lathrodectus*. After describing the present favourable state of the arrangements for an expedition to one of the South Sea atolls, to realise the suggestion of Darwin to bore and bring up a core, and thus probably settle the question of the origin of the atoll, he announced that, acting on behalf of the Committee of the British Association, he had secured the loan of a diamond drill from the Government of New South Wales. He also spoke of the artesian water supply of the colony in reference to the probable limits of its supply, and favoured the naming after Darwin of some place in the Blue Mountains associated with Darwin's visit. He then reviewed certain questions of present importance in the colony, such as the disposal of sewage, the characters of sewer-air, and the backward condition of sanitary legislation in the colony, &c. The Society is maintaining its position very well, in spite of the present extremely adverse circumstances of the colonies. The officers and council were elected for the ensuing year, Prof. R. Threlfall being President.

Linnean Society, May 30.—Prof. David, President, in the chair.—Notes on the methods of fertilisation of the *Goodeniaceæ*, by Alex. G. Hamilton. Three species of *Scævola*, one of *Selliera*, and one of *Brunonia* were dealt with. The writer concluded that although there is an elaborate contrivance in the first four for securing cross-fertilisation by the aid of insects—which was described in detail—yet, if that fails, self-fertilisation occurs. *Brunonia* was said to be anomalous in its methods. The process of fertilisation in the three allied orders—*Lobeliaceæ*, *Goodeniaceæ*, and *Campanulaceæ*—was contrasted, and it was shown that the same end is secured by widely different adaptations of the same organs.—On three highly ornate boomerangs from the Bulloo River, N.S.W., by R. Etheridge, junr.—Note on the tertiary fossils from Hall Sound, New Guinea, by Prof. Ralph Tate. The author's observations were based on an examination of the specimens in the Macleay Museum, obtained during the voyage of the *Chevert*. These were reported on by the late Rev. J. E. Tenison-Woods (*P.L.S.*, N.S.W. 1878, ii. (2), pp. 125 and 267), who referred them "to a very recent tertiary formation, much newer than any of the Murray River or Western Victorian beds." The author concurred in this view, but pressed for a more recent origin than that implied by Tenison-Woods—even Pleistocene. Some critical observations on the specific determination of the specimens were given—a matter of some difficulty in most cases by reason of their imperfect condition.—On the morphology of the muscles of the shoulder-girdle in monotremes, by W. J. Stewart McKay. The author has found a clavicular deltoid present in both *Echidna* and *Ornithorhynchus*; also a pectoralis quartus, teres minor and subclavius. The teres major is single in both forms; the sub-scapularis of great extent. Much attention has been given to the nervous system, and elaborate dissections have been made to trace out "the latent cutaneous nerve of the thorax" (Patterson) and its communication with the intercostal nerves.—Description of a new Australian snake by J. Douglas Ogilby. The habitat of the new species (*Hoplocephalus waitii*), which differs mainly from *H. pallidiceps*, Gunth., in having 21 series of scales round the body instead of only 15, appears to be the central district of N.S.W., whereas *H. pallidiceps* is a North Queensland form.—Fishes new or rare on the Australian coasts. By Edgar R. Waite. The fishes dealt with were from Maroubra, N.S.W., and are either new to Australia or of exceedingly rare occurrence, and with two exceptions obtained for the first time on the coasts of this colony. The species mentioned are:—*Dules argenteus*, Bennett, *Acanthurus triostegus*, Linn., *Psenes whiteleggii*, sp. nov., *Nomeus gronovii*, Gmel., *Schedophilus maculatus*, Gunth., *Glyphidodon brownriggii*, Bennett, *Solenognathus hardwickii*, Gray, *S. spinosissimus*, Gunth., *Monacanthus filicauda*, Gunth., *M. nitens*, Hollard, and *Leptocephalus*. The author expressed the opinion that *Solenognathus fasciatus*, Gunth., is not specifically distinct from *S. spinosissimus*.—Description of a new mite belonging to the genus *Heteropus* found in wasps' nests, by W. W. Froggatt. The name *Heteropus alastori* was proposed for a mite which has been found in great numbers in the clay nests of the solitary wasp, *Alastor eriurgus*, Sauss., in the neighbourhood of Sydney. The gravid female has an immense globular abdomen eight times the length of the head and thorax combined.—On the mode of attachment of the leaves or fronds to the caudex in *Glossopteris*, with remarks on the relation of the genus to its allies, by R. Etheridge, Jun., with note on the stratigraphical distribution of *Glossopteris* in Australasia, by Prof. T. W. Edgeworth David. The fossil plant *Glossopteris*, which formed the predominant type of swamp vegetation in Eastern Australia during the Permo-Carboniferous Period, when the productive coal-measures were being formed, has left records of its former presence almost invariably in the form of leaves only. Only two authentic cases have been recorded of *Glossopteris* leaves having ever been found attached to any kind of stem, previous to the discovery of the specimen found near Mudgee by Mr. J. C. McTaggart, which makes the third specimen ever discovered, and which was described by the authors. The specimen shows that some variety, at all events, of *Glossopteris* in Australia had somewhat the form of a dwarf tree-fern, with a caudex, or stem, at least six inches in length, and surmounted by a clump of closely packed fronds to the number of about eight. The fronds, as proved by the scars on the caudex, were not placed on a verticil, but spirally on the caudex. They are sessile, not petiolate as in the case of the specimen described by Prof. Dana from Illawarra.—Mr. Hedley read the following note:—"From the throat of a *Rallus pectoralis* Mr. J. A. Thorpe of the Australian Museum extracted the snail I now exhibit. This is a specimen of *Chloritis jervisensis*, Quoy and Gaimard, a species common in this neighbourhood, whose almost adult and uninjured shell measures 18 mm. in diameter, and which weighed, shell and animal together, 1·26 grammes. When found by Mr. Thorpe, to whom I am indebted for both facts and specimen, the snail was quite dead; as a test I immersed the animal in strong spirits without inducing contraction: since, however, its consumer had been killed forty hours earlier, the suffocation of the mollusc was to be expected. The bird was shot at Randwick, near Sydney, on May 19, 1894, by Mr. Newcombe, Deputy Registrar-General. In enumerating 'Means of Dispersal,' Darwin observes ('Origin of Species,' 6th ed. p. 372): 'A bird in this interval [eighteen hours] might easily be blown to the distance of 500 miles, and hawks are known to look out for tired birds, and the contents of their torn crops might thus readily get scattered.' In view of the above incident, this suggests a means whereby the geographical range of *jervisensis* might be considerably extended."

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THURSDAY, JULY 26, 1894.

MATHEMATICAL GEOLOGY.

Popular Lectures and Addresses by Sir William Thomson (Baron Kelvin), P.R.S., LL.D., D.C.L., &c. In three volumes. Vol. II. "Geology and General Physics." With illustrations. NATURE Series, pp. x. + 599, with index. (London and New York: Macmillan and Co., 1894.)

THIS handy republication of the lighter scientific utterances of Lord Kelvin was begun in 1889, with the volume reviewed in NATURE (vol. xl. p. 433), was continued in 1891, with a volume on "Navigational Affairs," and is now concluded for the present by a volume, nominally the second of the series, which deals mainly with Geological Dynamics, or the application of the physical sciences to the past history of our planet, and likewise includes such later addresses on general physical topics as were not included in the volumes already issued.

The preliminary remarks appropriate before reviewing utterances of leaders in science, were made in connection with the first of the series (vol. xl. p. 433), and need not now be repeated; we will enter straight upon a summary, and perhaps an occasional slight criticism, of the contents.

The first paper is a little article on dew, wherein it is pointed out that the protective action conspicuously exerted on vegetation by invisible aqueous vapour is due not to its "athermancy," as Tyndall imagined, and as text-books teach, but to its infinite heat-capacity. The temperature of bodies which cool only from the surface cannot fall below the point at which dew is being deposited upon them; and naturally the moister the air the higher is this said point.

Then comes a brief note, a kind of text or starting-point for many subsequent addresses, in which the extreme doctrine of geological uniformity is briefly refuted. The refutation consists in the simple arithmetical calculation, that if the observed gradient of temperature in the earth's crust had been uniform for, say, twenty thousand million years back, the amount of heat that must have flowed out from it into space in that time would be enough to heat the whole earth ten thousand centigrade degrees, unless it were made of material very different from surface rock, or unless fresh quantities of heat had been generated by chemical action. In any case, allowing for these possibilities to the uttermost, the past temperature would have been at some such date so excessively high that *ipso facto* no approach to uniformity of other conditions could possibly be maintained or contemplated.

In this simple argument the "mathematics" is but little more severe than that needed in what the author later on (p. 240) calls "a simple effort of geological calculus," whereby it is estimated that 1° per 30 metres is the same as 1000° per 30,000 metres; or (a fairer comparison) that quoted on p. 86, that a deposit at the rate of one inch per century demands ninety-six million years for the deposition of the stratified rocks; yet the simple argument may well be held as more conclusive and convincing than an appeal to Fourier and the laws of distribution of temperature in a cooling sphere. For this reason: an immediate application of Fourier to the gradient of temperature observed in the earth's outer skin is liable to all the uncertainties attaching to very violent extrapolation both in space and time; it has to assume that the sole operative cause is conduction of heat, and always has been conduction of heat, up to a certain past date deduced from the data as the era of reckoning.

Now, it is quite possible to hold that the main mass of the earth consists of metal, chiefly iron, and that the heat, observed in the damp skin or coat of rust on which we live and into which we bore, is being generated *de novo* by the rusting action still going on.

The heat generated by the oxidation of a pound of iron is (I estimate) sufficient to warm an equal mass of rocky material something like three thousand centigrade degrees; so that small confidence can be felt, by those who are impressed with the probability of a meteoric view of the earth's origin, in refined calculations as to successive distributions of temperature in a simply cooling globe started in a molten condition and left to radiate into space undisturbed.

But it is to be observed that the argument of Lord Kelvin contemplates the possibility of fresh generation of heat, but maintains that nevertheless at some by no means infinitely distant date the obvious physical conditions of the earth's surface must have been extremely different from what they are now.

The doctrine of extreme uniformity, which at one time was undoubtedly held by some leading geologists, is now however abandoned, a result due most likely in large measure to the author's calculations and reiterated arguments; and the only reasonable hesitation which can now be felt is as to how far the numerical data available, from observations hitherto made in the earth's outer skin, are sufficient for fixing an upper limit to the age of the earth: especially since these underground thermometer-readings are likely to be disturbed by local and by general chemical action at considerable depths.

The author suggests borings in the African deserts, where moisture is less prevalent than elsewhere, and it may be that observation of underground temperature there conducted will be productive of valuable information; but it is unlikely that these data have already been obtained.

Whatever hesitation may still rationally be felt as to the acceptance of the author's numerical estimate of the earth's age—and he is careful to allow ample margin when he extends the more strictly estimated ten million into a possible hundred million years—yet the reception of his calculations by contemporary palæontological and stratigraphical geologists, as summarised in a controversial address on Geological Dynamics in this volume, will probably be surprising to a more fully informed posterity. Instead of heartily welcoming fresh light on the subject of the earth's past history, from an unexpected quarter, they seem to resent interference from what they are pleased to consider "outside," and their most able advocate, Prof. Huxley, accepts a brief to repel the intruder.

The quotations made by Lord Kelvin from Playfair, from Lyell, from Darwin, and from writers of text-books, are evidences of the natural though exaggerated reaction into scientific uniformitarianism, from the ancient legendary prescientific cataclysmal period, when everything was done in a hurry, and a week was an epoch of serious moment in the earth's history. In the reactionary period, on the contrary, it was customary to airily postulate a few thousand million centuries for any particular achievement; geologists then drew upon "a practically unlimited bank of time, ready to discount any quantity of hypothetical paper." Lord Kelvin by physical reasoning recalled them from this unnecessary vagueness, and put into their hands new data, ascertained by observation of the earth's crust of just as close and valid a character as any inspection of strata or classification of fossil remains, but of a kind more immediately amenable to mathematical calculation; he called for more data from observers, and meanwhile treated in the light of present knowledge the data already available, just as the observing geologists had endeavoured to treat ordinary stratigraphical facts in the light of what they perceived to be at the present time occurring near river-mouths and coast-lines.

And in thus discussing and drawing deductions from terrestrial data, Sir Wm. Thomson was a true geologist. If researches and discoveries concerning the past history of the earth, in respect of age and temperature and physical condition and length of day and exposure to sunshine, are not geology, it is difficult to adduce anything that has a right to that title. Yet Prof. Huxley, in a peroration to an address to the Geological Society of London in 1869, on the subject of Sir Wm. Thomson's address to the Glasgow Society the year before, speaks of "the cry for reform which has been raised from without," says "the case against us has entirely broken down," and concludes with the comfortable assurance: "we have exercised a wise discrimination in declining to meddle with our foundations at the bidding of the first passer-by who fancies our house is not so well built as it might be."

And another more astounding but very characteristic sentence occurs in an earlier part of this forensic speech:—

"I do not suppose that at the present day any geologist would be found to maintain absolute uniformitarianism, to deny that the rapidity of the rotation of the earth *may* be diminishing, that the sun *may* be waxing dim, or that the earth itself *may* be cooling. Most of us, I suspect, are Gallios, 'who care for none of these things,' being of opinion that, true or fictitious, they have made no practical difference to the earth, during the period of which a record is preserved in stratified deposits."

This attitude of "not caring" for the results of scientific investigation in unpopular regions, even if those results be true, is very familiar to some of us who are engaged in a quest which *both* the great leaders in the above-remembered controversy agree to dislike and despise. It is an attitude appropriate to a company of shareholders, it is a common and almost universal sentiment of the noble army of self-styled "practical men," but it is an astonishing attitude for an acknowledged man of science, whose whole vocation is the discovery and reception of new truth.

Certain obscure facts have been knocking at the door of human intelligence for many centuries, and they are knocking now, in the most scientific era the world has yet seen. It may be that they will have to fall back disappointed for yet another few centuries, it may be that they will succeed this time in effecting a precarious and constricted right of entry; the issue appears to depend upon the attitude of scientific men of the present and near future, and no one outside can help them.

I admit that it savours of presumption even to quote in a critical spirit from the utterances of a man of Prof. Huxley's eminence, a man who fought with surpassing eloquence and vigour the battle of free and open inquiry into the facts of the universe before most of us had cut our wisdom teeth; but having been guilty of such an act of presumption, I propose to cap it with another: I shall take permission to say how cordially we recognise the immense service to truth and progress which has been effected by those gladiators who, in despite of fierce hostility, and in face of deadly odds, encountered and overcame the forces of superstition and won for us who follow so great a measure of freedom and friendly countenance as we now enjoy.

It requires an effort of imagination now, or a visit to some stagnant country town, to realise the strength of prejudice which the evolutionary spirit of science had at one time to encounter. It would ill beseem us who are enjoying the peaceful outcome of this struggle to regard with other than the deepest honour those veterans who bore the burden of the fray, even though they sometimes display their fighting front to a left wing of earnest investigators who come heavily marching over the bog and swamps not far removed from those into which the conquered hosts retreated. The morass is difficult and treacherous—it may once more be overwhelming—but if ever secure foothold is gained, and the mud on our clothing has time to dry, the veterans will recognise their own colours and not the colours of their former foes.

Returning to our immediate subject, I pick out from the address on Geological Time the following interesting points. The tides are a case of forced vibration in which the natural period of free swing is *longer* than that corresponding to the forced period; consequently, but for friction, the tidal humps are at right angles to the line of tide-generating force. Were the free period shorter than the forced, the tidal humps would be in the line of force, again excepting friction; and were the two periods the same, the tidal humps, but for friction, would be infinite. The fact that the natural or free period is longer, not shorter, than the lunar or solar day period, as well as the bare fact of appreciable friction itself, are proved by a delay in the occurrence of spring-tide, which again establishes the fact that the lunar tide is more accelerated by friction than is the solar tide; the solar being of slightly shorter period than the lunar, and therefore slightly more discordant with the natural swing.

The effect of friction is to accelerate the tidal phase, and by this acceleration its amount can, or could if the data were good enough, be estimated. It is equivalent to a friction brake applied to the equator, and tightened till it requires a total tangential force equal to the ordinary weight of four million tons to hold it still.

Or, if the earth be supported like a terrestrial globe by a polar axis 100 miles in diameter, that axle must be clamped and subjected to a tangential drag of 320 million tons in order to represent the energy dissipated by tidal friction.

Given this gigantic retarding "couple," it is surprising to remember how slow the consequent lengthening of the day actually is: that the earth, in fact, lags behind a perfect time-keeper only an accumulated few seconds—the estimate in this book is the rather high one of twenty-two seconds—in the course of a century, *i.e.* in the course of 36,500 rotations.

To test or detect this retardation by direct observation is, as is well known, very difficult, because the only other time-keeper available for purposes of comparison is the moon, and she is a very bad and complicated one. Only by efforts of great genius has the astronomical discovery of the diminishing speed of the earth's rotation been made; but if astronomical clocks were as perfect as Lord Kelvin thinks they ought to be, the observation would be comparatively easy. He looks forward to a time when clocks will not be set by the stars, as at present, but when the earth's motion will be rated by a standard clock of extraordinary perfection. At present, or at least in 1868, "astronomical clocks are just as great a disgrace to the mechanical genius of Europe and America as chronometer watches are a credit."

(Incidentally a curious statement is made as to the feasibility of working coal at enormous depths, in spite of the presumably high temperature there—"Suppose there was coal, or rather charcoal, where the strata were red hot, it might be gone into, and that with perfect ease. All that is necessary is plenty of ventilation": the ventilation being conducted on the freezing-machine principle of adiabatic expansion of previously compressed air.)

Other causes affecting the rate of the earth's rotation are likewise considered, such as the deposition of meteoric dust, the redistribution of polar ice and equatorial water, the shrinking of the earth by cooling. If meteoric dust, without initial moment of momentum, were deposited at the rate of one foot in 4000 years it would produce the observed retardation, and likewise the acceleration of the moon's mean motion, without aid from the tides. On the other hand, any redistribution or accumulation and dissipation of polar ice must be a periodic phenomenon, and therefore, though it may exert a distinct effect for some cycles of years, disturbing calculations of eclipses and such like, yet in the long run it must integrate out and be inoperative. As to the accelerative influence of thermal contraction, it is believed by the author to be extremely small, probably not the 1 6000th part of that due to tidal friction.

Concerning the probable antecedent condition of the matter which has fallen together to make the earth, it is interesting to note (p. 121) that "any great degree of *relative* motion of different portions of matter through space renders the chance of their hitting one another very small"; it is probable, therefore, that the heat developed by the falling together of the earth's materials arose simply from their gravitative potential energy, which is fairly calculable, and not from vague stores of unknown initial motions.

On p. 185 a statement is made with respect to Helmholtz' theory of solar heat, to the effect that "this condensation can only follow from cooling." It is rash to question a statement allowed to stand by this author after revision, but perhaps he would look at it again. Surely condensation can, under some conditions, not only generate heat but also elevate temperature?

Towards the end of a Presidential address delivered to the British Association at Edinburgh in 1871, the author, while quoting with "cordial sympathy" a couple of sentences from "The Origin of Species," on the subject of biological evolution, omits an intervening sentence "describing briefly the hypothesis of 'the origin of species by natural selection' because [he] had always felt that this hypothesis does not contain the true [*i.e.* doubtless the complete] theory of evolution . . . in biology. Sir John Herschel, in expressing a favourable judgment on the hypothesis of zoological evolution . . . objected to the doctrine of natural selection, that it was too like the Laputan method of making books [which it may be recollected was something like this: haphazardly composing all the type available, and hoping that of all the random statements thus made the fittest might survive] and that it did not sufficiently take into account a continually guiding and controlling intelligence. This seems to me a most valuable and instructive criticism."

Eliminating the slightly anthropomorphic mode of expression from one sentence of this quotation, it illustrates, what is certainly the truth, that to the interested onlookers from other sciences there already seemed cogent need of a supplement to the fraction of truth contained in Natural Selection, a supplement involving some such treatment of the Origin of Variations as is now attempted in Mr. Bateson's recent work.

In an address to Section A, at Glasgow, 1876, the author goes back to geology and considers the question of a possible shift of the earth's polar axis and of possible temporary alterations in the length of the day, while he entirely repudiates and demolishes the view that the earth's interior can be mainly or even largely liquid. His conclusion from the whole of tidal phenomena is that the earth is now extremely rigid and must be practically solid all through.

He nevertheless contemplates with equanimity Newcomb's bold hypothesis, based on the lunar theory and on apparent irregularities in the moon's motions, that the earth actually went slow and lost seven seconds between 1850 and 1862, and then went fast and gained eight seconds from 1862 to 1872. Lord Kelvin tentatively explains the conceivable possibility of this acceleration by possible changes in the earth's shape, as detectable by changes in sea-level.

"A settlement of 14 centimetres in the equatorial regions, with corresponding rise of 28 centimetres at the poles (which is so slight as to be absolutely undiscoverable in astronomical observatories, and which would involve no change of sea-level absolutely disproved by reduction of tidal observations hitherto made), would suffice. Such settlements must occur from time to time; and a settlement of the amount suggested might result from the diminution of centrifugal force due to 150 or 200 centuries' tidal retardation of the earth's rotational speed."

A paper on Geological Climate continues what we are treating as the geological portion of the volume under review. One of the chief subjects therein discussed is the probable cause of the warm Arctic climate once experienced, so that not only are remains of forest trees found within fifteen degrees of the North Pole, with every evidence of their having grown there, and that not so very long ago, but the return of the Arctic expedition in 1876 brought "evidences of a very warm climate, probably as warm as we have it now in the tropics, within nine degrees of the North Pole"!

For explanation, at any rate of the more moderate pine-forest temperature, we are told to look in the direction indicated by Lyell's twelfth chapter, viz. to a redistribution of land and water.

The Arctic Ocean is a land-locked sea, and the effect of the surrounding coasts is to hem the ice in and prevent free oceanic circulation, while the land itself serves to receive and accumulate snow wherewith to load the neighbouring sea with a thin layer of surface ice.

But now lower the land 2000 feet: the sea would be open, but for a few islands, and the water would be deep enough for plenty of warm currents to flow in, sufficient to clear the ice away and keep it clear. Even now the ice seems to be only 5 feet thick, evidently melting away underneath. It is asserted that the climate of a small island in an iceless circumpolar sea would be probably "temperate and free from frost except in hollows." Considering all the defences, the heat-capacity of moist air, the formation of dew, and so on, it appears that the same defences as protect a large continent in temperate zones from destructive cold during a summer night, would "prevent even so much as hoar-frost on a small island at the very pole during its whole winter six months' night, if it were surrounded by a deep ocean with no land to obstruct free circulation between it and tropical seas."

And in the other direction Lord Kelvin agrees that the simplest cause of the glaciation of India is some 15,000 feet extra elevation. But at the same time "the astronomical cause invoked by Herschel must have had, and must now have, its effect," the well-known fact, namely, of the varying distance of the sun, and the periodic coincidences of its least distance with the northern summer. The sometimes postulated shift of the earth's axis to account for changes in climate does not satisfy Lord Kelvin; he says that there is no evidence, either geological or astronomical, for any considerable shifting of the position of the poles. As to the warmer climate evidenced all over the earth at one time: underground heat is often appealed to, but it is hopelessly inadequate, it can never have sensibly influenced the climate during the period of the stratified rocks. "The earth might be a globe of white hot iron covered with a crust of rock 2000 feet, or there might be an ice-cold temperature within 50 feet of the surface, yet the climate could not on that account be sensibly different from what it is, or the soil be sensibly more or less genial than it is for the roots of trees or smaller plants."

The simple and in every way "almost infinitely probable" hypothesis to account for past high temperature is *a warmer sun*.

Persons who are inclined to imagine a future limit to the duration of life on the earth as in any way dependent on a failure in the supply of heat from below, will do well to note the above strong pronouncement.

The next essay, on "The Internal Condition of the Earth," asserts that on the meteoric theory the earth would once have been just about molten throughout, by reason of the heat of its own formation; but subsequent occurrences must depend on whether solid rock sinks or swims in molten rock. Definite experimental information on this fundamental point appears to be still wanting, but so many facts show that the earth is rigid, that practically the author seems to have little doubt but that it would *sink*. He is careful to point out, however, that the crude notion sometimes met with of a rise of temperature in arithmetic progression at different depths in the crust is certainly false. The law of increase is an asymptotic one, and the temperature at the centre *need* not be higher than two or three thousand degrees. He denies altogether the intensely high temperature often imagined, and thus has no difficulty in accepting the solidity and rigidity otherwise indicated.

Some ingenious arithmetical calculations attempted in Dr. Croll's book on Climate and Time, form the subject of the next paper, on "Polar ice-caps and their influence in changing sea-levels." It is interesting to know that if the ocean were of quicksilver instead of water, it would not spread over the earth as it does, but would accumulate itself entirely at one side. The stability of the ocean depends on the low specific gravity of sea-water as compared with earth. Now, any great piling of material over a large area, such for instance as over the gigantic Antarctic continent, would have the effect of drawing by gravitation some of the ocean toward itself, and thereby lowering the sea-level all over the rest of the earth. And if the material so piled up were itself ice, having been withdrawn by distillation from the ocean itself, the fall of level would be greater still. By the formation of an ice-cap on the Antarctic continent, twelve miles thick, an immense change of sea-level can be produced; the amount of lowering thereby caused in distant parts of the globe being differently estimated as 380 feet, 650 feet, 1140 feet, and 2000 feet.

But Lord Kelvin denies the possibility of a coat of ice twelve miles thick, such as Dr. Croll postulates; the pseudo-viscosity of ice forbids it; but suppose it only a quarter-mile, suppose the thickness varied by 1200 feet from some cause, the area of the Antarctic continent is something like $\frac{1}{40}$th of the whole earth, and so, if such a coat of ice melted off it, the sea-level all over the world would rise twenty-five feet,—sufficient to make many important changes.

The greatest permissible thickness of ice at the South Pole seems to be about 18,000 feet, such a height as that with a gradual slope could stand; and a comparatively small fluctuation in its thickness would have very important geological results. What the actual condition of affairs now is at the South Pole can only be settled by an Antarctic expedition, of which the feasibility and importance are now in some quarters being seriously considered. The thickness of the ice-cap would depend on the annual snowfall and on the rate of viscous sliding down. The internal heat of the earth has nothing to do with the problem—the underground heat could not melt a millimetre of ice thickness per annum. It is singular that an increase in the southern ice-cap tends to increase that of the northern also, by lowering the level of the ocean, and so retarding circulation. Any cause which lessened the Antarctic ice-cap would moderate the rigour of the extreme northern climate, and tend to warm the Arctic Ocean.

So much for the first half of the book under review. The remaining half will be treated in another article.

OLIVER J. LODGE.

ELEMENTARY METEOROLOGY.

Elementary Meteorology. By William Morris Davis, Professor of Physical Geography in Harvard College. (Boston, U.S.A.: Ginn and Co., 1894.)

THE necessity for the production of text-books would seem to diminish with lapse of time, but the examination of publishers' catalogues discloses no diminution in their numbers. If there be any excuse for the writing of new text-books in any branch of science, it might be found in those at present unformed departments, like meteorology, where well-directed and systematic inquiry is constantly enlarging the boundaries of knowledge by the addition of new facts, or the discovery of fresh grounds for the acceptance of facts not yet admitted as demonstrated truths. The science of meteorology is not like that of mathematics, which immediately displays its power, and has nothing to hope or fear from passing time; but appealing as it does to observation and experience, its progress must be gradual and comparative. And if any one be entitled to write text-books, it is those who having been engaged practically in teaching have felt a particular want to be ill-supplied, and who feel themselves qualified by their office and minute acquaintance with the subject to remedy the defect. For these reasons we may welcome the appearance of Prof. Davis' work on "Elementary Meteorology," which originally intended for those engaged in the earlier years of college study, and with whom the author has been brought much into contact, may well be read by others, who wish to keep themselves acquainted with the more recently-acquired facts concerning the behaviour and the processes of atmospheric circulation. In fact, Prof. Davis has had both classes of readers in his mind, as he has prepared this work; and further, recognising how many in his own country are more or less intimately connected with the national and state weather services, he has endeavoured to supply them with a well-digested treatise which may be a supplement to the meagre but precise instructions issued to observers under official authority.

It is not to a text-book of this character that one goes to learn the present position of the more speculative side of meteorology, and since the author excludes from his programme purely mathematical discussion, some of the more recondite inquiries cannot be treated. The qualities that we should look for in a book intended primarily for college students, are exactness of facts and expression, lucidity of description, and orderly consecutive arrangement, carrying the student gradually forward to complete knowledge of the subject, within the limits proposed by the author. And, supposing this to have been the aim of the writer, it seems to have been admirably fulfilled. A text-book embracing the views and the experience of others cannot hope to be original, but it should be thorough, and this on the whole is the opinion we have conceived of the book.

In a few short chapters, we have a description of the atmosphere as a whole, and of the forces that are continually operative, giving rise, by the succession of day and night and summer and winter, to vertical interchanging currents whose behaviour under varying conditions and circumstances embraces the whole province of meteorology. Having thus prepared the way by sufficient reference to the physical processes which influence the temperature of the earth as a whole, it might have been expected that the author would have proceeded naturally to the consideration of local temperatures, and a more minute division of his subject. But, unfortunately, he delays the progress by the introduction of a chapter on the colour of the sky. Doubtless the author can defend himself, but to us, it appears an interruption of the orderly development of the subject, and a defect in the arrangement of the work. It is, however, the only distinct blemish to which we shall have to refer in the plan and conception of the book. We should suspect that the subject of the colour of the sky has had great attraction for Prof. Davis, and that he has over-valued its importance in a book of this nature. But having surmounted that difficulty, there is nothing to stop the consideration of temperature, its measurement, its distribution, and the causes affecting its disturbance, either as a whole by the obliquity of the earth's axis, or locally as by ocean currents, &c. All this is very admirably arranged; and here we may say a word for the sufficiency and clearness of the diagrams. Prof. Davis has apparently had access to a very admirable and complete collection, and his selections are judicious and well illustrative of the points under discussion.

From isotherms the transition to isobars is easy and natural, and though we cannot expect anything original in the description of a barometer, the quality of thoroughness to which we have before alluded is again illustrated. The author does not recommend the correction of the individual readings of the barometer to the sea-level, a practice which is falling more and more into disuse. Unfortunately a definition of sea-level, as understood in America, is not given, at least where we expected to find it. We doubt whether many English readers could supply a correct definition, but the expression may be perfectly clear on the other side of the Atlantic.

Proceeding as far as possible with the discussion of barometric readings, revealing the varying distribution of pressures, the author finds it necessary to introduce the subject of the observation and distribution of the winds. This we consider absolutely in its right place, and assists the gradual progress materially. On the subject of the reduction of wind observations the information is certainly meagre. Wind observations offer one of the most complicated problems in meteorology, one certainly out of the range of the ordinary college student, and this may be a sufficient apology for the author. Here, too, we should have looked for some reference to the recent work of Prof. Langley, indicative of both the difficulty of making exact observations of velocity, and of the important results that may be expected from a complete discussion. But the author is more intent upon describing the general effects of wind circulation as affected by the rotation of the earth, before proceeding to partial and local disturbances. Of course, in this section, the author follows Ferrel, and without employing mathematical illustration, succeeds in fairly well placing before the student an outline of the essential features that mark the work of his distinguished countryman.

This gradual progress of the book seems to throw the question of rain and precipitation far into the work. No inconvenience arises from this, though in many minds, not necessarily scientific, the subject of rain is considered the most important fact in connection with meteorological science. Prof. Davis, however, is not to be hurried. He wishes to approach the subject of cyclones and local storms, and as these are more or less accompanied with rainfall, he finds it necessary, in pursuance of his scheme, to clear away the general features connected with the moisture of the atmosphere, including clouds, dew, frost, and the various forms in which we find water precipitated. In connection with cloud observation, a simple method is mentioned of determining the direction and velocity of cloud movement, which might be worthy of more systematic trial than, it is believed, has yet been accorded to it. The method consists in noting the path of the reflection of a cloud in a horizontal mirror, in which the observer looks through an eye-piece that remains fixed during the observation. If the eye-piece is placed so that the reflection of a certain part of the cloud falls at the centre of the mirror, and after a few seconds a radial arm is turned so as to bring its edge on the position then taken by the cloud, the edge of the arm will lie parallel to the cloud's motion, on the admissible assumption that the cloud is drifting in a horizontal plane. (pp. 181–2.) A slight addition to the apparatus permits the ready appreciation of the relative velocity of the cloud drift, far better than can be estimated by the eye alone.

Having dealt with the general subject of rain and clouds, the author is in a position to treat of cyclonic storms, thunderstorms and tornadoes, and the more violent interruptions of meteorological phenomena. The reason for this section, interesting as it is, being sandwiched in between the description of clouds, &c., and the causes and distribution of rainfall is, however, not so clear. The author probably did not wish to have a greater separation than possible between his chapter on winds and that on cyclones; but we think it would have been better to have finished the subject of rainfall before returning to the motion of the atmosphere. But the writer is clearing the way for the consideration of the "weather," "weather prediction," and climate, with which his book ends. On the subject of weather forecasts, Prof. Davis does not take a very hopeful view. We believe that our authorities at Victoria Street look with a certain degree of satisfaction on the results of their predictions. They are able to point to a percentage of some 90 per cent. of successes, and as far as is known, they, and the public too, consider their existence justified. But listen to Prof. Davis: "The number of stations has grown, and their equipment has been materially improved; the accuracy of various processes preparatory to charting has been increased; a vast body of information has been accumulated for study relative to the kinds and changes of weather; various predicting officers have had extended practice in their art, and while the forecasts are truly made for longer periods than they were at first, and are certainly superior in definiteness and accuracy to those issued twenty years ago, their improvement is not so great as was hoped for. Mistakes in prediction are still made, and of much the same kind as at the beginning of the service." (p. 325.)

In laying aside this book, which we have read with pleasure, and heartily commend to the student, one word of caution may not be unnecessary to the English reader. The book is written for American students, and the use of "our" and "us" is apt to be a little confusing. For instance, "our" damp winter north-easters (p. 145) will scarcely apply to "our" climate, and the statement (p. 269) "that in the six years 1885–1890 there were 2233 buildings set on fire by lightning in this country," is one which must be considered in connection with the area of the country to which it applies. W. E. P.

THE WEALDEN FLORA.

Catalogue of the Mesozoic Plants in the Department of Geology, British Museum. Part I. *Thallophyta—Pteridophyta.* By A. C. Seward, M.A., F.G.S. (London: Printed by order of the Trustees, 1894.)

THIS hand-book serves to show how interesting a monograph of all that is known regarding this mysterious formation would prove. In the folds of the Wealden we imagine the secret of the evolution of angiosperms must be locked. It is as if we stood at the mouth of a great river flowing from an unexplored interior, whose flotsam we anxiously interrogate for clues as to the nature of the unknown hinterland; yet nothing reaches us from beyond the coast-belt, which we have already explored. The Wealden flora is in fact so meagre that it is hard to regard the formation as fluviatile, and one is tempted to believe that it was formed in some brackish lake into which the spoils of the land were rarely drifted.

The first pages afford a comparison of the plants of the English Wealden with those of other countries, but that any of the formations included, especially from beyond Western Europe, are really contemporaneous, must be open to doubt. None of them, however, with trifling exceptions, contain any indications of the presence of angiosperms. Another remarkable fact is the extraordinary geographical range of the English species, only ten out of thirty being peculiar to this country, and these are the most poorly represented. A perhaps unavoidable drawback, to this book and former ones of the series, is that they change established nomenclature so greatly as to render preceding lists of British fossils useless.

A new term, *Algites*, designates the markings which probably represent Algæ. A rather widely distributed *Chara* and a new species under *Marchantites* are important acquisitions; as are the three species of *Equisetum* with tuberous roots, of which one is new. These tubers show that some description of fruit could have been preserved if they had ever been present.

The bulk of the volume is taken up with the Ferns, which are fairly, perhaps over-cautiously, treated. The time-honoured *Sphenopteris Mantelli*, with an enormous range, becomes *Onychiopsis*, representing *Onychium*. A second British form is identified with one hailing from Japan and China; and a new and pretty *Acrostichum*, described as *Acrostichopteris*, completes the list assigned to the vast family of the *Polypodiaceæ*. Tree ferns are more abundant. A remarkable and oft-described species will probably find its final resting-place in *Matonidium*, where it was first placed by Schenk. Another, known from the trunk only, is described under the scarcely satisfactory name *Protopteris*, Presl., preferred by the author to *Caulopteris*. With its marked affinities, it would have been convenient if this, and perhaps two other species, had been given a generic name suggesting relationship with *Dicksonia*.

Sphenopteris is further dismembered by the reference, with a query, of *S. Gœpperti* to the *Schizaceæ*, a family so well represented in the newer Cretaceous and Eocene rocks. It seems again somewhat unfortunate that this species should have received a new generic name (under cover, perhaps, of the query) which in no way reveals its presumably strong affinities with *Anemia*. If nomenclature is to be an aid instead of a stumbling-block, meaningless names should be prohibited. In this particular case Mr. Rufford did not even discover the species, and *Ruffordia* as a generic name will probably disappear when the highly probable close relationship is incontestably established. Moreover, the author's desire to pay Mr. Rufford a well-earned compliment could have been easily gratified among the "genera which afford no trustworthy evidence as to their affinities with existing families," which follow on. Of species falling under this head six are placed in Brongniart's *Cladophlebis*, a provisional genus adopted by some of the best palæobotanists. Two species, one new and the other renamed, represent *Sphenopteris*. The old *Lonchopteris Mantelli* becomes *Weichselia*. It is an abundant but distinctly brittle fern, which may prove to be a *Gleichenia*, a species so abundant in the newer Cretaceous that it could hardly be unrepresented in the Wealden. The remaining forms comprise a number of interesting fragments, the Oleander-like *Tæniopteris*, *Sagenopteris*, two curious net-veined fragments, *Dictyophyllum* and *Microdictyon*, new to the Wealden of England, and which might have come from the Eocene, so closely do they agree. These suffice, at all events, to show that if we could only meet with some fairly representative leaf-beds, such as abound in newer formations, the Wealden would yield a flora, both varied, and of enormous interest. The descriptions conclude with a sufficiently exhaustive discussion of the affinities of that difficult fossil *Endogenites erosa*, which the majority appear agreed to place in *Tempskya*. This, by the by, as an arborescent fern, would have more properly followed the *Cyatheæ*.

The whole result shows that a few species which grew on or near where they are found are abundant in the Wealden, while the rest are rare and fragmentary. A large proportion possessed separate fertile pinnæ, a character maintained in ancient fern-life down to the Tertiaries, and judging from the preponderance of ferns, the Wealden must be still reckoned in the age of Cryptogams. The next part, dealing with Gymnosperms, will be awaited with interest.

OUR BOOK SHELF.

A Monograph of Lichens found in Britain; being a Descriptive Catalogue of the Species in the Herbarium of the British Museum. By the Rev. James M. Crombie, M.A., F.L.S., F.G.S., &c. Part I. (London: Printed by order of the Trustees, 1894.)

MR. CROMBIE'S monograph of the British lichens, of which the volume before us forms the first half, is a valuable addition to that splendid series which, issued by the order of the Trustees, form the "Catalogues" of the vast collections preserved in the British Museum.

Botanists will welcome Mr. Crombie's book, for notwithstanding the works of Leighton and others, the lichens have for the most part been treated with singular neglect. Nor need we seek very far, perhaps, for the reason of this; their isolation, and the tedious difficulties connected with the task of dealing minutely with the group, have all tended to restrain people from a pursuit which is further hedged about with a formidable and unwieldy terminology. Other problems more immediately awaiting, or at least inviting, solution, have attracted the majority of investigators, and this notwithstanding the splendid results yielded by the researches of Schwendener and others into the real nature of these plants. And yet the disregard into which the study of lichens has fallen is really not deserved. It is even possible that a clue to the physiological solution of some of the most interesting questions of morphology may ultimately be found amongst these very plants, which from their composite nature can be constructed or altered at the will of the investigator.

It must, however, be admitted that the taxonomy of lichens is not altogether an inviting study, and Mr. Crombie has rendered a great service in lessening the actual difficulties which necessarily have to be encountered. He begins by providing a glossary (which we think might with advantage have been more extensive), and then, after a synopsis and a conspectus of the groups and genera, occupying a dozen pages in all, he enters at once on the main body of the work.

The diagnoses are extremely good and, in so far as we have tested them, accurate and distinctive. We cannot, however, help wishing that some stand could have been made against the practice of using incorrect, though possibly convenient, "chemical" formulæ (*e.g.* CaCl for chloride of lime) to denote the reagents so often used in determining the different species.

Those who are familiar with the literature will recognise Nylander's influence through the book as a whole, and we do not hesitate to express our satisfaction at this; indeed, in a systematic treatise it is perhaps impossible for some of Nylander's own definitions to be improved on.

Perhaps the only parts of the book which are at all suggestive of weakness, are the illustrations. These are frequently rather diagrammatic, but at the same time we venture to think they are sometimes not as clear as they might have been, and the impressions are unfortunately not seldom lacking in sharpness and definition. Of course the actual preparations of lichens are often neither very clear nor particularly illuminating; but these are precisely the defects which admit of remedy in a diagram or a figure. Apart, however, from this point, the book deserves the very highest praise, and its great merits will assuredly cause it to occupy a distinguished and a permanent position in the literature of lichens.

Travels in a Tree-top. By Charles Conrad Abbott. Pp. 208. (London: Elkin Mathews and John Lane, 1894.)

THE naturalist with poetic fancy, who sees beauty in "all that run, that swim, that fly, that crawl," and publishes his feelings in writings more or less after the style of Richard Jefferies, is very much abroad just now. Sometimes he is more poet than naturalist, but he is always a lover of nature, and though his interpretations are often lacking in scientific accuracy, his observations are generally worth putting on record. Dr. Abbott belongs to this class of nature's disciples. Systematic science has no charms for him. He prefers rather to roam the fields and woods, and watch life in all its varying moods and motions. Ensconced in the branches of a high tree, he has seen sights never vouchsafed to mortals with more limited horizons. He has watched the building of nests, and his observations on the method of working are as valuable as they are interesting. The footprints of various birds, the sinuous traces made by mussels and water-snakes on the ripple-washed sand of a sea-shore, and an infinite variety of similar impressions, have furnished him with objects of study. These are the kind of topics treated in the book, the scene of which, judging from internal evidence, is in Maryland. For the most part, the reading is pleasant gossip, free from rhapsody and tiresome platitude. The title does not, however, clearly express the character of the contents, for it only refers to one of the seventeen papers which make up the volume.

The publishers are famed for their tasteful editions in *belles-lettres*, and they have done their best to give an æsthetic value to Dr. Abbott's musings on sundry phenomena.

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 Electrification of Air.

As attention is called to this subject by the paper, by Lord Kelvin and Mr. Magnus Maclean, in NATURE for July 19 (p. 280), it may be worth while to point out that two distinct questions, which it is important should not be confused, arise as to the electrification of air. The first question is whether an electric charge can be given to a quantity of dust-free air? In other words, whether a gas can get into a condition in which it can carry a charge of electricity? The evidence derived from the electrification observed in vacuum tubes, &c., seems almost conclusive in favour of an affirmative answer to this question, which is the one considered by Lord Kelvin. The second and quite different question is whether this electrification of the gas is possible unless some of the gas is in a special state, such, for example, as would be produced if some of the molecules were split up into atoms? To adopt a definite theory, for the sake of putting the question clearly: Is the electricity in the charged gas carried by molecules or atoms?

It was the second of these questions, not the first, which I discussed in my "Recent Researches in Electricity and Magnetism," under the heading "Can a *molecule* of a gas be electrified?" The ultimate fate of a charged drop of water, alluded to by Lord Kelvin and Prof. Elihu Thomson, is, as far as I can see, not in any way inconsistent with the view which I advocated, that the *molecule* of a gas can not be electrified. For take the case of a drop of water impure enough to be regarded as an electrolyte, and suppose it negatively electrified. The negative charge will be carried by oxygen ions or atoms; thus, if it were possible to evaporate all the water away, the electricity would be left on these atoms, and there would be no charge on either the *molecules* of water or air. On the other hand, the fact that the water molecules escape from the electrified surface without any electrification, seems in favour of the view that the water molecules can not be electrified. Again, it is worth remembering that a square centimetre of surface, immersed in air at the standard temperature and pressure, is struck by about 10[illegible] molecules per second; yet such a surface will retain for hours, without sensible loss, a charge of electricity, which, as we know from the electrolytic properties of liquids and gases, could be carried by a few thousand millions of particles if these were to receive such a charge as the *atoms* of the gas are able to carry.

J. J. THOMSON.

Cambridge, July 20.

"Testacella Haliotoidea," Drap.

IN NATURE for the 5th inst. Mr. J. Lloyd-Bozward has a note headed "Testacella haliotoidea," of which slug he says that "specimens are not infrequently collected in asparagus-beds, as are also those of the much rarer *T. scutulum*."

It will be allowed that the latter species is often found in such places, those recently recorded from Buckhurst Hill, for instance (*Essex Naturalist*, vol. vii. 1893, p. 46), but exception may be taken to the statement that *Testacella scutulum*, Sow., is much rarer than *Testacella haliotoidea*, Drap.—in fact, it would seem that the opposite is the case.

Until recently every British example of the genus not referable to *Testacella maugei*, Fér., was called *haliotoidea*: however, the late Mr. Charles Ashford in 1885 pointed out to Mr. J. W. Taylor that there were anatomical differences between the form that seventy years before had been called *scutulum* by Sowerby, and the typical *haliotoidea*. The figures in Mr. Taylor's paper (*Journal of Conchology*, 1888, p. 337), which was the outcome of this, were not altogether convincing, and the present writer, in some remarks to the Linnean Society (June 1893), on the method of feeding in Sowerby's species (see *Zoologist*, August 1893) thought it advisable to endorse Mr. Taylor's statements from his own observations. Again, in the following July, Mr. Walter E. Collinge (*Annals and Magazine of Natural History*) gave some very clear figures and descriptions of some anatomical details of the genus, ably supplementing Mr. Ashford's work.

Now that the specific distinctness of *Testacella scutulum* is beginning to be recognised, the records for this species are getting numerous, while those for *haliotoidea* are apparently dwindling, doubt being thrown on existing records, and, as can easily be foreseen, supposed localities having to be struck out in favour of the allied form. Almost all the shells of this genus preserved in the British Collection at South Kensington, on running through them with Mr. Edgar Smith, turned out to belong to *Testacella scutulum*.

Mr. Bozward's record of *Testacella haliotoidea* is interesting, as Tate's list of counties can hardly be reliable now, a catalogue of localities as exhaustive as that given for the other species by Mr. Taylor, in his paper, already referred to, would be most useful. The following are a few records which the writer has been able to lay his hands upon, at short notice, for the *true haliotoidea*.

Horsham.—The first specimen which Mr. Taylor sent to Mr. Ashford, which was really this species, was from here (letter to the writer).

Oxford.—Mr. Taylor mentions having a specimen from Prof. Poulton (in his paper on *T. scutulum*).

Chepstow.—Mr. Taylor mentions this locality (letter to the writer).

Yorkshire and Cornwall.—Mr. Collinge had his specimens chiefly from these counties (letter to the writer).

Ireland.—Dr. Scharff gives Youghal, co. Cork (in "Irish Land and Freshwater Mollusca," *Irish Naturalist*, 1892).

Kew.—The writer collected specimens in the Royal Gardens some years ago.

WILFRED MARK WEBB.

Biological Laboratory, Chelmsford, July 19.

Two Arctic Expeditions in One Day.

THE 7th of July was memorable as the date of sailing of two Arctic expeditions, one from St. John's, Newfoundland, the other from New York. The steamer *Falcon*, having set out from New York in June, and touched at St. John's, made its final departure from that point for Bowdoin Bay, Inglefield Gulf, Greenland, having on board the Peary auxiliary expedition, the intention being to convey Lieut. Peary and his twelve companions back to the United States in September, after their twelve months' sojourn in the Arctic regions. The *Falcon* was saluted in passing by the British man-of-war *Cleopatra*.

The expedition will be gone about ten weeks. Cary Island, Cape York, and Clarence Head will be visited. Various scientific work will be pursued, including the study of glacier systems.

The iron steamer *Miranda*, chartered by Dr. Frederick A. Cook, of Brooklyn, sailed from New York the same afternoon with a party of fifty men of science and pleasure-seekers. Labrador and the west coast of Greenland will be visited. Several of the party will remain in Greenland to prosecute scientific researches. The steamer will then go to Melville Bay, and perhaps visit the quarters of Peary and other explorers, returning about the middle of September.

Among the passengers were ten Eskimo, who had been stationed in the Eskimo camp at the World's Fair in Chicago last year, and are returning home. WM. H. HALE.

Brooklyn.

Rearing of Plaice.

IN NATURE of July 12 (p. 251), there is an interesting note on the rearing of larval plaice at Plymouth, by Mr. J. T. Cunningham, in which it is mentioned that they have been reared to the age of thirty-seven days; but it is not stated how long the incubation went on. It may be interesting to say that at the Fishery Board's Marine Hatchery, at Dunbar, I succeeded in preserving many millions of larval plaice from twenty-four to thirty-three days, counting from the time of fertilisation; and some were reared in jars for longer. On one occasion I kept them in a thriving condition to the forty-seventh day after impregnation of the eggs, at which age they were carried away by an accidental overflow. The eggs were fertilised on April 3, hatched on April 19, and larvæ reared until May 20, when the accident occurred. A description in full will be given in the Fishery Board's report. HARALD DANNEVIG.

Fishery Board's Marine Hatchery, Dunbar, July 17.

Absence of Butterflies.

REFERRING to "Delta's" note, I may say that in the fine weather which we had here in April, the small tortoise-shell butterfly appeared more numerously than ever I had witnessed it at that season, or indeed at any time. I recollect counting a dozen at one time on a small bush of *Andromeda floribunda*, then in flower. Many of them were on wing in the latter days of March, alighting on the willow blossoms. With the fall of temperature in May they disappeared, and only in these recent warm days of July have I again seen them. The first white butterfly of the season was seen here April 21, the glowworm on June 23 (three weeks later than last year), and the horse-fly, *Hippobosca equina*, on June 28. J. SHAW.

Tynron, Dumfriesshire.

THE OXFORD MEETING OF THE BRITISH ASSOCIATION.

WE regret to announce that Mr. W. H. White, C.B., will be unable, through ill-health, to give the evening lecture on "Steam Navigation at High Speeds," announced for Thursday, August 9. The Council of the Association has secured the services of Dr. J. W. Gregory to fill his place, and we believe that the title of Dr. Gregory's lecture will be "Experiences and Prospects of African Exploration."

During the past week further information has come to hand as to the work in some of the Sections. In Section C (Geology) the President, Dr. L. Fletcher, will deal in his address with the progress of mineralogy since Dr. Whewell's report was presented in 1832. Prof. Green will read a paper on the geology of the country round Oxford, with special reference to the places to be visited during the excursions. Prof. Boyd Dawkins will contribute several papers, including one on the probable range of Coal Measures under the newer rocks of Oxfordshire. Amongst others are papers by Mr. H. A. Miers, on a new method of measuring crystals; by Mr. E. P. Culverwell, on an examination of Croll's and Ball's theory of Ice Ages and Glacial Epochs; Mr. W. W. Watts, on barytes in Keuper sandstone; Dr. H. Hicks, on some Lacustrine deposits of the Glacial Period in Middlesex; and Dr. J. Anderson, on some volcanic subsidences in the North of Iceland. There will be a joint meeting of Sections C and H, to discuss the implements of the plateau gravels and their bearing on the antiquity of man.

In Section G (Mechanical Science), the President, Prof. A. B. W. Kennedy, will deal in his address with modern mechanical training, constructive and critical. Sir Frederick Bramwell will read a paper on Thursday, August 9, on Steam Locomotion on Common Roads. On the Friday there is to be a joint discussion with Section A, on Integrators, Harmonic Analysers, and Integraphs, and their applications to physical and engineering problems. This discussion will be opened by Prof. O. Henrici, who is expected to exhibit some valuable models and instruments. On the same day, Lord Kelvin will read a paper on the resistance experienced by solids moving through fluids, which will be followed by a discussion on Flight. Other papers, by Prof. Fuller, Mr. FitzMaurice, and Mr. H. Davey, will follow. On the Saturday, Sir A. Noble, F.R.S., will open with a valuable paper on the measurement of pressures in gun bores; and other papers, by Mr. B. Donkin and Mr. J. Kenwood, will follow. The Monday will be devoted to electrical questions, and among others Mr. W. H. Preece will give two papers on Signalling without Wires, and on the Efficiency of Glow Lamps. On the Tuesday, several papers of mechanical engineering interest will be read by Prof. Unwin, Mr. J. Swinburne, Prof. Capper, and Prof. Hudson Beare.

The programme of Section H (Anthropology) is already a large one, including nearly fifty reports and papers of great interest. Amongst these are papers by Mr. Lionel Decle, on the native tribes of Africa between the Zambesi and Uganda; Dr. A. B. Meyer, on the distribution of the Negritos; M. Émile Cartailhac, on the art and industry of the Troglodytes of Bruniquel (France), and two other communications; Mr. J. Theodore Bent, on the natives of the Hydramoot; Count Goblet d'Alviella, on recent discoveries in prehistoric archæology in Belgium; Prof. Max Lohest, on observations relative to the antiquity of man in Belgium; Mr. Arthur Evans, on the discovery of a new hieroglyphic system and pre-Phœnician script in Crete; and Prof. J. Kollmann, on pygmies in Europe. It must be understood that where dates have been given above, they are only provisional, and that the order in which the papers are to be read is liable to alteration before and during the meeting, due notice of which will be given in the daily journal.

Section I (Physiology) will meet in the fine Physiological Laboratory of the University adjoining the Museum; and, judging from the number and interesting character of the communications which have been already promised, its launch into independent existence should prove most successful. A very large number of the physiologists of Great Britain have announced their intention of being present, and, in addition, the President of the Section, Prof. Schäfer, will have the support of several distinguished foreign physiologists, amongst whom are Prof. Chauveau (of Paris), Prof. Hermann (of Königsberg), Prof. Engelmann (of Utrecht), Prof. Heger (of Brussels), and Prof. Gaule (of Zurich).

The programme of local arrangements is drawn up, but owing to alterations being required, consequent on the withdrawal of Mr. W. H. White's lecture, and other causes, it will not be ready for distribution before the beginning of next week.

The Local Secretaries desire to give notice that all communications should be addressed to them at the British Association Office, the Examination Schools, Oxford, and *not* to the University Museum, as heretofore.

BIG GAME SHOOTING.[1]

WHILE partridges and pheasants, and even hares and rabbits (in spite of the Ground Game Bill) continue to increase and multiply, to the delight of the ordinary sportsman, there can be no doubt that the supply of what is termed "big game" is rapidly and seriously diminishing year by year. In North America the bison or "buffalo" is extinct as a wild animal, and the wapiti is hardly to be met with anywhere within reach. In Europe the steinbock has entirely disappeared, and the chamois is found only in certain districts where it has been carefully preserved. Cashmere, formerly the happy hunting-ground of the Indian officer, is now nearly cleared out, and it is very hard work, we are told, to get one decent "head" of barasingha or ibex in a whole season. As for Africa, the whole of the easily accessible country has been swept clean by the host of "big game" shooters, and it is only by penetrating into such distant places as the swamps of the Luapula, or the torrid deserts of Lake Rudolph, that the larger mammals, which formerly populated its whole surface, can be "got at" in any numbers. Such being the case, it was quite time that an account of what has been for many years one of the great national sports of the British race should be taken in hand. It will help the adventurous spirits of the present generation to share more easily in a pastime that cannot last much longer, and, at the same time, hand down to future ages a record of what were the delights and dangers of slaughtering the extinct mammals of the preceding era.

Of the high qualifications of the editor and those who have assisted him in the present work, there can be no doubt whatever. Mr. Phillipps-Wolley is a recognised authority upon the game of the Caucasus and Western America. The names of Baker, Oswell, Jackson, Pike, and Selous are well known to sportsmen all over the world as those of ardent and intrepid hunters of the past and present generation. In the present work they have all made excellent contributions to the common stock of knowledge on the subject; but, as is usually the case where five or six people join together in writing one book, there is perhaps a little want of a uniform system in the combined product. We may even venture to hint that a little judicious compression and excision might have combined the two volumes into one. On the whole, however, this perhaps would not have been altogether desirable; it might have caused the omission of some of the excellent illustrations which pervade the two volumes, and possibly have interfered with the very plain and legible print now before our eyes.

The first volume of "Big Game Shooting" opens with an essay by Mr. Phillipps-Wolley on the general principles of the subject. No apology, we agree with him, is required for "Big Game Shooting." Man from his earliest origin has been a hunting animal. Even in the most highly civilised races the love of wild sport affects some of the most highly gifted and intelligent of the race, and gives exercise to those masculine virtues which in these days it is so necessary to encourage. The best hunters, moreover, have done much for geography and much for science, although it may be the mere love of hunting that has originally prompted them in their expeditions. In Africa, as Mr. Phillipps-Wolley well puts it, hunting and exploration have certainly gone hand in hand; in America, it was the hunter who first explored and settled the great West; while in India, not the least amongst those latent powers which enable us to govern our Asiatic fellow-subjects, is the "respect won by generations of English hunters from the native shikaris and hillsmen."

Agreeing fully with the author in his vindication of the

Fig. 1. Game animals in British East Africa.

[1] "Big Game Shooting." By Clive Phillipps-Wolley. With contributions by Sir Samuel W. Baker, W. C. Oswell, F. J. Jackson, Warburton Pike, and F. C. Selous. The Badminton Library. Two vols. (London: Longmans, Green, and Co., 1894.)

merits of big game shooting, we will not follow him into the arcana relating thereto, which will be mainly profitable to those who wish to indulge in the pursuit.

The four chapters which follow Mr. Phillipps-Wolley's introduction are devoted to a biography of Oswell, and to a history of his various expeditions in South Africa. These are all of great interest, and will be read by his brother shooters with an affection and reverence correctly due to so renowned a pioneer of their favourite pursuit. But the days of Oswell, alas, are past and gone, and we doubt whether the modern shooter of big game will profit much by the narrative of his hazardous exploits, although they will form excellent chapters for reading round the camp fire—if big game shooters ever have time for such a diversion. Very different is the case with Mr. F. J. Jackson, of Uganda fame, whose eleven chapters occupy the next place. East Africa is now almost the only country in the world where there is still unoccupied space left for the shooters of big game, and where the elephant, the buffalo, the lion, the rhinoceros, the hippopotamus, the giraffe, and a host of antelopes are still to be met with in luxuriant abundance. Mr. Jackson commences with good advice on the proper mode of fitting out an expedition, and on the routes and districts to be traversed with greatest profit.

He then devotes separate chapters to the various animals above mentioned, and gives us altogether what will prove to be a most useful guide-book to the hunter in Eastern Africa. The chapter on antelopes is of very great interest even to the scientific naturalist. The various species are separately enumerated, and discussed under their correct scientific names. Their number, not only as regards individuals, but species, is simply astonishing. Dividing them according to the sportsman's point of view into two categories, Mr. Jackson places eighteen antelopes under the head of those which frequent the open plains, while those which are usually found in the bush make fifteen more, so that not less than thirty-three species of these elegant bovine animals are registered as occurring in East Africa. Had Somaliland been included within East African limits, several more species might have been added. We look upon Mr. Jackson's contribution as the most original and valuable part of the first volume, although Mr. Selous' chapter on the lion and his ways, and Mr. Pike's account of the slaughter of the musk-ox in the barren lands of Arctic America, are likewise of considerable value.

To the second volume of "Big Game Shooting" the contributors are hardly less inferior in fame than those who have written the former portion. Mr. Arnold Pike discourses on Arctic hunting, in which the walrus and the polar bear form the chief subjects of attraction. Mr. Phillipps-Wolley tells us of his adventures in the Caucasus, where the chief mountain game consists of the chamois and two species of ibex, while the slopes on the northern side of the chain are the favourite haunts of the few bison that are left, and of a large stag, termed by Mr. Phillipps-Wolley the red deer. But this stag is more probably the maral (*Cervus maral*) which many years ago was introduced into the Zoological Society's gardens from Circassia, and flourished abundantly for more than ten years.[1] Of the bison, or as it is called in this work, the "Caucasian aurochs," the redoubtable traveller and hunter, Mr St. George Littledale, the only Englishman who has slain this mighty beast in the Caucasus, gives us full particulars. As is now well known, a small district on the northern slope of the Caucasus and one far-distant forest in Lithuania are the only remaining spots on the face of the earth where this splendid animal is still to be met with. Not many centuries ago, no doubt, the European bison pervaded the whole intervening district, and in past ages spread all over Europe, and was abundant even in England. But to call it the "aurochs" is a misnomer, for the true aurochs is the extinct Urus (*Bos primigenius*) which was found in the forests of Germany during the time of Julius Cæsar. Mr. Littledale also gives us a good account of the huge *Ovis argali* of Mongolia, and the corresponding *Ovis polii* of the Pamir, two gigantic sheep, which he was amongst the first of British sportsmen to encounter.

FIG. 2.—Spanish Ibex.

Another well-known hunter, Mr. Baillie-Grohman, writes chapters on the more familiar chamois and stag of the Alps, while Messrs. Chapman and Buck contribute an excellent account of the large game of Spain and Portugal, a subject on which they are well qualified to speak from long personal experience. The picture of the Spanish ibex, taken from Mr. Chapman's sketches, with the lammergeiers floating in the distance, gives us a good idea of the attractions still to be met with in "Wild Spain," which he and Mr. Buck have done so much to

[1] See Mr. Sclater's article on "The Deer, now or lately living in the Society's Menagerie." (*Trans. Zool. Soc.* vii. p. 336.

make known to us. Indian shooting is well treated by Colonel Percy, who goes very fully into the subject. It is, indeed, an ample one, and Colonel Percy enumerates no less than fifty-three animals to be included in the category of big game by the fortunate sportsmen of India. The second volume concludes with good advice about camps, transport, rifles, and ammunition, and with a few hints on taxidermy, showing the way in which the larger animals should be skinned and their heads set up as sportsmen's trophies.

In concluding our notice of this attractive work, we may be permitted again to call notice to the illustrations, which, with few exceptions, are of a high degree of excellence. Two of these, by the kind permission of the publishers, we reproduce on the present occasion. The first of them represents a scene in British East Africa, between Teita and Taveta, in the Kilima-njaro district, where (in September 1886) the country was "literally crawling" with zebra, hartebeest, impala, oryx, and Grant's antelope, besides eland and giraffe, and an occasional steinbok and wart-hog." In those days Taveta was correctly designated the "Hunters' Paradise." The second illustration shows us the haunt of the Spanish ibex, of which we have already spoken.

Before concluding our notice of what will no doubt quickly and deservedly become the big-game-shooters' favourite handbook, we venture to call attention to what is probably a slight slip on the part of Mr. Phillipps-Wolley. General Richard Dashwood, than whom there can be no better authority on the subject, has commented, in an article in *Land and Water* (March 24, 1894), rather severely on some of Mr. Phillipps-Wolley's statements regarding the caribou and moose of North America. It is no doubt incorrect to say that caribou and moose feed upon the same food. As explained by General Dashwood, their tastes are very different. It is also an error to describe the "call-cry" of the female moose as a roar. General Dashwood's experienced ear teaches him to describe it as a "beautiful clear note, rising and falling with a sort of entreaty in the tone and a soft grunt at the end."

POPULARISING SCIENCE.

"POPULAR science," it is to be feared, is a phrase that conveys a certain flavour of contempt to many a scientific worker. It may be that this contempt is not altogether undeserved, and that a considerable proportion of the science of our magazines, school text-books, and books for the general reader, is the mere obvious tinctured by inaccurate compilation. But this in itself scarcely justifies a sweeping condemnation, though the editorial incapacity thus evinced must be a source of grave regret to all specialists with literary leanings and with the welfare of science at heart. The fact remains that in an age when the endowment of research is rapidly passing out of the hands of private or quasi-private organisations into those of the State, the maintenance of an intelligent exterior interest in current investigation becomes of almost vital importance to continual progress. Let that adjective "intelligent" be insisted upon. Time was when inquiry could go on unaffected even by the scornful misrepresentations of such a powerful enemy as Swift, because it was mainly the occupation of men of considerable means. But now that our growing edifice of knowledge spreads more and more over a substructure of grants and votes, and the appliances needed for instruction and further research increase steadily in cost, even the affectation of a contempt for popular opinion becomes unwise. There is not only the danger of supplies being cut off, but of their being misapplied by a public whose scientific education is neglected, of their being deflected from investigations of certain, to those of doubtful value. For instance, the public endowment of the Zetetic Society, the discovery of Dr. Platt's polar and central suns, or the rotation of Dr. Owen's Bacon-cryptogram wheel, at the expense of saner inquiries might conceivably and very appropriately result from the specialisation of science to the supercilious pitch.

It should also go far to reconcile even the youngest and most promising of specialists to the serious consideration of popular science, to reflect that the acknowledged leaders of the great generation that is now passing away, Darwin notably, addressed themselves in many cases to the general reader, rather than to their colleagues. But instead of the current of popular and yet philosophical books increasing, its volume appears if anything to dwindle, and many works ostensibly addressed to the public by distinguished investigators, succeed in no notable degree, or fail to meet with appreciation altogether. There is still a considerable demand for popular works, but it is met in many cases by a new class of publication from which philosophical quality is largely eliminated. At the risk of appearing impertinent, I may perhaps, as a mere general reader, say a little concerning the defects of very much of what is proffered to the public as scientific literature. As a reviewer for one or two publications, I have necessarily given some special attention to the matter.

As a general principle, one may say that a book should be written in the language of its readers, but a very considerable number of scientific writers fail to realise this. A few write boldly in the dialect of their science, and there is certainly a considerable pleasure in a skilful and compact handling of technicalities; but such writers do not appreciate the fact that this is an acquired taste, and that the public has not acquired it. Worse sometimes results from the persistent avoidance of technicality. Except in the cases of the meteorologist, archæologist, and astronomer, who are relatively free from a special terminology, a scientific man finds himself at a great disadvantage in writing literary English when compared with a man who is not a specialist. To express his thought precisely he gravitates towards the all too convenient technicality, and forbidden that, too often rests contented with vague, ambiguous, or misleading phrases. It does not follow that, because, what from a literary standpoint must be called "slang," is not to be used, that the writer is justified in "writing down" as if to his intellectual inferiors. The evil often goes further than a lack of precision. Out of a quite unwarrantable feeling of pity and condescension for the weak minds that have to wrestle with the elements of his thought, the scientific writer will go out of his way to jest jests of a carefully selected and most obvious description, forgetting that whatever status his special knowledge may give him in his subject, the subtlety of his humour is probably not greatly superior, and may even be inferior to that of the average man, and that what he assumes as inferiority in his hearers or readers is simply the absence of what is, after all, his own intellectual parochialism. The villager thought the tourist a fool because he did not know "Owd Smith." Occasionally scientific people are guilty of much the same fallacy.

In this matter of writing or lecturing "down," one may even go so far as to object altogether to the facetious adornment of popular scientific statements. Writing as one of the reading public, I may testify that to the common man who opens a book or attends a lecture, this clowning is either very irritating or very depressing. We respect science and scientific men hugely, and we had far rather they took themselves seriously. The taste for formal jesting is sufficiently provided for in periodicals of a special class. Yet on three occasions recently very considerable distress has been occasioned the writer by such mistaken efforts after puerility of style. One was in a popular work on geology, where the beautiful problems of the past of our island and the evolution of life were defaced by the disorderly offspring of a quite megatherial wit—if one may coin such an antithesis to "etherial." One jest I am afraid I shall never forget. It was a Laocoon struggle with the thought that the huge subsidiary brains in the lumbar region of *Stegosaurus* suggested the animation of Dr. Busby's arm by the suspicion of a similarly situated brain in the common boy. The second disappointment was a popular lecture professing to deal with the Lick Observatory, and I was naturally anxious to learn a little of the unique appliances and special discoveries of this place. But we scarcely got to the Observatory at all. We were shown—I presume as being more adapted to our intelligence—numerous lantern-slides of the road to the Lick Observatory, most of them with the "great white dome" in the distance, other views (for comparison probably) with the "great white dome" hidden, portraits of the "gentlemen of the party on horseback," walks round the Observatory, the head of an interesting old man who lived in a cottage near, the dome by moonlight, the dome in winter, and at last the telescope was "too technical" for explanation, and we were told in a superior tone of foolish things our fellow common people had said about it. For my own part, I really saw nothing very foolish in a lady expecting to see houses on the moon. My third experience was ostensibly a lecture on astronomy, but it was really an entertainment—and a very fair one—after the lines of Mr. Grossmith's. "Corney Grain in Infinite Space" might have served as a title. It was very amusing, it was full of humour, but as for science, the facts were mere magazine *clichés* that we have grown sick of long ago. And as a pretty example of its scientific value I find a newspaper reporter, whose account is chiefly "(laughter)" with jokes in between, carried away the impression that Herschel discovered Saturn in the reign of George the Third.

Now this kind of thing is not popularising science at all. It is merely making fun of it. It dishonours the goddess we serve. It is a far more difficult thing than is usually imagined, but it is an imperative one, that scientific exponents who wish to be taken seriously should not only be precise and explicit, but also absolutely serious in their style. If it were not a point of discretion it would still be a point of honour.

In another direction those to whom the exposition of science falls might reasonably consider their going more carefully, and that is in the way of construction. Very few books and scientific papers appear to be constructed at all. The author simply wanders about his subject. He selects, let us say, "Badgers and Bats" as the title. It is alliterative, and an unhappy public is supposed to be singularly amenable to alliteration. He writes first of all about Badger A. "We now come," he says, "to Badger B"; then "another interesting species is Badger C"; paragraphs on Badger D follow, and so the pavement is completed. "Let us now turn to the Bats," he says. It would not matter a bit if you cut any section of his book or paper out, or shuffled the sections, or destroyed most or all of them. This is not simply bad art; it is the trick of boredom. A scientific paper for popular reading may and should have an orderly progression and development. Intelligent common people come to scientific books neither for humour, subtlety of style, nor for vulgar wonders of the "millions and millions and millions" type, but for problems to exercise their minds upon. The taste for good inductive reading is very widely diffused; there is a keen pleasure in seeing a previously unexpected generalisation skilfully developed. The interest should begin at its opening words, and should rise steadily to its conclusion. The fundamental principles of construction that underlie such stories as Poe's "Murders in the Rue Morgue," or Conan Doyle's "Sherlock Holmes" series, are precisely those that should guide a scientific writer. These stories show that the public delights in the ingenious unravelling of evidence, and Conan Doyle need never stoop to jesting. First the problem, then the gradual piecing together of the solution. They cannot get enough of such matter.

The nature of the problems, too, is worthy of a little attention. Very few scientific specialists differentiate clearly between philosophical and technical interest. To those engaged in research the means become at last almost as important, and even more important than the end, but apart from industrial applications, the final end of all science is to formulate the relationship of phenomena to the thinking man. The systematic reference of *Calceola*, for instance, *Theca*, the Lichens, the Polyzoa, or the Termites, is an extremely fascinating question to the student who has just passed the elementary stage, and so too is the discussion of the manufacture and powers of telescopes and microscopes; morphological questions again become at last as delightful as good chess, and so do mathematical problems. But it must be remembered that morphology, mathematics, and classification are from the wider point of view mere intellectual appliances, and that to the general reader they are only interesting in connection with their end. To the specialist even they would not be interesting if he had not first had their end in view. The fundamental interest of all biological science is the balance and interplay of life, yet for one paper of this type that comes to hand there are a dozen amplified catalogues of the "Cats and Crocodiles" description. I find again, presented as a popular article, a long list of double stars with their chief measurements. Now, to a common man one double star is as good as a feast. Again, the botanist, asked to write about leaves, will get himself voluminously entangled in the discussion whether an anther is a lamina, or in an exhaustive and even exuberant classification of simple and compound, pinnate and palmate, and the like, making great points of the orange leaf and the barberry. But the kind of thing we want to have pointed out to us is *why* leaves are of such different shapes and so variously arranged. It is a thing all people who are not botanists puzzle over, and a very pretty illustrated paper might be written, and remains still to be written, linking rainfall and other meteorological phenomena, the influence of soil upon root distribution and animal enemies, with this infinite variety of beautiful forms.

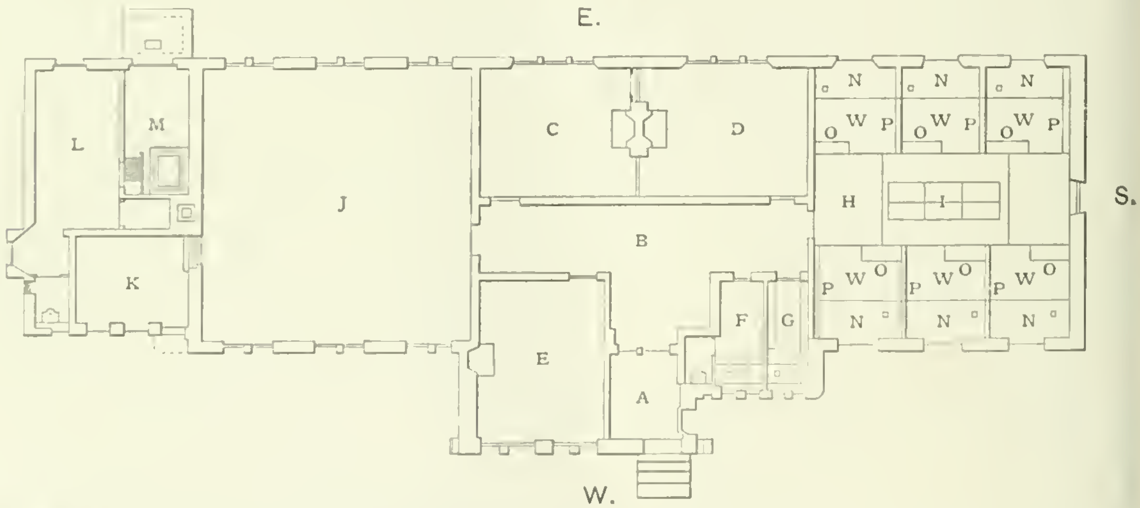
Enough has been said to show along what lines the genuine populariser of science goes. There are models still in plenty; but if there are models there are awful examples—if anything they seem to be increasing—who appear bent upon killing the interest that the generation of writers who are now passing the zenith of their fame created, wounding it with clumsy jests, paining it with patronage, and suffocating it under their voluminous and amorphous emissions. There is, I believe, no critical literature dealing generally with the literary merits of popular scientific books, and there are no canons for such criticism. It is, I am convinced, a matter that is worthy of more attention from scientific men, if only on the grounds mentioned in my opening paragraphs.

H. G. Wells.

ON THE NEW BUILDINGS FOR THE ST. ANDREWS (GATTY) MARINE LABORATORY.

That St. Andrews had not one of the oldest marine laboratories was the result of an accident. Nevertheless it has the oldest marine laboratory in Britain, since it was opened early in 1884, though since 1882 the practical laboratory in the College had been used for this purpose; and it could not well be otherwise, since it was within a stone's cast of the bay—so rich in a varied fauna and flora. For ten years the work of the laboratory has been carried on under considerable difficulties in a wooden building originally erected as a temporary fever-hospital, and the walls and roof of which were neither wind- nor water-tight. This structure was situated on a spit of sand near the harbour, and most conveniently placed for easy access to the fishing-boats and the beach; but it was on a public common, and though for nearly two years every effort has been made to get the new laboratory erected on the same site, it was found to be impracticable, and a new site was therefore chosen on University ground, about 300 yards further south, and close to the beach. This site affords ample space, and, besides, a small fresh-water stream flows through it.

The new laboratory is the munificent gift of Dr. Charles Henry Gatty, of Felbridge Place, East Grinstead, who has placed £2500 at the disposal of the University of St. Andrews for its erection. The building will face the west, with the back towards the east and the sea, and will be for the most part of one storey. From its eastern or sea face the windows command an extensive view of the picturesque bay, with the Forfarshire coast terminating in the steep rocks of the "Red Head" on the left, and on the right the well-known cliffs from which the "Rock and Spindle" and "Maiden Rock" stand out boldly, while here and there a more gentle slope gives a patch of bright green sward. The western face or front has a view embracing the fine old ruins of the cathedral, the southern suburbs of the city, and a wide stretch of Fife, including such eminences as Drumcarro Craig and Clatto Hill. It has a frontage of 125 feet, and the building is in the Scottish style of architecture—unpretending externally, but comfortable and convenient internally.



A, Vestibule; B, Hall; C, Director's Room; D, Library; E, Room for Specimens; F, Cloak Room and Lavatory, G, Chemical Room; H, Research Room, I, Tanks of Room; W, Workers' Compartments; O, Workers' Cabinets; P, Workers' Bookshelves; J, Tank Room; K, Receiving Room; L, Engine and Pumps; M, Heating Chamber.

The entrance is in the projecting block on the west, leading into a vestibule (A), and a spacious hall (B), with lobbies leading right and left. In this block are situated three official rooms, viz. the Director's room (C), the library (D), and the room for specimens (E), the two former looking into the bay, the latter to the west. Besides these are a cloak-room with lavatory (F) and a chemical room (G). The lobby on the right leads to the research room (H), which is 30½ ft. × 30 ft., and contains compartments (W) 10 ft. square, with partial partitions about 8 ft. in height, for six workers. Each of these has at the window a large and convenient table (N) with sink, mirror, and other fittings, on the right wall a series of shelves (P) for books and other things, while behind is a cabinet of drawers (O) for storage of delicate apparatus and specimens. From the position of the building three of these windows look to the sea, and three to the west; while a seventh admits light from the southern end of the building. In the centre of the room is a series of tanks of sea-water, six in number (one for each worker), besides various shelves for smaller glass aquaria, and the necessary pipes and nozzles for distributing sea-water as required. A fireproof compartment for long-continued use (all night) of the hot bath occurs at one end, while each worker has a separate small paraffin apparatus in his compartment.

The lobby on the left leads to the tank-room (J) or aquarium, 30 ft. 6 in. × 30 ft., and with three windows on each side (east and west) for illuminating the tanks—of slate and glass—ranged round the room, as well as placed in the centre. While that part of the building already described has wooden floors, the aquarium is paved with concrete. A door at the northern end leads by a few steps to the receiving-room (K), with its long table and sink, where the specimens procured by the boats are arranged by the attendant before being introduced into the tank-room or distributed to the workers. The outer door to this room is on the western face of the building (front), and above it is a large storage-tank for sea-water. In this block are the apartments for the engine and pumps (L), a store and the heating-chamber with accessories (M), all these being entirely separated from the tank-room by a thick wall of stone.

The main apartments are heated by hot-water pipes, with the exception of the three in the centre (viz. Directors' room, library, and museum), which have fire-places for gas.

The laboratory is capable of easy extension should that ever be necessary, and it is readily reached from the class-rooms of the University. Moreover, being in direct connection with the latter, the workers have the advantage of free access to the University library and museum, besides that communication with those of similar tastes, which is so congenial as well as profitable to the naturalist, and which cannot be compensated by mere richness of fauna and flora, if these are in an isolated locality or difficult of access.

Further, in addition to its connection with the University, the laboratory from the first has been under the control of the Fishery Board for Scotland, who administered the Parliamentary grant given in 1884 for its equipment, and who maintain the attendant and defray certain other expenses.

Ample space exists for the formation of large external ponds and tanks, and certain portions of the tidal rocks in the neighbourhood are fitted for enclosure, so that young fishes and crustaceans may be reared from the post-larval stages onward, under conditions as closely approaching nature as possible. In the same way the culture of useful mollusks can be experimented with.

The beach at St. Andrews is remarkably adapted for marine researches, since it combines extensive reaches of sand with their special forms, and on which a vast variety of materials in a fresh state are stranded by storms, with great stretches of tidal rocks and rock-pools so rich in littoral animals and plants. The valuable mussel-bed in the estuary of the Eden, the proximity of the Forth and the Tay, the constant stream of specimens brought by the fishing-boats, and the plenitude of life in the bay itself—all combine to render it classic ground to the naturalist. For example, amongst the rarer forms at St. Andrews are *Corymorpha*, *Cerianthus*, *Pennatula*, *Asterias Mülleri*, *Echiurus*, *Magelona*, *Tornaria Mitraria*, swarms of Appendicularians (*Oikopleura*), *Pelonaia*, *Actinotrocha*, the Pteropods *Clione* and *Spirialis*, the Nudibranch *Idalia*, and the Tectibranch *Aplysia*.

The greatly improved facilities for research which the munificence of Dr. Gatty has granted to St. Andrews cannot but increase the results in regard to marine biological science and the fisheries, and render the old University city even better known in this connection in the future than in the past. Yet there are those still living who remember the glee of Edward Forbes as he picked up the living spoon-worms (*Echiuri*) on the west sands, and who listened to a short course of lectures he gave in the University on star-fishes, before the publication of his work on this group, and who were familar with the figure of John Reid as he descended the steps at the Baths to hunt for *Hydra tuba*, and watch the scyphistoma-stage of *Aurelia*, which he independently worked out there. It is unnecessary on the present occasion to allude to the names of more recent workers, but they are many, and include continental and American, as well as those of our own country.

W. C. M.

NOTES.

All who take an interest in science will be glad to hear that the health of Prof. von Helmholtz has been improving of late, and that he has regained partial use of his paralysed side.

The resignation of Prof. Dana, from the position he has so long occupied at Yale University, is announced. Dr. Dana was appointed, in 1850, Silliman Professor of Natural History and Geology at Yale, and now at the age of eighty-one years he is compelled to abandon further active work by reason of feeble health. We hope that many years of well-earned rest remain to him.

Prof. H. S. Williams, formerly of Cornell University, has been appointed Prof. Dana's successor at Yale University.

The sixty-second annual meeting of the British Medical Association will take place at Bristol, from July 31 to August 3, under the presidency of Dr. E. Long Fox. The report which the council has to present is, we understand, a very favourable one, and shows that the membership of the Association has increased from 14,703 to 15,090, and the total investments to £41,789. Dr. Long Fox is to deliver his address on Tuesday, July 31, and during the meeting the following addresses will be delivered:—On Medicine, by Prof. Sir T. Grainger Stewart; on Surgery, by Prof. Greig Smith; and on Public Medicine, by Sir Charles Cameron.

The Société Industrielle de Mulhouse has issued a programme of the prizes to be awarded next year. The prizes are open to all, whether natives of France or not, and works competing for them must reach the President of the Society before February 15, 1895. Most of the awards consist of medals only, but some carry with them prizes varying from one hundred to five thousand francs. A complete programme can be obtained by applying to the Secretary of the Society, Mulhouse.

The twenty-third meeting of the French Association for the Advancement of Science will be opened at Caen on August 9, under the presidency of Prof. Mascart. The work of the Association will be divided into four groups, each containing from three to five sections. The first group (Sciences Mathématiques) will be devoted to mathematics, astronomy, and geodesy, mechanics, navigation, civil and military engineering. To Group II. (Sciences Physiques et Chimiques) belong physics, chemistry, meteorology, and terrestrial physics. In the third group (Sciences Naturelles et Médicales) will be found geology and mineralogy, botany, zoology, anatomy, physiology, anthropology, and medical sciences. The fourth group (Sciences Économiques) is concerned with agriculture, geography, political economy and statistics, pedagogy, hygiene, and public health.

The next annual meeting of the Italian Botanical Society will take place at Palermo, in 1895. For the present year a botanical excursion is arranged, on September 25 and the three following days, to the Island of Giglio, the largest of the Tuscan Archipelago, except Elba, the flora of which has been but imperfectly explored. Botanists desirous of taking part in the expedition should communicate, not later than September 15, with the President, Prof. Arcangeli, 19 Via Romana, Florence.

Information has come to hand respecting an International Exhibition of Arts, Industries, &c., which is to be held at Bordeaux in 1895. The exhibition, which is the thirteenth held at Bordeaux, will be opened on May 1, and will be divided into some ten Sections, as follows:—Section I. Education. II. Arts (Liberal, Industrial, and Decorative; Medicine, Hygiene, &c.). III. Social Sciences. IV. Agriculture, Horticulture. V. Wines and Spirits. VI. Industries (Mineralogical, Mechanical, Chemical, &c.). VII. Habitation (Furniture, Dress, &c.). VIII. Transport, Civil Engineering, and Military Art. IX. Electricity. X. Commerce and Colonies. England, Belgium, Italy, Portugal, Spain, and Switzerland are invited to contribute.

The seventeenth annual meeting of the Midland Union of Natural History and Scientific Societies will take place on August 3 and 4, at Ellesmere, under the auspices of the Ellesmere Natural History Society and Field Club. A strong programme has been arranged, and after the business meetings of August 3 a conversazione will be held at St. Oswald's College. The following day will be taken up by three excursions: one to Chirk, Llangollen, and Valle Crucis for the archæologists, led by Mr. A. T. Jebb; a second, round the Meres and Peat Mosses of the neighbourhood for the biologists, under the leadership of Messrs. Peake, Jennings, and Thompson. The third, for the geologists, will be under the guidance of Dr. Callaway, who will conduct his party to Hawkstone and Grinshill. We understand that the Ellesmere Society hope that many of the visitors will be able to stay in the neighbourhood over the Bank-holiday, when further excursions may be arranged, and they are perfecting the arrangements in a most generous and hospitable spirit.

We hear, with much regret, of the death, at the age of seventy-nine years, of Dr. Daniel Cornelius Danielssen, who has been since 1864 president of the Directors of the Bergen Museum, and of Prof. Michele Lessona, President of the Royal Academy of Science at Turin.

THE death is announced of Mr. Alfred Williams, who for many years has been closely identified with the branch of his profession relating to gas engineering. Mr. Williams was one of the founders of the Society of Engineers, and has acted as its honorary secretary and treasurer since its inauguration in 1854.

THE Accademia dei Lincei at Rome held its annual meeting on June 3, the President, Senator Brioschi, being in the chair. The King of Italy always attends these meetings, and this year the Queen accompanied him. The magnificent Palazzo Corsini, which compares with the rooms of the Royal Society very much as the consideration shown to men of science in Italy does with the neglect of science by the powers that be in England, was *en fête*, and the sitting, already recorded at length in the *Atti*, was a most interesting one. The President referred to the work done by the Society, and the constant sympathy of the King with its affairs; and Prof. Ferraris, of the Turin Industrial Museum, gave a discourse on the electric transmission of energy.

WE have often in these columns had to complain of the backwardness of the Government of this country to recognise the value of men of science and the work in which they are engaged, and a fresh instance of this slowness of vision is furnished in a recent number of the *Electrical Review*. It seems that of the deputations sent last year to the International Congress at Chicago, the delegates who represented France and Germany had the whole of their expenses paid, and were rewarded according to their several merits with decorations, honours, and with courteous thanks. The representatives of Great Britain alone have been ignored entirely: and, so far from their services receiving remuneration or thanks, it is doubtful whether her Majesty's Government even know the names of those who looked after British interests and maintained the credit of Britain on this most important occasion. Yet they were all men of the highest eminence, who sacrificed much time and trouble to this thankless business. According to our contemporary, among them was one whose labours have been rewarded abroad with every kind of honour and acclaim, whose work has wrought incalculable benefit, whose inventions are in constant universal use, who gave his greatest discovery freely to the world and who has never in his own country received the smallest official recognition or distinction. Truly, a prophet is not without honour save in his own country and among his own people.

SOME sensational paragraphs have appeared in evening papers as to all hope of the Wellman arctic expedition being abandoned; but this is not the case. There is serious cause for anxiety, but the probability that Mr. Wellman had left the *Ragnvald Jarl* before she was lost, is at least as great as that he was on board at the time. During the next month there will be frequent communication with Spitzbergen, and the position of Mr. Oyen on Danes Island will not be one of utter desolation. Colonel Feilden writes to the *Times* from Lerwick on July 21, correcting some of the extravagant rumours which had been published. He states that none of Mr. Wellman's party had any previous experience of Arctic work, and that the conduct of the expedition, so far as known, showed ignorance of the risks they would have to run.

THE American Museum of Natural History have commissioned Prof. Rudolph Weber to organise an expedition to Sumatra, for the purpose of scientific exploration and the collection of specimens. Mr. Weber will leave New York on the 28th inst., and will study for a short time in Germany, thence proceeding to Sumatra, where he will collect and equip a force of natives for the expedition.

WITH reference to the note in our last number, respecting the Rev. S. A. Thompson Yates's gift to the University College, Liverpool, a correspondent writes:—"The Thompson Yates Laboratories are to be exclusively devoted to physiology and pathology; and since of no two subjects can it be said with more truth that "aliud ex alio clarescet," it is to be hoped that both will largely benefit by the fact of their being housed in the same building. Many of the requirements are identical, so that the proposed new laboratories, whilst providing the separate accommodation for such teaching and research as the study of the subjects requires, will be as far as practicable dovetailed, so as to avoid the reduplication of costly special rooms. It is hoped that such combined laboratories may prove of value by bringing into intimate association pathological and physiological scientific workers, and it is certain that a building complete in itself, which provides for both departments, must lend itself most advantageously to economical maintenance. The building will be situated in the ample grounds of the College, and will form a block to which, at some subsequent date, the Medical faculty hopes to add further new buildings for other departments of its Medical School."

BY permission of the postal authorities, the wires between St. Margaret's and the General Post Office, London, were, on Sunday afternoon and evening last, used for the purpose of some experiments with the teleautograph, the invention of Prof. Gray, of New York; the time for the experiments being selected owing to the wires being comparatively idle on Sundays. The experiments took place between the General Post Office, London, and Cable Hut, St. Margaret's Bay, through which the London and Paris telephone passes. Special instruments were fixed up at both ends, and as this was the first time that long distance experiments in teleautography have taken place in this country, they were watched with unusual interest. The results were excellent, the messages transmitted being in every respect most successful, and the instruments working without the slightest hitch over a distance of 83 miles. Messages were both sent from and received at St. Margaret's Bay. The principle of the instrument is that it automatically records an exact *facsimile* of the writing contained in messages. In the experiments on Sunday the receiving pencil recorded with ease and clearness different handwritings, giving thick and thin strokes, dotting i's, and crossing t's very correctly.

THE current number of the *British Medical Journal*, in a leader on "Cholera Prospects," laments the fact that "there are half-a-hundred places in England where, if cholera were to be introduced to-morrow, it would, unless at once detected, spread, and not only so, but spread to the danger of communities around, and which, by reason of gathering grounds of their water supply, or the like, are at the mercy of some rural body whose sole aim as a body seems to be to cut down the rates at the expense of the public health." The outlook, as far as this country is concerned, is not of the brightest, and health bodies would certainly do well to take to heart the advice of our contemporary, and bestir themselves betimes to the proper fulfilment of the duties devolving upon them.

CONFIRMATION of the wisdom of the old adage, "There is nothing new under the sun," is to be found in the *Lancet* for July 21, which details from the "Newes" of 1665 a series of precautions employed in combating the plague of London in that year. "These include the appointment of parochial examiners to investigate cases of sickness and to take measures for their isolation if needful and the employment of watchmen to ensure this result and of chirurgeons to certify the presence of plague. Notification of this disease was the duty of householders; every infected house was marked in the manner with which we are all familiar and underwent a quarantine of longer or shorter duration, and disinfection was carried out by airing with fire and by medicated fumigation. Nurses on the termination of a case were subject to twenty-eight days' seclusion, and visitors were forbidden the house of sickness." We of to-day could do worse than act upon much of the advice here given.

IN the report of the Puffin Island Biological Station, just received, we find a history of the station since its vacation by the Liverpool Biological Society for their new home at Port Erin. The laboratory was taken over in 1892 by a number of members of the staff of University College, Bangor, and other residents in the neighbourhood; and a committee of management was formed, with Mr. P. J. White, who also edits the report, as director of the station. The contributors to the present report of thirty-two pages deal briefly with special points of interest in the terrestrial fauna and flora and the archæology of the island, and the director offers some suggestions in regard to the improvement of the sea-fisheries (shell-fish) of the district.

THE *Compte Rendu* of the fifth session of the International Geological Congress, held at Washington in 1891, has just appeared. The general arrangement of the book closely follows that of the report of the London Congress (1888), but it is printed on larger paper. The formal reports of discussions, &c., are printed in French, but these occupy only a small portion of the book; the greater part consists of descriptive papers and of fuller reports of some discussions, mainly in English. The description, by C. R. van Hise, of the pre-Cambrian rocks of the Lake Superior region, and the geological guide-book to the Rocky Mountain Excursion, edited by S. F. Emmons, are interesting portions of the report. Some notes and sketches by "visiting geologists"—Prof. T. McK. Hughes and Dr. Fr. Frech—are appended. We may also here note that Dr. F. Wahnschaffe has published detailed descriptions of the Western districts in *Naturwissenschaftliche Wochenschrift*. The Rocky Mountain Guide-book is by numerous contributors, and we have received a separate copy of that part relating to the Yellowstone Park, by A. Hague.

WE have received part i. of the twelfth annual report of the Fishery Board for Scotland, being for the year 1893. Following the practice of previous years, the report will be issued in three parts. The third part deals with the scientific investigations conducted under the direction of the Board, and in it the hatchery established at Dunbar for the propagation of marine food-fishes will be described. We learn from the present part that the establishment consists of a small tidal pond, in which a limited number of spawning fishes may be collected and preserved; a large concrete spawning tank, in which the fishes at maturity are placed; a chamber for the automatic collection of the fish eggs, and for the filtration of the water; a hatching room, in which the special hatching apparatus is fitted up; together with the necessary pumping apparatus. The whole of the expenditure, amounting to about £1600, has been met from the ordinary vote for scientific investigations. So far, the operations have been limited by the want of a sufficiently capacious sea-water enclosure. Nevertheless, over 25,000,000 eggs of the plaice have been hatched in the establishment, and arrangements are in progress with the view of obtaining a supply of adult turbot and soles, so as to admit of these fishes being propagated on a large scale, and the fry placed on the fishing grounds. The opinion is expressed that when large sea-water ponds or enclosures are added, it will be possible to retain the young flat fish until they have assumed the habits of the adults, and thus greatly increase the usefulness of the establishment to the fishing industry.

A REPORT on the cultivable land on Kilimanjaro, with special regard to its climate and healthfulness, is published by Dr. Brehme in the last number of the *Mittheilungen aus Deutschen Schutzgebieten*. The fertile land may be taken as the zone between 3700 and 7000 feet of elevation; this zone, strictly speaking, measures only 500 square miles, but several thousand square miles of the neighbouring country may be included as fit for settlement. The soil is the result of the weathering of volcanic rocks mixed with the humus formed by decaying vegetation; it is from 1 to 3 metres thick on the lower slopes, and of great natural fertility. The water supply is good, from melting snow, as well as from the discharge of the clouds which usually hang over the upper part of the mountain. Rains or wet mists occur frequently at all times of the year. The healthfulness of the slopes watered by rapid streams is in contrast with the fever-haunted marshes of the plain at the base of the mountain, where the slope of the land is insufficient for natural drainage. One very important circumstance is that the water of the mountain streams may be drunk unboiled without any risk. At the station of Marangu (1430 metres), meteorological observations, taken from October 1892 to December 1893, the highest monthly mean temperature at 7 a.m. was 17°·9 C. in December 1892, and the lowest 13° C. in August 1893. The mountain is exposed to the trade winds, the south-east trade blowing from April to October, and the north-east from the end of October to March; but the local winds are modified by a general up-hill wind during the day-time, and a down-hill wind at night. The illnesses most common on the cultivable zone of the mountain are much more frequently due to cold than to malaria. In addition to the banana, sorghum, and maize, all European cereals and vegetables grow readily. There seems to be no reason why the experiment of settling European farmers on the temperate uplands of the mountain should be unsuccessful if fairly tried.

IN the last number of the *Scottish Geographical Magazine*, Prof. Otto Pettersson continues his memoir on recent Swedish hydrographic research in the Baltic and North Seas. In this instalment, which is profusely illustrated with coloured charts and sections, he shows how the observations have thrown new light on the Baltic Current in the Skagerack and North Sea. The outflowing and inflowing currents which traverse the Skagerack can readily be distinguished by the different salinity of the water, the inflowing current containing more than 3·2 per cent. and the outflowing less than 3·0 per cent. of salt. In winter, when the outflowing current, or Baltic Stream, is reduced to its minimum by the freezing of the rivers, it shrinks to the dimensions of a narrow current along the coast, the Skagerack resembling a whirlpool with still water in the middle, and the moving water flowing along the coasts. The water is everywhere warmer than the air, but most so in the centre. Thus, while the air at or below 0° C. is in contact with water of nearly the same temperature off the Swedish coast, in the centre of the Skagerack it rests on water the surface temperature of which may be as much as 5°; thus a central mass of relatively warm air is produced, surrounded by concentric layers which are colder and colder. This not only affects the climate of the Swedish coast, but is favourable to the formation or attraction of cyclones. In spring the cold Baltic Stream overspreads the warm central waters of the Skagerack with a fresher and colder layer, destroying the conditions favouring the formation or passage of cyclones, and thus produces the typical dry and cold spring weather which prevails in Sweden.

IN a letter to the *Electrician*, Prof. Elihu Thomson mentions a curious and rather amusing illustration of the principle upon which the instrument for detecting the presence of electric oscillations, devised by Prof. Oliver Lodge, and called by him the "coherer," is based, which came under his notice lately. It will be remembered that the "coherer" depends on its action on the alteration in the resistance of a "bad contact" between an aluminium plate and an iron wire when electric oscillations are set up in the circuit containing the coherer. It was reported to Prof. Thomson that a certain electro-plater at Philadelphia had found that he could not pursue his silver-plating operations during a thunderstorm, and that if he left his plating over-night, and a thunderstorm came on, the work was invariably ruined. Prof. Thomson says :—"I was disposed to be thoroughly sceptical, and expressed my disbelief in any such effect. Being urged, however, I went to the silver-plater's shop, which was a small one, and questioned the silver-plater himself concerning the circumstances which had been reported. While it was evident that he was not a man who had informed himself electrically, I could not doubt that he had indeed stated what was perfectly true, namely, that when his plating operations were going on and a thunderstorm arose, his batteries, which were Smee cells, acted as though they were short-circuited, and the deposit of metal was made at too rapid a rate. The secret came out on an inspection of his connections. The connections of his batteries to his baths were made through a number of bad contacts, which would not fail to be of high resistance under ordinary conditions. I could readily see that virtually he was working through a considerable resistance, and that he had an excess of battery power for the work. Under these circumstances a flash of lightning would cause coherence of his badly-contacting surfaces, and would improve the conductivity so as to cause an excessive flow of current, and give a too rapid deposit. The incident suggests the employment of Dr. Lodge's ingenious instrument in the study of the waves which are propagated during thunderstorms, of which waves we have practically little or no information."

PROF. R. LEPSIUS, of Darmstadt, is preparing a new geological map of Germany, which will give a valuable summary of our knowledge of that area. It is founded upon the various national surveys and upon other good authorities. The scale is 1 : 500,000. The map will be complete in twenty-seven sheets, each measuring 15¾ inches by 13 inches. Four sheets in the south-western areas are published (by J. Perthes, Gotha); these are :—Sheets 17, Koln ; 22, Strassburg ; 23, Stuttgart ; 25, Mülhausen. The sheets are completed beyond the German boundary. The meridian of the map is Paris, but the longitude east of Greenwich is also indicated on the upper margin of each sheet. A new point in this map is that a complete index is printed with each sheet, but only those rock-divisions indicated on the sheet are coloured. The subdivisions shown may be grouped as follows :—Post-Tertiary, 4 ; Tertiary, 4 ; Secondary, 11 ; Palæozoic, 10 ; Metamorphic, 2 ; Volcanic and Plutonic, 7. The "Silur System" includes Cambrian, Lower Silurian, and Upper Silurian. The map is unusually bright and clear; this is partly due to the black printing (topography, &c.) having been done last, over the colours. Like many other geological maps recently published, the price is small: two marks for one sheet, or three marks for each Lieferung containing two sheets.

THE generous manner in which reports on scientific matters are prepared and published in the United States has frequently been commented upon in these columns. In 1891 the sum of two thousand dollars was voted by Congress for investigations respecting the advisability of establishing a fish-hatching station in the Rocky Mountain region in the States of Montana and Wyoming, and also a station in the Gulf States. The results of these investigations are contained in a *Bulletin* (vol. xi. 1891) recently received from the U.S. Fish Commission. Prof. B. W. Evermann carried out the chief of the investigations. In looking for a suitable site for a fish-cultural station, the following requirements for the successful operation of such a station were kept in mind :—(1) There should be a constant supply of not less than one thousand gallons a minute, at a temperature never exceeding 50° or 55°, and free from any possibility of contamination. (2) There should be twenty to thirty acres of ground conveniently near the source of water supply. There should also be sufficient fall between the source of water supply and the hatchery building to permit a gravity supply. (3) The location should be central with reference to the region to be stocked, and should also afford good railroad facilities. Prof. Evermann and his party visited fourteen of the most promising localities, and the explorations were very satisfactory, both from the economic and scientific points of view. It was eventually decided that the region most nearly filling all the natural requirements was Horsethief Springs. These springs, situated in Montana, near the north-west corner of the Yellowstone National Park, are among the largest and most remarkable to be found anywhere in the United States.

WE are glad to see, from the "Abstract of Proceedings of the South London Entomological and Natural History Society" for the years 1892 and 1893, which has just reached us, that the condition of the Society is still a very satisfactory one, although the membership is slightly lower now than a year ago. The Society now numbers 192 members. The volume contains, in addition to reports of the various meetings held, the addresses of the respective presidents for 1892 and 1893.

THE London Matriculation Directory for June has just been issued by the University Correspondence College, and contains the papers set for the Matriculation Examination, June 1894, and solutions to the same.

A SECOND edition has been issued of the catalogue of the "Bibliothèque du Jardin Botanique de Buitenzorg," Java. The edition has been prepared by Dr. Brutel de la Rivière, and it is much more complete and better arranged than the first. We are requested to state that naturalists desiring to obtain a copy of the catalogue, should communicate with M. Treub, the Director of the State Botanic Garden, and the volume will be sent without delay.

THE July part of the *American Naturalist* contains, besides general notes, articles on "Animal Mechanics," by Dr. Manly Miles; "The Meaning of Tree-Life," by H. L. Clarke; "Lepidosirenids and Bdellostomids," by Theodore Gill; and "The Origin of Pelagic Life," by Prof. W. K. Brooks.

THE Quarterly Statement of the Palestine Exploration Fund for July contains many items of interest, among which we notice a translation of a paper by M. Th. Barrois, "On the Depth and Temperature of the Lake of Tiberias."

MESSRS. MACMILLAN AND CO. have just published a new edition, revised and enlarged, of "Arithmetic for Schools," by Rev. J. B. Lock.

THE Seventeenth Annual Report of the Connecticut Agricultural Experiment Station has just been issued at New Haven, and tells of a vast amount of work done during 1893.

AN interesting mode of converting oxide of iron into small but perfect crystals of hæmatite, exhibiting the characteristic forms of the naturally occurring mineral, is described by Prof. Arctowski, of Luttich, in the current number of the *Zeitschrift fur Anorganische Chemie*. The experiment simply consists in passing partially or totally dissociated ammonium chloride vapour over the oxide heated to a particular temperature. The oxide is placed in a combustion tube closed at one end, and at the closed end a quantity of ammonium chloride. The portion of the tube containing the latter is placed in a combustion furnace, and that containing the ferric oxide in an air bath, so constructed that the reaction within the tube can be observed, in order to be able to attain any desired temperature. When the ferric oxide is heated to about 600° in the stream of ammonium chloride vapour small glittering crystals commence to form after the expiration of a few minutes, the remainder of the oxide increases considerably in volume, and ammonium chloride is rapidly absorbed. No fusion occurs, so that the absorption is a mechanical one; the ammonium chloride condenses upon the exterior of the particles, eventually converting the powder into a white mass. Upon subsequent microscopic examination of this white product large numbers of the small brilliant crystals of hæmatite are observed interspersed among the whitened particles. When the experiment is performed at 700°, the whole of the ferric oxide is converted into miniature crystals of hæmatite; it is probable that the ammonium chloride is totally dissociated at this temperature. The crystals exhibit all the peculiar crystallographic properties of hæmatite. The fundamental rhombohedron possesses the characteristic angle of 86°, and the subsidiary forms developed, including those of the scalenohedron, are precisely those exhibited by the natural mineral and are developed to about the same extent. This mode of synthesising hæmatite is very probably intimately connected with that described by M. Sainte Claire Deville in 1861. The latter method consisted in heating ferric oxide to redness in an indifferent atmosphere into which traces of hydrochloric acid gas were admitted. As the ammonium chloride in the experiment at 700° was most probably completely dissociated into hydrochloric acid and ammonia, it is extremely likely that the crystallising action was due to the free hydrochloric acid. The synthesis of hæmatite by means of partially or totally dissociated ammonium chloride vapour is interesting, however, as throwing light upon the mode of formation in nature, for the vapours evolved by the fumaroles in volcanic districts always contain a certain proportion of sal-ammoniac, and it is usually observed that the fissures through which these vapours pass are more or less covered with crystals of specular iron and hæmatite. There is every probability, therefore, that the formation of the crystals is due to the partially dissociated sal-ammoniac, just as in the artificial experiments above described.

THE additions to the Zoological Society's Gardens during the past week include a Moustache Monkey (*Cercopithecus cephus*) from West Africa, presented by Mr. Clayton Pickersgill; a Leopard (*Felis pardus*) from East Africa, presented by Mrs. J. R. W. Pigott; a Lioness (*Felis leo*) from East Africa, presented by Major Oweo; two Tiger Cubs (*Felis tigris*) from Pehang, Malay Peninsula, presented by Lieut.-Colonel Sir Charles B. H. Mitchell, K.C.M.G.; a Common Jackal (*Canis aureus*) from India, presented by Mr. Gerard Gurney; a Monk Seal (*Monachus albiventer*) from Madeira, presented by Mr. C. F. R. Blandy; a Cockateel (*Calopsitta novæ-hollandiæ*) from Australia, presented by Miss Sloane Stanley; six South African Francolins (*Francolinus afer*), a Puff Adder (*Vipera arietans*) from South Africa, presented by Mr. J. E. Matcham; a Smooth Snake (*Coronella lævis*) from Hampshire, presented by Mr. Willingham F. Rawnsley; a Long-eared Fox (*Otocyon megalotis*) from Somaliland, a Geoffroy's Terrapin (*Platemys geoffroyana*) from the Argentine Republic, a Ceylonese Terrapin (*Clemmys trijuga*) from Ceylon, an Ocellated Monitor (*Varanus ocellatus*) from Lake Tanganyika, two Black and White Snakes (*Pituophis melanoleucus*) from New Jersey, U.S.A., a Black-winged Peafowl (*Pavo nigripennis*) from Cochin China, deposited; a Muscat Gazelle (*Gazella muscatensis*) from Muscat, received in exchange; two Collared Fruit Bats (*Cynonycteris collaris*), four Mandarin Ducks (*Æx galericulata*), six Australian Wild Ducks (*Anas superciliosa*), two Slender Ducks (*Anas gibberifrons*), a Magellanic Goose (*Bernicla magellanica*), a Black-headed Gull (*Larus ridibundus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE RESULTS OF IMPRUDENT SOLAR OBSERVATIONS.—Dr. George Mackay, of the Royal Infirmary, Edinburgh, has sent us a pamphlet "On Blinding of the Retina by Direct Sunlight" (J. and A. Churchill), being a study in prognosis, based chiefly upon accidents incurred during the observation of partial solar eclipses. Tyros in observations of the sun, and also many incautious astronomers, have sustained more or less permanent injury to the sight by looking at it or its image without the interposition of a dark glass, or similar absorber, of sufficient thickness. During the progress of partial solar eclipses, the laity often make incautious observations, and the results of gratifying such curiosity have furnished Dr. Mackay with the chief part of the clinical material for his study. The paper, which originally appeared in the *Ophthalmic Review*, opens with a historical survey of the few cases of ocular injury from exposure to sunlight, recorded in historical literature. There is a tradition that Galileo seriously impaired the sight of his right eye by his solar observations, but Dr. Mackay has not been able to trace the story to its origin. It is well known that, in his later years, Galileo became quite blind, but the loss of sight was apparently caused by an affection of the cornea, and not by injury to the retina. The earliest precise description of the subjective sensations consequent upon focussing solar rays upon the retina is due to Reid, a Professor of Moral Philosophy in the University of Glasgow. He observed the transit of Venus in May 1761, without taking any precautions to modify the intensity of sunlight, and the result was that he was afflicted with metamorphosia; that is, objects appeared to him in distorted forms. Very few other cases of similar ocular injury have been described. Fortunately for Dr. Mackay, the partial eclipse of the sun in June 1890, and that of June 1891, both visible at Edinburgh, furnished him with seven new cases of "Eclipse Blinding," all of which he examined with great care, both with the ophthalmoscope and with type and colour-tests. The patients suffered from an impairment of visual acuteness, and, to most of them, dark spots appeared in their fields of vision. Sometimes these spots were fixed, and in other cases they oscillated rapidly. Dr. Mackay says that complete recovery from the injury, even in cases of only slight failure for test-type, is exceptional if investigated by sufficiently refined methods. It is pointed out that the treatment ought to be preventive: smoked and coloured glasses of the feeble shades ordinarily used by the public to view solar phenomena are quite insufficient. Experience shows that, to view the sun with impunity, even in January, it is necessary to use a glass so dark that no object illuminated by diffuse daylight is visible through it.

A NOVEL METHOD OF SOLAR OBSERVATION.—Dr. Deslandres made an important communication to the Paris Academy of Sciences on July 9. In December 1893, he suggested that separate photographs of the sun should be taken by means of the light of individual dark and bright lines in the solar spectrum. The success with which Prof. Hale has done this with the light of the K line shows that striking results may be expected from the development of the method. An ordinary photograph of the sun is mainly produced by the action, upon the sensitive plate, of the bright intervals between dark lines. Dr. Janssen's marvellous pictures of the sun are produced by using only light of high actinic power, and covering but a small region of the spectrum, to act upon his photographic plate. By carrying this principle still further, there can be no doubt that solar physics will be considerably advanced. The dark lines in the solar spectrum are only dark by contrast. Both Prof. Hale and Dr. Deslandres have shown that sun pictures can be produced by the light from them alone. Hence, by isolating a line due to any element, and using it to act upon a sensitive plate, a photograph is obtained of the layer of the sun in which that particular element predominates. Dr. Deslandres exhibited to the Paris Academy some of the photographs obtained in this way. His first results were produced by means of the light from the bright interval between two dark lines. The pictures thus obtained showed the photosphere with spots and faculæ much the same as

Janssen's photographs. One point confirmed by the pictures is that the difference between the brightness of the solar disc and that of the spots and faculæ is more marked the greater the refrangibility of the light employed. The bright lines due to the vapour of calcium, gave a different set of results. Such reversed lines do not represent incandescent solid or liquid, as in the preceding case, but are emitted by gaseous calcium at a higher level. Their light therefore imprints the image of the chromosphere upon the photographic plate. Dr. Deslandres' photographs of this kind agree with those previously mentioned as regards disposition and general forms of faculæ, but they differ in the fact that they show faculæ near the centre of the disc as clearly as faculæ near the edge, and also by greatly extending the areas of these bright patches. Using the light from a portion of the dark and wide calcium line, and exposing the photographic plate a little longer than when the bright reversal in the middle of the line was employed, a curious and altogether different result was obtained. The same faculæ appear upon the photograph, but they are not so clearly marked, and are of less extent. On the other hand, spots are shown very distinctly, with their penumbræ sharply defined. Dr. Deslandres has obtained similar photographs by using absorption lines of iron, aluminium, and carbon, which are wide enough to permit them to be isolated by means of his spectrograph. The results of further work in this direction will be awaited with interest.

THE ROYAL BOTANIC GARDEN, CALCUTTA.[1]

THE ponderous and important *Annals of the Royal Botanic Garden, Calcutta*, are known to all students of Indian flora. We have from time to time referred in terms of praise to these solid monuments of Dr. King's industry, and to the skill of the native lithographers and printers. The fourth volume of the *Annals* is before us, and is of equal excellence to the preceding ones. It is concerned with "The Anonaceæ of British India," a family of about six hundred species of woody plants. Although Dr. King, in an admirable introduction, gives an outline of the arrangement of the whole family, the present monograph only contains "a detailed account of those species which are indigenous to British India proper, to that part of the Malayan Peninsula which is under British protection, to the Islands of Singapore, Pangkore and Penang, and to the Nicobar and Andaman groups. This is the geographic area covered in the latter volumes of Sir Joseph Hooker's *Flora of British India*; and it may in the broad sense be considered for botanical (though not for political) purposes as *British* India, as distinguished from *Dutch* or *Netherlands* India, which consists of the Malayan Archipelago. The majority of the species indigenous to the British Indian area have already been dealt with by Sir Joseph Hooker and the late Dr. T. Thomson in that splendid fragment their *Flora Indica* (published in 1855), and still more recently by Sir Joseph Hooker in the first volume of his *Flora of British India*. It is with no idea of improving upon the work of these distinguished authors that I have re-described the same species in the following pages, but chiefly in order that the species which have been discovered since the order was dealt with by them may be described, and that the relations of the new to the older species may be understood." Dr. King points out that the Malayan Peninsula remains even now but partially explored, and that its complete examination must bring to many new *Anonaceæ*. But as there was an opportunity of printing a fully illustrated account of the family at the present time, and as there is no knowing when the mountain range which forms the backbone of the Peninsula may be explored, it was decided to publish the monograph, and risk the charge of having done so prematurely.

The great importance of such a work as that under notice can only be adequately judged by botanical experts. Altogether there are 220 lithographic plates, a figure of each species being given. These are accompanied by 169 pages of text, in addition to an index and the useful introduction, to which reference has been made. For the immense labour involved in the publication of such a volume, Dr. King deserves the thanks of all systematic botanists, and the Government of Bengal has done a great service to science by enabling the work to be published.

The hundredth anniversary of the death of Colonel Kyd, the founder and first superintendent of the Royal Botanic Garden at Calcutta, occurred last year, and Dr. King has taken advantage of the occasion by putting on record as much as can be traced of the early history of the Garden, and the career of its founder. The volume is dedicated to Colonel Kyd (of whom a portrait is also given), and prefaced with an interesting account, from which we have taken the following extracts:—

"Robert Kyd belonged to an old Forfarshire family, several members of which had preceded him in the service of the Honourable East India Company. He was born in 1746. At the age of eighteen he became a cadet of the Bengal Engineers, and on October 27, 1764, he received his commission as Ensign in that corps. His promotion to the rank of Lieutenant followed in the year after. Two and a half years later he became Captain, getting his majority on May 29, 1780, and his Lieutenant-Colonelcy on December 7, 1782. He died at Calcutta on May 26, 1793. From the fragmentary evidence which is still extant it appears that Colonel Kyd was a man of wide and varied sympathies and experience, and that, during the later years of his service he attained a position of so much influence that his suggestions on various weighty matters were not only listened to but promptly acted upon. Himself a keen gardener, he had brought together, round his country house at Shalimar, a collection of various plants of economic and horticultural interest which had been sent to him, partly by correspondents in the interior of the country, but which had chiefly been brought to him by Captains of the Company's ships returning from their voyages to the Straits and to the Malayan Archipelago. Colonel Kyd conceived the idea of supplying the Company's Navy with teak timber grown near the ports where it could be used in ship-building, and of increasing their commercial resources by introducing into India the cultivation of the spices which, in those days, formed so important an item in their trade, but for supplies of which they had to depend on their factories in Sumatra and Penang. He communicated this idea to the Governor-General of the day; and, in a letter written on June 1, 1786, he officially submitted a scheme for the establishment of a Botanical Garden, or Garden of Acclimatisation, near Calcutta. This scheme also included proposals for introducing, into territories subject to the Company, the cultivation of cotton, tobacco, coffee, tea, and various other commercial products. To have suggested to the local representatives of what was then practically a trading Company, the provision (at a considerable annual cost) of facilities for the pursuit of pure, as distinguished from economic, botany would probably not have increased the chances of the acceptance of the Garden scheme. The scientific aspect of the matter was therefore, with commendable sagacity, excluded from mention in the original proposal. So much, in fact, were the local Government impressed with the advantages of Colonel Kyd's proposed scheme that, without waiting for a reply to this letter from the Board, they secured land for the Garden 'in anticipation of sanction'; and, in a letter dated July 27, 1787, they reported this action to the Directors. This second letter, however, must have crossed a dispatch, dated London, July 31, 1787, in which the Board not only conveyed their sanction to the formation of the Garden suggested by Colonel Kyd, but warmly approved his action in bringing the proposal to their notice.

"Colonel Kyd's country house and garden stood near the village of Sibpur, on a promontory round which the Hooghly bends in passing the site of the present Fort William (at that time only recently completed), and which was known then (as it is now) as Shalimar. And it was land in the vicinity of Shalimar, and separated from his own private garden only by a ditch, which Colonel Kyd selected for the proposed Botanic Garden. The piece of land thus selected measures more than three hundred acres in extent, and is of rather irregular shape. It consists of a rather narrow strip running along the right bank of the Hooghly for about a mile and a half, but expanding towards its lower extremity into a large square block.

"Colonel Kyd, whose office at this time was that of Military Secretary to Government, was appointed Honorary Superintendent of the Garden, a post which he retained until his death. He never lived within the Garden. In fact, there was no dwelling-house within its limits until his successor, Dr. Roxburgh, built the present Superintendent's house in 1795.

[1] *Annals of the Royal Botanic Garden, Calcutta*, vol. iv. The Anonaceæ of British India. By Dr. George King, F.R.S., &c., Superintendent of the Garden, Calcutta. (Printed at the Bengal Secretariat Press, 1893.)

Colonel Kyd probably, as was the fashion of the day, had a town house in Calcutta. But he appears to have passed a good deal of his time at Shalimar; and in his will he directed that he should be buried in his garden there. The part of the Botanic Garden nearest to Colonel Kyd's house was devoted to the planting of teak trees, in accordance with the Company's earnest desire to supply themselves with timber for ship-building. The experience of thirty-four years having shown that good teak timber cannot be successfully raised on the muddy soil of the Gangetic delta, this part of the garden (extending to about forty acres) was in the year 1820 given up by Government to the Lord Bishop of Calcutta (Dr. Middleton) as the site for a Christian college. The Garden was thus reduced to its present area of 270 acres."

SCIENTIFIC SERIALS.

Bulletin of the New York Mathematical Society, vol. iii. No. 9, June 1894. (New York: Macmillan.)—Prof. E. W. Brown, under the heading "The Lunar Theory" (pp. 207-215), gives an admirable abstract of vol. iii. of Tisserand's "Théorie de Mécanique Céleste, Perturbations des Planètes d'après la Méthode de Hansen; Théorie de la Lune." Herein he opens with the remark: "It is somewhat strange that a subject like the lunar theory, which has received so much attention since its first principles were given by Newton, should be allowed to pass its second centenary before the appearance of a treatise like the present one." His opinion is that, notwithstanding a few defects, the book will take a high rank amongst the many classic treatises on celestial mechanics.—Students of the Theory of Numbers have recently been gratified by the publication (1892) of Bachmann's "Die Elemente der Zahlentheorie." An analysis of its contents, with a brief consideration of the parts which call for special remark, is given by Dr. J. W. A. Young (pp. 215-222).—Prof. Conant (pp. 223-224) calls attention to a work which occupies a unique place among translations, viz. "Memoirs on Infinite Series." These are classic memoirs by Lejeune-Dirichlet (2), Abel, Gauss, and Kummer. The book is brought out, under the auspices of the Tokio Mathematical and Physical Society, by Japanese professors.

IN the numbers of the *Journal of Botany* for June and July, Mr. A. B. Rendle describes new species of Asclepiadeæ and Convolvulaceæ from Tropical Africa, including a new genus of the former order *Odontostelma*, which is also figured.—A new British *Rubus*, *R. Rogersii*, n. sp., is described by Mr. E. F. Linton.—Mr. F. J. Hanbury contributes "A Tentative List of British *Hieracia*," numbering upwards of 100 species.

IN Nos. 5-7 of the *Bullettino della Societa Botanica Italiana* are two papers on fungus diseases of cultivated trees, by Sig. P. Baccarini. The "petecchia" or "vaiolo" (pock) of the orange has been ascribed to various causes. It is always accompanied by a number of fungi, but these are apparently saprophytic, and not pathogenic. The true cause appears to be a bacillus. The "mal nero" of the vine is also attributed to a microbe, *Bacillus vitivorus*, n. sp.—Sig. S. Sommier has two papers on the little-known flora of the Island of Giglio, near to Elba.—Sig. A. Jatta completes his paper on the lichens of Italy, of which he enumerates 1407 species.

THE number of the *Nuovo Giornale Botanico Italiano* for July is occupied by three papers:—"On the Roman Flora," by Sig. A. Terracciano; "On the Flora of Sicily," by Sig. L. Nicotra; and "On the Disease of the Strawberry caused by *Sphærella Fragariæ*," by Sigg. E. Baroni aud G. Del Guergio.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 24.—"On the Influence of certain Natural Agents on the Virulence of the Tubercle-Bacillus." By Dr. Arthur Ransome, F.R.S., and Sheridan Delépine.

June 7.—"The Influence of Intra-Venous Injection of Sugar on the Gases of the Blood." By Dr. Vaughan Harley.

In a previous paper (*Roy. Soc. Proc.* 1893), he showed that the intra-venous injection of grape sugar caused an increase in the lactic acid in the circulation. It appeared probable that the lactic acid had combined with the bases of the carbonates in the blood, having driven out the carbonic acid.

Experiments were made on dogs to see what changes were produced in the gases of the blood after intra-venous injections of sugar.

It was found the quantity of carbonic acid was diminished, it being most markedly so during the first hour after the sugar injection, and still somewhat so three to five hours later. These results support the view that the lactic acid drives the carbonic acid from the sodium salts and replaces it.

In the next place, the changes met with in the quantity of oxygen in the blood were investigated. It was found the oxygen was markedly diminished during the first hour after the sugar injection. During the third and fifth hours the quantity in arterial was that usually found in venous blood. The explanation of this cannot up to the present be explained.

June 21.—"Researches on Explosives. Preliminary Note." By Captain Sir A. Noble, K.C.B., F.R.S.

The researches on which I, in conjunction with Sir F. Abel, have been engaged for very many years, have had their scope so altered and extended by the rapid advances which have been made in the science of explosives, that we have been unable to lay before the Society the results of the many hundreds of experiments under varied conditions which I have carried out. We are desirous also of clearing up some difficulties which have presented themselves with certain modern explosives when dealing with high densities and pressures, but the necessary investigations have occupied so much time that I am induced to lay a few of our results before the Society, trusting, however, that before long we may be able to submit a more complete memoir.

A portion of our researches includes investigations into the transformation and ballistic properties of powders varying greatly in composition, but of which potassium nitrate is the chief constituent. In this preliminary note I propose to refer to powders of this description chiefly for purposes of comparison, and shall devote my attention principally to gun-cotton and to those modern explosives of which gun-cotton forms a principal ingredient.

In determining the transformation experienced during explosion, the same arrangements for firing the explosive and collecting the gases was followed as are described in our earlier researches,[1] and the gases themselves were, after being sealed, analysed either under the personal superintendence of Sir. F. Abel, or of Prof. Dewar, and to Prof. Dewar's advice and assistance I am indebted, I can hardly say to what extent.

The heat developed by explosion, and the quantity of permanent gases generated were also determined as described in our researches, but the amount of water formed plays so important a part in the transformation that special means were adopted in order to obtain this product with exactness.

Numerous experiments were made to ascertain the relation of the tension of the various explosives employed, to the gravimetric density of the charge when fired in a close vessel, but I do not propose here to pursue this part of our inquiry, both because the subject is too large to be treated of in a preliminary note and because approximate values have already been published[2] for several of the explosives with which we have experimented.

With certain explosives, the possibility or probability of detonation was very carefully investigated. In some cases the explosive was merely placed in the explosion vessel in close proximity to a charge of mercuric fulminate by which it was fired, but I found that the most satisfactory method of experiment was to place the charge to be experimented with in a small shell packed as tightly as possible, the shell then being placed in a large explosion vessel and fired by means of mercuric fulminate. The tension in the small shell at the moment of fracture and the tension in the large explosion vessel were in each experiment carefully measured.

It may be desirable here to explain that I do not consider the presence of a high pressure with any explosive as necessarily denoting detonation. With both cordite and gun-cotton I have developed enormous pressures, close upon 100 tons per square inch (about 15,000 atmospheres), but the former explosive I have not succeeded in detonating, while gun-cotton can be detonated with the utmost ease. It is obvious that if we suppose a small charge fired in a vessel impervious to heat, the rapidity

[1] *Phil Trans.* vol. clxv. p. 61.
[2] Noble, "Internal Ballistics," 1892, p. 33; *Roy Soc. Proc.* vol. lii. p. 128.

or slowness of combustion will make no difference in the developed pressure, and that pressure will be the highest of which the explosive is capable, regard being of course had to the density of the charge. I say a small charge, because, if a large charge were in question and explosion took place with extreme rapidity, the nascent gases may give rise to such whirlwinds of pressure, if I may use the term, that any means we may have of registering the tension will show pressures very much higher than would be registered were the gases, at the same temperature, in a state of quiescence. I have had innumerable proofs of this action, but it is evident that in a very small charge the nascent gases will have much less energy than in the case of a large charge occupying a considerable space.

The great increase in the magnitude of the charges fired from modern guns has rendered the question of erosion one of great importance. Few, who have not had actual experience, have any idea how rapidly with very large charges the surface of the bore is removed. Great attention has therefore been paid to this point, both in regard to the erosive power of different explosives and in regard to the capacity of different materials (chiefly different natures of steel) to resist the erosive action.

The method I adopted for this purpose consisted in allowing large charges to escape through a small vent. The amount of the metal removed by the passage of the products of explosion, which amount was determined by calibration, was taken as a measure of the erosive power of the explosive.

Experiments have also been made to determine the rate at which the products of explosion part with their heat to the surrounding envelope, the products of explosion being altogether confined. I shall only briefly allude to these experiments, as, although highly interesting, they have not been carried far enough to entitle me to speak with confidence as to final conclusions.

Turning now to ballistic results. The energies which the new explosives are capable of developing, and the high pressures at which the resulting gases are discharged from the muzzle of the gun, render length of bore of increased importance. With the object of ascertaining with more precision the advantages to be gained by length, the firm to which I belong has experimented with a 6-inch gun of 100 calibres in length. In the particular experiments to which I refer, the velocity and energy generated has not only been measured at the muzzle, but the velocity, and the pressure producing this velocity, have been obtained for every point of the bore, consequently the loss of velocity and energy due to any particular shortening of the bore can be at once deduced.

These results have been obtained by measuring the velocities every round at sixteen points in the bore and at the muzzle. These data enable a velocity curve to be laid down, while from this curve the corresponding pressure curve can be calculated. The maximum chamber pressure obtained by these means is corroborated by simultaneous observations taken with crusher gauges, and the internal ballistics of various explosives have thus been completely determined.

Commencing with gun-cotton, with which a very large number of analyses were made, with the view of determining whether there was any material difference in the decomposition dependent upon the pressure under which it was exploded, two descriptions were employed: one in the form of hank or strand, and the other in the form of compressed pellets. Both natures were approximately of the same composition, of Waltham Abbey manufacture, containing in a dried sample about 4·4 per cent. of soluble cotton and 95·6 per cent. of insoluble. As used, it contained about 2·25 per cent. of moisture.

[Tables were given showing the results of the analyses of the permanent gases.]

From my very numerous experiments on erosion I have arrived at the conclusion that the principal factors determining its amount are: (1) the actual temperature of the products of combustion; (2) the motion of these products. But little erosive effect is produced, even by the most erosive powders, in close vessels, or in those portions of the chambers of guns where the motion of the gas is feeble or *nil*; but the case is widely different where there is rapid motion of the gases at high densities. It is not difficult absolutely to retain without leakage the products of explosions at very high pressures, but if there be any appreciable escape before the gases are cooled they instantly cut a way for themselves with astonishing rapidity, totally destroying the surfaces over or through which they pass.

Among all the explosives with which I have experimented I have found that where the heat developed is low the erosive effect is also low.

With ordinary powders, the most erosive with which I am acquainted is that which, on account of other properties, is used for the battering charges of heavy guns: I refer to brown prismatic powder. The erosive effect of cordite, if considered in relation to the energy generated by the two explosives, is very slightly greater than that of brown prismatic, but very much higher effects can, if it be so desired, be obtained with cordite and, if the highest energy be demanded, the erosion will be proportionally greater. There is, however, one curious and satisfactory peculiarity connected with erosion by cordite Erosion produced by ordinary gunpowder has the most singula effect on the metal of the gun, eating out large holes and form ing long rough grooves, resembling a ploughed field in minia ture, and these grooves have, moreover, the unpleasant habit o being very apt to develop into cracks; but with cordite, so fa as my experience goes, the erosion is of a very differen character. The eddy holes and long grooves are absent, and th erosion appears to consist in a simple washing away of th surface of the steel barrel.

Cordite does not detonate; at least, although I have mad far more experiments on detonation with this explosive tha with any other, I have never succeeded in detonating it. Wit an explosive like cordite, capable of developing enormous pres sures, it is, of course, easy, if the cordite be finely comminuted to develop very high tensions, but, as I have already explained a high pressure does not necessarily imply detonation.

[The velocities and energies developed by the new explosiv were shown by the aid of diagrams.]

"The Rotation of the Electric Arc." By Alexander Pelha Trotter.

In the course of experiments made with the view of realisin as a practical standard of light, the method of using one squa millimetre or other definite area of the crater of the positiv carbon of an electric arc,[1] the author has found that the effecti luminosity is not as theory would predict,[2] either constant o uniform. By the use of a double Rumford photometer, givin alternating fields, as in a Vernon Harcourt photometer, h attention was called to a bright spot at or near th middle of the crater. The use of rotating sectors accidental revealed that a periodic phenomenon accompanied the appea ance of this bright spot, and although it is more marked wi a short humming arc, the author believes that it is alwa present.

An image of the crater was thrown on a screen by a phot graphic lens; and a disc having 60 arms and 60 openings of 3 and rotating at from 100 to 400 revolutions per minute, w placed near the screen. Curious stroboscopic images we observed, indicating a continually varying periodicity seldo higher than 450 per second, most frequently about 100, diffic to distinguish below 50 per second, and becoming with a lo arc a mere flicker. The period seemed to correspond with t musical hum of the arc, which generally breaks into a hiss at note a little beyond 450 per second. The hum is audible in telephone in the circuit, or in shunt to it. The current w taken from the mains of the Kensington and Knightsbrid Electric Light Company, often late at night, after all t dynamos had been shut down. The carbons were, of cours not cored; six kinds were used.

A rotating disc was arranged near the lens, to allow the bea to pass for about 1/1000th of a second, and to be cut off f about 1/100th of a second. It was then found that a brig patch, occupying about one quarter of the crater, appeared be rapidly revolving. Examination of the shape of this pat showed that it consisted of the bright spot already mentione and of a curved appendage which swept round, sometim changing the direction of its rotation. This appendage seem to be approximately equivalent to a quadrant sheared ec centrically through 90°. Distinct variations in the luminos of the crater are probably due to the fact that this is only approximation.

The *à priori* theory of the constant temperature of the cra is so attractive, that the author is inclined to attribute t phenomenon, not to any actual change of the luminosity of t

[1] J. Swinburne and S. P. Thompson, discussion on paper by the aut "Inst. Electrical Eng.," vol. 21, pp. 384 and 4[illegible].

[2] Abney and Festing, *Phil. Trans.* 1881, p. 890; S. P. Thompson, *Arts. Journ.* vol. 37, p. 32.

crater, or to any wandering of the luminous area, as is seen with a long, unsteady arc, but to the refraction of the light by heated vapour. All experiments, such as enclosing the arc in a small chamber of transparent mica, or the use of magnets, or an air blast, have failed to produce any effect. A distortion of the image of the crater while the patch revolves, has been looked for, but nothing distinguishable from changes of luminosity has been seen.

An unexpected difficulty is thus introduced in the use of the arc as a standard of light, and one which may interfere with its use under some circumstances as a steady and continuous source of light. The author is further examining this phenomenon, with the view of ascertaining its nature, and of finding practical conditions under which it is absent or negligable.

"On the Viscosity of Water as determined by Mr. J. B. Hannay, by means of his Microrheometer." By Robert E. Barnett.

In a paper entitled "On the Microrheometer," published in the *Phil. Trans.* for 1879, Mr. Hannay described an apparatus which he devised for measuring the rate of flow of liquids through a capillary tube, and gave the times of flow of water at various temperatures, and of certain aqueous salt-solutions which he had observed by its means. The capillary was 21 mm. long, and 0·0938 mm. in diameter; the bulb had a capacity of 4·053 c.c., and the pressure employed was that of 1 metre of water at 20°. In order to compare the results with those of other observers, the author has converted the measurements of time of flow recorded by Mr. Hannay for water into viscosity-coefficients by means of the formula :—

$$\eta = \frac{\pi r^4 pt}{8Vl} - \frac{V\rho}{8\pi lt}.$$

The figures thus obtained are given in tabular form, and on comparison with the results given by Poiseuille, Slotte, Sprung, and Thorpe and Rodger, are seen to yield discordant values for the viscosity of water. Not only is the value at 0° far below that of any known liquid, but it diminishes so rapidly that at 6° and above it is a *minus* quantity. This paradoxical result is due to the fact that Mr. Hannay's experimental figures are inconsistent. It is physically impossible to pass such a volume of water under the stated pressure through a capillary tube of the dimensions given, in the times recorded. At 20°, for instance, the time of flow required under these conditions would be about 4600 seconds, instead of 131·3 seconds, as stated. The author has attempted in several ways to account for the discrepancy, but without success.

"On the Singular Solutions of Simultaneous Ordinary Differential Equations and the Theory of Congruencies." By Prof. A. C. Dixon.

PARIS.

Academy of Sciences, July 16.—M. Lœwy in the chair.—New researches on chromium, by M. Henri Moissan. Chromium has been prepared in large quantity by means of the electric furnace. Pure chromium has the density 6·92 at 20° C. It is more infusible than platinum, and has, apparently, no action on a magnetic needle. It is practically unacted on in moist air, but burns at 2000° C. in oxygen. It readily combines with silicon and carbon, to form very hard compounds; the silicide scratches the ruby. The pure metal is not nearly so hard, and readily takes a fine polish. It is hardly attacked by acids, resisting aqua regia, and is not acted on by fused potash, though oxidised by fused potassium nitrate or chlorate.—On the two ourang-outangs which have recently died at Paris, by M. A. Milne-Edwards.—On the mechanism of the murmurings caused by the passage of air in tubes; determination of the moment when a soundless flow, transformed instantaneously into a murmuring flow, becomes sonorous in the different points of the tube, by M. A. Chauveau.—On the necessity for ostriches, and most birds, to swallow hard bodies which remain in the pyloric region of the stomach, and which play the part, as regards foods, of masticatory organs, by M. C. Sappey.—On dimethylamidobenzoylbenzoic acid, diethylamidobenzoylbenzoic acid, and dimethylanilinephthalein, by MM. A. Haller and A. Guyot.—Note on some biological variations of *Pneumobacillus liquefaciens bovis*, the microbe of contagious peripneumonia of cattle, by M. S. Arloing. The author describes a non-liquefying variety of this microbe, and shows that it is not an independent species.—Studies on central actions: general laws relative to the effect of media, by M. F. P. Le Roux.—On interferences due to mean difference of path, by M. Georges Meslin.—Direct autographic record of the form of periodic currents by means of the electrochemical method, by M. P. Janet. A battery of fifteen steel styles, connected with fifteen points of the circuit taken, so that the difference of potential between consecutive points was about four volts, gave traces on prepared paper which indicated the characteristics of the discharge through the circuit.—Coefficient of self-induction of n equal and equidistant parallel threads of which the sections are distributed on a circumference, by M. Ch. Eug. Guye. The coefficients calculated for two selected definite systems by means of a formula quoted agree with the experimental values within about one per cent.—On the equation of discharges, by M. R. Swyngedauw.—Separation and estimation of tin and antimony in an alloy, by M. Mengin. The oxides are obtained as usual by means of nitric acid acting on the alloy of tin and antimony, and the metal antimony is reduced therefrom by means of a plate of pure tin and hydrochloric acid, and weighed separately.—On rotatory powers variable with the temperature; a reply to M. Colson, by M. A. Le Bel.—Synthesis of mesoxalic acid and bismuth mesoxalate, by M. H. Causse. The acid has been obtained by oxidation of glycerine by means of nitric acid in presence of bismuth nitrate. Insoluble bismuth mesoxalate is formed and, by virtue of its insolubility, the mesoxalic acid is removed from the field of action and escapes further oxidation.—Contribution to the study of some amido-acids obtained by the condensation of vegetable proteid substances, by M. E. Fleurent. On some derivatives of the propylamines, by M. F. Chancel. The preparation and properties are described of the compounds (1) propylpropylideneamine, (2) monopropylacetamide, (3) dipropylacetamide, and (4) tetrapropylurea.—On some points in the anatomy of the ourang-outang, by MM. J. Deniker and R. Boulart.—On the male genital apparatus of the ourang-outang (*Simia satyrus*, L.), by M. E. de Pousargues.—On the osteology of the ourang-outang, by M. P. Delisle.—Researches on the excitability of rigid muscles and on the causes of the disappearance of cadaveric rigidity, by M. J. Tissot. The author shows that the relaxation of the cadaveric rigidity of muscles is not due to putrefaction, which only sets in after the rigidity disappears.—Physiological mechanism of egg-laying among Orthopterous insects of the family of the Acridii. The *rôle* of the air as a mechanical agent, and multiple functions of the genital apparatus, by M. J. Kunckel d'Herculais.—Conditions of the development of *Rougeot* (*Exobasidium vitis*) on the leaves of the vine, by M. Albert Renault.—On a parasite of the vine, *Aureobasidium vitis*, by MM. P. Viala and G. Boyer.—On the carved ivories from the Quaternary station of Brassempouy (Landes), by MM. Ed. Piette and J. de Laporterie. An account of five statuettes or parts of statuettes of human figures, found among cinders and numerous bones of the rhinoceros, mammoth, aurochs, horse, and hyæna.—On the Constantinople earthquake. An extract from a letter from M. Moureaux to M. Mascart.

AMSTERDAM.

Royal Academy of Sciences, June 30.—Prof. van der Waals in the chair.—Prof. Behrens, Delft, gave some particulars concerning the detection of alkaloids by microchemical methods. A good method must give slides, showing the alkaloids pure or well crystallised combinations, from which the pure alkaloid can be set free by simple and trustworthy reactions. Such slides can be kept any time as documents for comparing with standard slides and further experiments, while the colour-tests in current use generally destroy the alkaloid. Volatile alkaloids are the most easy to isolate. Thus, from 0·3 mgr. of tea, and from 1 mgr. of coffee, by extraction with lime water and with alcohol, and subsequent sublimation, characteristic needles of theine were obtained without any difficulty. Cocoa must be extracted with weak acetic acid. After purifying with acetate of lead and concentrating, the liquid is dried with an excess of sodium carbonate, and sublimed at 300° C. Powdery theobromine is obtained, giving characteristic prisms with silver nitrate, and, later on, needles, resembling theine, more volatile than theobromine and more soluble in water. Their angle of extinction is 0°, and their chloromercurate is easily soluble. For theine, angle of extinction 45°, chloromercurate thrown down as long needles.

Two mgr. of cocoa are sufficient for showing both alkaloids. Among alkaloids that are not volatile, quinine may be cited, treated with success by the author six months ago. As another example, strychnine and brucine may be taken. For tracing strychnine the limit was found by de Vry and van der Burg at 0·001 mgr. With the aid of microchemical methods, well-defined crystals of strychnine can be obtained down to 0·0002 mgr. in the presence of as much brucine; afterwards the latter is made to crystallise as chloroplatinate. The actual limit is found at a fourth of this quantity. A detailed paper will be published next year.—Mr. Bakhuis Roozeboom discussed the graphical representation of heterogeneous equilibrium in systems of one to four substances. For systems of one substance we have only p, t lines which encounter each other in triple points. Systems of two substances may be represented in space between two parallel plans, by points which indicate p, t and the composition. For systems of three components the composition may be expressed in an equilateral triangle, and in a direction perpendicular to this plan, either p, or t. For systems of four substances the composition only can be expressed for one single temperature and pressure by points in a tetrahedron. The author discussed the conditions for a right selection of the components, and demonstrated that, in systems which admit single or double substitution, the number of components is one inferior to that of the apparent components.—Prof. J. A. C. Oudemans presented a note on the geographical position of the Astronomical Observatory at Utrecht, revised by him on a request from the editor of the British Nautical Almanac. The latitude = 52° 5′ 9″·5. Using Leiden-Greenwich, as newly found by telegraph, and Utrecht-Leiden, geodetically determined, he deduced 20m. 31s.·00, practically the same result as given by the old observations of Hennert, van Utenhove, Wagner, van Beeck, Calkoen, and Keyzer, from 1778 to 1820.—Prof. C. A. J. A. Oudemans exhibited two new fungi, viz. *Septoria dictyotæ*, found on *Dictyota obtusangula*, a submerged *Rhodophycee*, detected by Miss Weber in the neighbourhood of Malacca, and *Ustilago Vuyckii*, discovered by Mr. Vuyck, in Leiden, in the ovary of *Luzula campestris*.—Prof. Kamerlingh Onnes commented on (1) the coefficients of viscosity of fluids in corresponding states, calculated by Mr. de Haas. They generally agree with the formula deduced from his theorem that the moving molecular systems in corresponding states are mechanically similar. Great deviations are shown by the fatty acids, and especially the alcohols. (2) The further experiments made by Dr. Kuenen, in the Leiden Laboratory, on the abnormal phenomena observed by Galitzine near the critical point. Dr. Kuenen proved that they are to be ascribed to impurities, and in particular to air. Gas can be originated at one side of the tube by heating a part of it, just as during the process of scaling. The gas being transferred to the opposite side of the tube, the density at this side changes in accordance. By admitting air at one side, anomalies such as were observed by Galitzine are obtained.—Mr. Jan de Vries presented an article on triple equations. He showed that the roots of such equations of degrees 7 and 9 cannot satisfy a symmetrical trilinear relation. This property is also verified for two distinct sorts of triple equations of degree 13; it has not yet been decided whether these are the only possible systems of this degree.

Netherlands.

Entomological Society, June 9.—Mr. A. van den Brandt in the chair.—Mr. Everts exhibited a fine collection of specimens illustrating the biology of the honey bee; Mr. Leesberg, specimens of the rare *Doryatoma chrysomelina*, new for the Dutch fauna; Mr. Snellen, both sexes of *Euplæa martinii* de Nicéville, and a bread specimen of *Meliana flammea*, Curt.; Mr. J. C. H. de Meyere, several rare and interesting indigenous Diptera; Mr. F. J. M. Heylaerts, specimens of *Coleophora* and *Psychidæ*; Mr. H. A. de Vos tot Nederveen Cappel, *Agrotis dahlii*, *Boarmia abietaria*, and a very curious variety of *Taeniocampa incerta*; Mr. A. J. F. Fokker, specimens of two rare indigenous Hemiptera, *Eurygaster maura* and *hottentotta*. The latter stated that the name of *Pedops horvathi*, a species which was not long ago described by him in the Dutch *Tijdschrift*, had been previously given by Distant to a Japanese species, and was therefore changed by Dr. Bergroth into *P. subalpina*.—Mr. H. J. Veth described the liquids emitted by the coxæ of several Coleoptera (Coccinellidæ and others), and which, according to Leydig, was a secretion of blood. A renewed chemica[l] inquiry into its nature, however, seems to be desirable.—Mr A. J. van Rossum gave a further account of his breedings o[f] *Cimbex fagi* and *saliceti*.—Mr. J. Th. Oudemans exhibited a[n] apparatus for setting Lepidoptera, and adapted to be use[d] during long journeys.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Observations and Researches made at the Hongkong Observa tory in 1893: W. Doberck (Hongkong).—Twelfth Annual Report of th Fishery Board for Scotland; Part 1, General Report (Edinburgh).—Tota Eclipses of the Sun: M. L. Todd (Low).—The First Technical College Prof. A. H. Sexton (Chapman).—Agricultural Zoology: Dr. J. R. Bos translated by Prof. J. R. A. Davis (Chapman).—Royal Natural History Part 9 (Warne).—Primary Geography: A. E. Frye (Boston, Ginn).—Arith metic for Schools: Rev. J. B. Lock, new edition (Macmillan).—A Labora tory Manual of Physics and Applied Electricity, 2 Vols.; Vol. 1, Junio Course in General Physics: E. Merritt and F. J. Rogers (Macmillan).—Organic Chemistry, Part 1: Prof. Perken and Dr Kipping (Chambers).—Histoire du Monde son Évolution et sa Civilisation: É. Guyard (Paris L'Auteur).—Knowledge through the Eye: A. P. Wire and G. Da (Philip).

Pamphlets.—Researches in the Nervous System of Myxine Glutinosa R. Sanders (Williams and Norgate).—Ueber die Geometrischen Eigen schaften homogener starrer Structuren und ihre Anwendung auf Krystalle W. Barlow (Leipzig, Engelmann).—The Growth of St. Louis Children: W T. Porter (St. Louis).

Serials.—Engineering Magazine, July (New York)—Journal of th Institution of Electrical Engineers, No. 113, Vol. xxiii. (Spon).—Annals of Scottish Natural History, July (Porter).—Actes de la Sociét Helvétique des Sciences Naturelles, 76e Session (Lausanne, Corbaz).—Compte Rendu des Travaux de la Société Helvétique des Science Naturelles, Soixante-seizième Session (Lausanne, Corbaz).—Mittheilunge der Naturforschenden Gesellschaft in Bern aus dem Jahre 1893, No 1305-1334 (Bern).—Morphologisches Jahrbuch, 21 Band, 3 Heft (Lei zig, Engelmann).—Botanische Jahrbücher für Systematik, Pflanzer geschichte und Pflanzengeographie, Achtzehnter Band, 4 Heft (Leipzig Engelmann).—Quarterly Review, July (Murray).—Palestine Exploratio Fund Quarterly Statement, July (Watt)—Séances de la Société Française d Physique, 1894, 1er Fasc. (Paris).—Journal of the Franklin Institute, Jul (Philadelphia).—Records of the Geological Survey of India, Vol. xxvii. Pa 2 (Calcutta).—Jahrbuch der K.K. Geologischen Reichsanstalt, Jahrg. 189 xli. Band, 4 Heft; Jahrg. 1894, xliv. Band, 1 Heft (Wien, Hölder).—Ab stract of Proceedings of the South London Entomological and Natur History Society, 1892-93 (London).—American Naturalist, July (Phil delphia).—17th Annual Report of the Connecticut Agricultural Experimen Station, 1893 (New Haven).—Proceedings of the Royal Society of Edin burgh, Vol. xx. pp. 161-240 (Edinburgh).

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THURSDAY, AUGUST 2, 1894.

LORD KELVIN ON GENERAL PHYSICS.[1]

Popular Lectures and Addresses by Sir William Thomson (Baron Kelvin), P.R.S., LL.D., D.C.L., &c. In three volumes. Vol. II. "Geology and General Physics." With illustrations. NATURE Series, pp. x. + 599, with index. (London and New York: Macmillan and Co., 1894.)

II.

AT the present time, when the need for a fully-equipped and well-manned National Physical Laboratory for expensive and for secular observations is sometimes discussed, it is interesting to quote from Lord Kelvin's Presidential address to the British Association at Edinburgh in 1871 as follows:—

"The success of the Kew Magnetic and Meteorological Observatory affords an example of the great gain to be earned for science by the foundation of physical observatories and laboratories for experimental research, to be conducted by qualified persons, whose duties should be, not teaching, but experimenting. Whether we look to the honour of England, as a nation which ought always to be the foremost in promoting physical science, or to those vast economical advantages which must accrue from such establishments, we cannot but feel that experimental research ought to be made with us an object of national concern, and not left, as hitherto, exclusively to the private enterprise of self-sacrificing amateurs, and the necessarily inconsecutive action of our present Governmental Departments and of casual Committees."

"On the Continent there exist certain institutions, fitted with instruments, apparatus, chemicals, and other appliances, which are meant to be, and which are made, available to men of science, to enable them, at a moderate cost, to pursue original researches."

"The physical laboratories which have grown up [in Universities] show the want felt of Colleges of Research; but they go but infinitesimally towards supplying it, being absolutely destitute of means, material or personal, for advancing science except at the expense of volunteers, or for securing that volunteers shall be found to continue even such little work as at present is carried on."

And in connection with the still urgently pressing need for a systematic abstract of papers and of a central comprehensive report of annual progress in physics, such as is already satisfactorily accomplished by our friends the chemists, the following quotation from the same address is likewise of interest:—

"A detailed account of work done and knowledge gained in science Britain ought to have every year. The *Journal of the Chemical Society* and the *Zoological Record* do excellent service by giving abstracts of all papers published in their departments. The admirable example afforded by the German *Fortschritte* and *Jahresbericht* is before us; but hitherto, so far as I know, no attempt has been made to follow it in Britain. It is true that several of the annual volumes of the *Jahresbericht* were translated, but a translation . . . cannot supply the want. An independent British publication is for many obvious reasons desirable. The two publications, in German and English, would, both by their differences and their agreements, illustrate the progress of science more correctly and usefully than any single work could do."

From the same address I cull the following detached morsels:—

"Our knowledge of the dark lines is due to Fraunhofer. Wollaston saw them but did not discover them." "The old nebular hypothesis supposes the solar system . . . . to have originated in the condensation of fiery nebulous matter. This hypothesis was invented before the discovery of thermodynamics, or the nebulæ would not have been supposed to be fiery."

In amongst the more geological portion of the book there comes a Presidential address to the Society of Telegraphic Engineers, from which it may be useful to extract the following compact statements concerning atmospheric electricity:—

"In fair weather the surface of the earth . . . . is always found negatively electrified. . . . The more common form of statement is that the air is positively electrified, but this form of statement is apt to be delusive. . . . . The surface of the earth is negatively electrified, and positive electrification of the air is merely inferential, ... the lower regions of the air [such air as comes in through windows] are negatively electrified. . . . . It is not always negative, however. I have found it positive on some days. In broken weather . . . . it is sometimes positive and sometimes negative. Now hitherto there is no proof of positive electricity in the air at all in fine weather; but we have grounds for inferring that probably there is positive electricity in the upper regions of the air."

Opening the book now at page 360, we find a paper which might well have been included in the volume on "Navigational Affairs," being on the subject of the Rate of clocks and chronometers as influenced by the mode of suspension. It is rather surprising to learn that the rough and ready conditions of a pocket by day and a pillow by night give a watch a better chance of going correctly than many other modes of support, such as hanging on a nail or even lying flat on a table. If a correctly-going watch be hung up by a single long thread normal to its plane it begins to gain, and if its case has n times the moment of inertia of the balance-wheel, it gains one in $2n$ swings; a watch actually tried, whose n was 650, gained more than a minute (67 seconds) in a day when so suspended. Suspend it by a bifilar suspension and gradually move the threads further apart, so as to increase the natural rate of swing of the case, and the watch gains more and more, until, when the periods of case and wheel coincide, it gains furiously, and then either stops altogether or else begins to lose equally furiously. Separate the threads a little more still, and the losing rate begins to diminish, until ultimately, when the constraint is great, it begins to keep correct time again. Thus by suspending a chronometer judiciously it can be adjusted to time without touching the hands; but if it be suspended so as to have a quick natural period of swing, it cannot be expected to keep good time. If placed on a cushion to protect it from jars, its case is not unlikely to have a quick swing-period;

[1] (Continued from page 293.)

it should be firmly fixed to something with a considerable moment of inertia, and then placed on its cushion. Any fairly regular motion of the case is fatal to good going. And as to astronomical clocks, they should be fixed to stone piers with the same sort of care as is bestowed on transit instruments.

Another paper, "On a New Astronomical Clock," notes the defects of Graham's dead-beat escapement, and suggests a new one, wherein the escapement wheel is carried by a loose friction collar at a rate a trifle faster than the proper rate, so that its pellets engage the pendulum only occasionally, receiving the necessary check and maintaining the motion of the pendulum sufficiently, even though they only touch once a minute or so.

In a paper "On Beats of Imperfect Harmonies," of date 1878, Lord Kelvin virtually lends his support to the view advocated by Koenig, that in the appreciation of harmony the ear detects phase-differences and is not limited to analysis of a complex note into simple harmonic constituents. For instance, a harmony of even and odd vibration numbers (like 2 : 3) will have one kind of phase relation, while a harmony of two odd numbers will have another kind, the most obvious feature of these phase relations being the way successive maxima and minima coincide or oppose. In general the shape of the curve representing the composition of two notes varies in appearance, as is well known, according to the phase in which they are compounded. If one of the constituents is out of tune there will be a gradual transition from one of these phase-relations to another. "In favourable circumstances . . . a variation of the sound recurring periodically in the successive cycles is distinctly heard. . . . It is this variation which is called the 'beat' on the imperfect harmony."

Lord Kelvin has made experiments on pure tuning-fork tones, and his experience is "that in every case the ear does distinguish the two halves of the period of each beat. . . . The ear distinguishes the quality of the sound represented by the sharp-topped and flat-hollowed curve from that represented by the flat-topped and sharp-hollowed curve. In the one case the pressure of air close to the ear rises very suddenly to, and falls very suddenly from, its maximum, and (as in cases of tides in which there is a long hanging on low water) there is a comparatively slow variation of pressure for a few ten-thousandths of a second on each side of the instant of minimum pressure; in the opposite phase-relation there is a slow change before and after the time of maximum pressure, and a rapid change before and after the time of minimum pressure."

The ear is thus found able to distinguish between a push and pull on the tympanum; or the receiving apparatus is not symmetrical on either side of zero. This is equivalent to saying that second order of small quantities must affect the sound as heard, and on this can be based the usual theory of the difference and summation tones of Helmholtz.

But the mode of expression adopted by Lord Kelvin is not that of interference of any resultant simple tones; he prefers to think of the actual phase changes as directly detected by the ear, and says that "a *revolving character* which I perceive in the beat is to me certainly distinct enough to prove that the ear does distinguish between these configurations, which are one of them the same as the other taken in the reverse order of time."

According to his experiments it is singular how very faint is the disturbance necessary to bring out these beat tones: much less than would appear to be necessary on Helmholtz' theory of difference tones, whose amplitude is proportional to the product of the constituent amplitudes. Thus, "if when the approximate harmony C E is being sounded, with the E slightly out of tune and the beats on it heard, the faintest sound of G is produced by a very gentle excitation of the fork by the bow, instantly a loud beat at half speed is heard. . . . It is marvellous how small an intensity of the sound G is required to give a smooth unbroken loud beat in the double period." This practical method of tuning a major third, by addition of the minor third above it, completing the common chord, is of course well known; but the ordinary Helmholtz explanation, of beats between the C E difference tone and the E G difference tone, scarcely seems to fit the above observed facts.

Again, if the notes C E G are sounded and one of the notes (say C) is flattened, the beats are not only very audible but "the sound dies beating, the beats being distinctly heard all over a large room as long as the faintest breath of sound is perceptible. The smooth melodious periodic moaning of the beat is particularly beautiful when the beat is slow (at the rate, for instance, of one beat in two seconds or thereabouts), being, in fact, sometimes the very last sound heard when the intensities of the three notes chance at the end to be suitably proportioned."

Incidentally an inconvenient usage of musical nomenclature is mentioned in a note. The word "tone," which is now coming to be used to mean a pure sine curve disturbance or simple note, means in music the interval of the major or minor or tempered second.

Those who have to do with acoustics must have often experienced the inconvenience of the ordinary childish nomenclature of intervals—a fourth, a third, a seventh, and so on—especially when these intervals are being numerically expressed at the same time. To call the interval 2 : 3 a fifth, 3 : 4 a fourth, and 1·25 a third, is often confusing. Might I suggest that these intervals, when true, might be named readily and intelligibly as respectively a do-sol, a sol-do, or if preferred a do-fa, and a do-mi; similarly a minor third would be a mi-sol; a major and a minor tone would be a do-re and a re-mi respectively; and so on.

It might be convenient to drop the *l* in sol, so as to make all the syllables of two letters; and then the flattening or sharpening of notes might be indicated readily by a final *a* or *e*: thus a flattened major tone would be a do-rea (the same as a re-mi), and a sharpened one a do-ree.

On the tempered scale the intervals could be called *cg*, *gc*, *ce*, *eg*, &c., with perfect ease.

Again, the ordinary musical notation, with its various clefs, if it were not hallowed by usage, would seem a barbarous piece of stupidity. Undoubtedly a couple of lines should have been understood as missing between the bass and treble clefs, instead of only one; so that the F label could be affixed to the top line of the bass instead of to the second from the top (see fig.); or rather, since the second line from the bottom is G, the same as in the treble, no labelling would be wanted, and one clef would serve for all instruments—a change which would

surely save a Conductor something? I wonder if it is too late now to make the change! This, however, is a digression, and Lord Kelvin is not to be held responsible for any of these musical notation heresies.

The remaining parts of the book consist, for the most part, of Presidential addresses and a couple of Royal Institution lectures. The first R.I. lecture, "On the origin and transformation of motive power," is now of only historical interest. It is of date 1856, and in it the energy of motion is called "dynamical" or "actual" energy, though in a note the author says that he very soon after suggested the name kinetic.

It is followed by the address to Section A at York in 1881, on the practical utilisation of wind and water power; and then begin the quite recent articles. First, an article on the Dissipation of Energy for the *Fortnightly Review* of 1892, wherein the author points out how near Carnot was to an appreciation of the second law of thermodynamics, and justifies his own limitation of its statement to "inanimate material agency" by the following:—

"My statement of this axiom was limited to inanimate matter because not enough was known either from the natural history of plants and animals or from experimental investigations in physiology to assert with confidence that in animal or vegetable life there may not be a conversion of heat into mechanical effect not subject to the conditions of Carnot's theory. It seemed to me then, and it still seems to me, most probable that the animal body does not act as a thermodynamic engine in converting heat produced by the combination of the food with the oxygen of the inhaled air, but that it acts in a manner more nearly analogous to that of an electric motor working in virtue of energy supplied to it by a voltaic battery. . . . It is, however, conceivable that animal life might have the attribute of using the heat of surrounding matter, at its natural temperature, as a source of energy for mechanical effect, and thus constituting a case of affirmative answer for Carnot's last thermodynamic question.[1] The influence of animal or vegetable life on matter is infinitely beyond the range of any scientific inquiry hitherto entered on. Its power of directing the motions of moving particles, in the demonstrated daily miracle of our human free-will, and n the growth of generation after generation of plants rom a single seed, are infinitely different from any possible result of the fortuitous concourse of atoms."

"Considerations of ideal *reversibility* . . . have no place in the world of life."

In an address on the opening of the Physical and Chemical Laboratories of the North Wales College, Bangor, it is stated that there is no philosophical division whatever between chemistry and physics; both "investigate the properties of matter." I would suggest that properties common to many kinds of matter belong to Physics, while the properties whereby one kind of matter differs from other kinds belong to Chemistry. Of course there can be no sharp line of demarcation, but instinctively we are conscious of a difference; and wherever the investigation is concerned essentially with specific varieties of matter, it is felt that the interest attaching to it is a chemical interest. Properties of matter in general, in its different states indeed but without regard to whether the matter is pure or impure simple or compound—those usually belong to Physics.

In this Bangor address there are some interesting reminiscences of the old building of Glasgow University, and of the early days of students' laboratory work there, where under the inspiration of their unique teacher, even theological students worked away at practical experimental physics. And an excellent training too! The modern system of different curricula for each class of professional students, even in the early stages of their degree course, is probably not half so wise as the old Scotch system, where everyone had a year at natural philosophy as well as a year at metaphysics; and the course for everyone up to a degree standard was the same, whatever he was going to be. Specialisation at an early stage is now largely advocated, but I believe that our descendants will regard it as a mistake; or certainly that in effecting a partially required reform we are running now too far into an opposite extreme.

A good wholesome uniform range of subjects, with sufficient variety for different tastes but no reprieve from any course, is the best pregraduate course for all but intellectual weaklings; and for weaklings to attempt to specialise, as they sometimes do now, because it is easier to pass a high stage badly than a low stage well, cannot be really useful or satisfactory.

Those who are incompetent to go deep, and are necessarily superficial, let them try to give their surface breadth; and for those who can go deep, let them spread wide too. A liberal culture and wide information can hurt nobody of decent ability, and it need not be inconsistent with any depth to which a man's genius can carry him. True depth is an affair of genius. Training has chiefly to do with breadth. (This is another digression.)

Of the author's brief annual addresses as President of the Royal Society, the first is on the recently observed slight shift of the earth's polar axis, and on the Faraday centenary; the second on terrestrial magnetism, and the conceivable modes by which the sun may be able to disturb it. The following sentence may be quoted: "I find it unimaginable but that terrestrial magnetism is due to the greatness and rotation of the earth." And on the hypothesis that magnetic disturbances are caused by the direct action of the sun acting as a variable magnet, he says:—"In eight hours of a not very severe magnetic storm, as much work must have been done by the sun in sending magnetic waves out in all directions through space as he actually does in four months of his regular heat and light. This result, it seems to me, is absolutely conclusive against the supposition that terrestrial magnetic storms are due to magnetic action of the sun; or to any kind of

[1] This question was:—"Is it possible to derive mechanical effect from heat of average temperature?"

dynamical action taking place within the sun, or in connection with hurricanes in his atmosphere, or anywhere near the sun outside.

"It seems as if we may also be forced to conclude that the supposed connection between magnetic storms and sun-spots is unreal, and that the seeming agreement between the periods has been a mere coincidence."

The next year's address is on electric radiation, the experiments of Hertz, and electric discharge in gases: with a reference to Mr. Crookes' discovery of vacuum-stresses as an outcome of experimental troubles experienced in his weighing of thallium, and with a characteristic foot-note by Lord Kelvin to the word "troubles":—"Tribulation, not undisturbed progress, gives life and soul, and leads to success when success can be reached, in the struggle for natural knowledge." It is followed by the speech delivered at the unveiling of Joule's statue in Manchester Town Hall on December 7, 1893, and by the Royal Institution lecture on Isoperimetrical Problems; this last being an attempt at popularising the calculus of variations! From how to surround a maximum acreage with a given boundary subject to certain conditions, and how to plan a railway route with a minimum of expense, the author ascends to recent researches in the problem of three bodies, and to the geometrical representation of problems of dynamical stability by the method of geodetics. The most curious part of this lecture is not scientific but social, viz. the treatment accorded to that unfortunate hero, "Horatius Cocles." The representation of Dido as a cute Phenician adventuress successfully wheedling a reasonable plot of ground out of a sarcastic African chief is fair enough, but the spectacle of the stout old warrior with his wounded leg scrambling after a plough along a single furrow from morning till night over all kinds of country, in order to secure as much of the public cornland as possible at the hands of his grateful countrymen, is an odd reading of the legend. That he was awarded a piece of land such that it would take two oxen the whole of a day to plough it, is a statement poetic perhaps in its terms but more precise in its meaning than if expressed in some extinct units of measurement; but to suppose that it was to be ploughed round, and that Horatius must guide the plough, and guide it with a constant eye to secure the maximum of benefit for his minimum of service, is hardly fair either to the memory of the patriot or to the spirit of the Romans in their early and wholesome days.

It can hardly be said even now to represent the attitude of any nation with respect to the services of its military or political heroes, but it may very well be held as a typical illustration of the way in which most countries at present attempt to reward their inventors through the medium of their patent laws.

Whether the author half intended the Horatian episode as a satire, or whether (as is more probable) he is taking the story as a myth for whose social significance or historical bearing he cares nothing, it serves as a popular introduction to what else would be rather an abstruse subject—a subject, indeed, which few people would have ventured to use as the basis for a Friday evening discourse.

These, then, are the varied and highly readable contents of this small book. May the author long live with undiminished vigour, and give us many more of these recreations of a great mind.

OLIVER J. LODGE.

THE FLORA OF CEYLON.

A Handbook to the Flora of Ceylon: containing Descriptions of all the Species of the Flowering Plants indigenous to the Island, and Notes on their History, Distribution and Uses. By Henry Trimen, M.B. (Lond.), F.R.S., Director of the Royal Botanic Gardens, Ceylon. With an Atlas of Plates illustrating some of the more interesting Species. Part i. Ranunculaceæ—Anacardiaceæ. 8vo. pp. xvi. 327, with plates i.-xxv. (4to). Part ii. Connaraceæ—Rubiaceæ. pp. 392, with plates xxvi.-l. (Published under the authority of the Government of Ceylon. London: Dulau and Co., 1893-94.)

WHEN Dr. Trimen left England at the beginning of 1877 to undertake the directorate of the Ceylon Gardens, he had already formed the determination to elaborate the flora of Ceylon, and to publish a descriptive handbook of its botany. Those who knew him knew that this work would only be undertaken after due preparation and without undue haste, but that it would be pushed forward steadily and with all reasonable speed to a satisfactory consummation: and the two instalments now before us amply justify such a conclusion.

Dr. Trimen was fortunate in having had so careful a predecessor as G. H. K. Thwaites, whose "Enumeratio Plantarum Zeylaniæ," published in 1858-64, he rightly describes as "an extremely accurate and most valuable work," rendered more useful by the extensive series of illustrative specimens distributed by Thwaites to the principal herbaria of the world. The first work of the new Director was to bring this up to date, which he did in a "Systematic Catalogue," published in 1885, and arranged in accordance with the "Genera Plantarum." In the course of a visit to England in 1886, Dr. Trimen found time to examine the invaluable Ceylon Herbarium of Hermann, preserved in the British Museum, upon which Linnæus based his Flora Zeylaniæ; and he published a complete enumeration and identification of the plants therein contained, with notes, in vol. xxiv. of the *Journal of the Linnean Society*. Various new species have from time to time been published by Dr. Trimen in the *Journal of Botany*; and these, with the results of the rest of his work, are embodied in the "Handbook."

In his younger days, Dr. Trimen was known as a painstaking British botanist, and the "Flora of Middlesex," issued in 1869, for which he was mainly responsible, initiated a new departure in works of the kind. It was marked by thoroughness and accuracy; every page showed care and research: and these qualities are abundantly manifest in this Ceylon "Handbook." A careful correlation of the work of predecessors in the same field is another characteristic shared by each book; and in each there was need for this, for Middlesex plants have been recorded since the days of William Turner, while the Cingalese flora has been treated of by various authors from Hermann (1717) downwards.

The opening sentence of the brief introduction strikes the key-note of the work, with which the two volumes before us are in perfect harmony. "One principal object of this Handbook is to enable observers in Ceylon to ascertain the name of any plant they may find growing wild. When this is arrived at, they are in a position to learn all that may have been written about it in botanical and other literature, to appreciate its relationships to other plants, to trace its distribution in other lands, and to intelligently investigate its properties and uses." The book being intended as a guide to the flora of Ceylon, the descriptions have been made wholly from Ceylon specimens, and the information given under each species is restricted to what affects it as a Ceylon plant. Technicalities have been avoided so far as this could be done consistent with accuracy, and the definitions of orders and genera are only such as are shown by the species found in Ceylon.

The same restriction is carried out in the references to published books and papers, which are almost entirely limited to those wherein the species is noticed as a Ceylon plant. The Latin name is followed by the vernacular names when known, in Cingalese and Tamil. Thwaites's distributed numbers are always quoted, and figures of the species, preference being given to such as are known to have been made from Ceylon specimens, are referred to. After the description, made wherever possible from living specimens, come the general distribution and comparative frequency in Ceylon, and notes as to the times of flowering and colour of the flowers—points which are not always to be found in works of this kind, but which are very useful to the field botanist, especially if he be a beginner. In addition to these matters, information is frequently added on peculiarities in structure, or on the properties, products, and uses of the plants, with brief notes on the history and nomenclature of the species. The diagnostic description of each order is followed by keys for the rapid determination of the genera and species. Dr. Trimen has wisely refrained from the startling novelties in nomenclature which are to be met with in various transatlantic local floras, where they are more than usually out of place; and lays down dogmatically that "no botanical name in the modern taxonomic sense can be of earlier date than 1753, when Linnæus first definitely published his binominal nomenclature."

Our colonial floras are for the most part so largely drawn up from dried specimens by botanists unacquainted with the plants in a living state, that their usefulness in the field must be considerably diminished. Their value for herbarium work is undoubted, a fact of which one is continually reminded by the absence of any enumeration for some countries, and the unfortunate incompleteness of most of those which have been set on foot. New Zealand and Australia are well provided for, although the unflagging zeal of Baron Ferdinand von Mueller and his many helpers has already added so much to our knowledge that the "Flora Australiensis" is by no means up to date. Africa, both South and Tropical, is less fortunate, the "Flora Capensis" remaining where it was at the death of Harvey in 1866, and the "Flora of Tropical Africa," although now once more in progress, having come to a standstill in 1877. Thanks to the energy of Sir Joseph Hooker, we are within reasonable distance of the completion of the "Flora of British India"; and the useful "Index Floræ Sinensis," although not a descriptive flora in the sense of those mentioned, is proceeding steadily. But we greatly need floras for the South American continent; and Mr. Hemsley's handsome Botany of the "Biologia Centrali Americana" can hardly be considered exhaustive for the region of which it treats. To take a much more limited area, we have no compendium for Madagascar, and our knowledge of its wonderful flora has to be gleaned from a large number of scattered papers.

The existing floras, however, do not contain in any great degree descriptions drawn from living material; and it is fortunate that the small area to which Dr. Trimen is restricted has enabled him to treat his plants in this rational manner. It is to be regretted that his aims will be to some extent frustrated by the unnecessarily bulky form which his "Handbook" has assumed. The two volumes already issued contain between seven and eight hundred pages, and at least as many more must be occupied by the remainder of the work. The paper employed is much too thick, and by a different arrangement of type considerable saving of space might have been effected, without materially detracting from the appearance of the volumes. It may well be, however, that when the work is completed, Dr. Trimen will issue an abridgement for use in the field, which would occupy to the present handbook the position which Mr. Hayward's "Botanist's Pocket-book" holds with regard to our larger British manuals.

A word must be said in praise of the excellent quarto plates which accompany the "Handbook." They are selected from a series of several thousand drawings, begun in 1823, when Mr. Moon was Director of the Gardens, and preserved in the library. These are entirely the work of three members of one family. Haramanis de Alwis, who has just died at a very advanced age, held the post of draughtsman to the Gardens for thirty-eight years, and was succeeded by his sons, one of whom has held the post for twenty-seven years. Most of the drawings here reproduced are his work.

James Britten.

OUR BOOK SHELF.

Biskra and the Oases and Desert of the Zibans. By Alfred E. Pease, F.R.G.S. Pp. 112. (London: Edward Stanford, 1894.)

Having spent six months in Biskra, Mr. Pease thought it worth while to use the knowledge gained during this period to supplement the comparatively slight information given in handbooks to the provinces of Oran, Algeria, Constantine, and Tunisia.

Biskra, Biskra-en-Nokkel, or Biskra aux Palmiers, is a beautiful green oasis, from which visits can be conveniently made to neighbouring oases in the Sahara. The oasis is about five kilometres in length, and its width ranges from one hundred to seven hundred metres. The town is situated 111 metres above sea-level in lat. 34° 52′ N., and long. 5°42′ E. Upon the oasis flourish 160,000 date palms, 6000 olive trees, as well as fig, orange, citron, and lemon trees. The people are kindly and unsophisticated, and the climate is delightful during most of the year, being specially suitable for persons suffering from pulmonary complaints. Tourists who like to leave the beaten track, and seekers after a refuge from an English winter, will be attracted to Biskra if they read Mr. Pease's little book.

Practical Photo-Micrography. By Andrew Pringle. (London: Iliffe and Son, 1894.)

WORKERS in this fascinating branch of science will no doubt be well acquainted with the author's large treatise, a book which is suitable, more especially, for those who wish to devote themselves very considerably to this kind of work, and to enter into all the details connected with it. The publication of the present book will not appeal so much to the interest of this class of readers, but will be welcomed more by those who wish to get a good working idea of photo-micrography. With this intention this manual has been kept within very reasonable limits, is decidedly explicit, and thoroughly practical. In the seventeen chapters the reader is led through all the manipulations, from the choice of instruments to suit his purse, kinds of plates to use, colour treatment of objects, and general photographic procedure, &c., to those dealing with good hints on lantern-slides, cover-glass preparations, and section cutting and staining. The text is accompanied with numerous well-chosen illustrations, and the get-up of the book is all that could be desired. It may interest our readers to know that in the above pages we are informed that no apparatus is recommended on hearsay, or is any statement made or step suggested "outside the knowledge and practice of the writer."

Twelve Charts of the Tidal Streams on the West Coast of Scotland. By F. Howard Collins. Small folio. (London: J. D. Potter, 1894.)

MR. COLLINS has elaborated the work of the Hydrographic Office by producing a set of charts showing the direction of the tidal streams on the west coast of Scotland at intervals of one hour from the time of high water at Greenock. The twelve charts are prefaced by a note describing how they should be used, and a tide-table. The sources of his information are duly acknowledged, and the work was carried out with the assistance of Captain Wharton, the hydrographer. The work is similar in scope and method to the atlas of tides in the North Sea by the same author. It is a serious defect that no method has been adopted for distinguishing the velocity of the tidal streams, or at least of indicating the furious tidal races which occur in many channels and off many headlands. So far as the direction of the streams is concerned, this compact set of charts should be useful to yachtsmen, and is not without interest for oceanographers.

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.*]

On Some Methods in Meteorology.

IS it not a *desideratum* in our rainfall records that they should give, with the amount of rain, not mere rain-days (or days' rain), but the exact time (or as near an approximation to that as possible), during which rain has fallen? This might at least, surely, be expected from our observatories and better equipped stations. Some of our continental neighbours are before us in this respect. Thus, the Geneva record, for more than thirty years, has contained as one of its items, "hours of rain." May we not then ask why an institution like that at Greenwich, goes on giving the number of days on which rain fell; a momentary sprinkle being thus put in the same category with an incessant downpour of twenty-four hours?

One might here remark on the great fulness of detail and excellence of arrangement in records of the weather at various continental stations (*e.g.* Pola); which are apt to lead us into invidious comparisons.

With regard to measurement of bright sunshine, the burning-glass method leaves much to be desired from a scientific point of view, and the photographic method seems likely to supplant it increasingly. But might not the concentrated rays be got to produce some other physical effect (metal-expansion?) than burning paper, yielding a more exact record of the amount of sunshine?

Again, may it not be said that the graphic method is far too little utilised in meteorology? Probably nine persons out of ten would agree that they apprehend a truth of statistical nature, a numerical variation, much better every way—more quickly, more clearly, more retentively—through a graphic curve, than through a column of figures, or a verbal description. Yet we have only to turn over the pages of our meteorological publications (and others dealing with figures) to see that this method is used very sparingly. And it is easy to pick out cases where the want of it is felt very plainly. I can recall one such case in a valuable paper by one of our ablest meteorologists (Dr. Buchan), published a short time ago in the Scottish Society's *Journal*, on mean temperature in the neighbourhood of London during 130 years. Here we find paragraph after paragraph, over several pages, describing how certain smoothed values of temperature had varied, now above, now below the line of average. This imposes a considerable strain on the imagination, proves, I am afraid, somewhat tedious reading, and leaves, perhaps, no very distinct impression after all. A simple diagram, giving the curves themselves, would here be an effective labour-saving contrivance, both to the author and his readers.

But to multiply diagrams means great expense, it will naturally be urged. Now the cost of a well-finished diagram (and we all like such) is no doubt considerable. But with the aid of photography diagrams can now be reproduced very cheaply; and it seems to me open to consideration whether we might not do well to sacrifice a little fineness and finish, for the sake of a freer and more frequent use of the method, and the greater clearness of comprehension which that would ensure. Moreover, such diagrams are not to be regarded as a mere addition, and therefore requiring more space; they may even mean an economy of words and space. There are frequent cases in which it is not necessary to give all the figures involved; the object being merely to point out a relation, the salient features of a curve. And if the diagram can be relied upon for accuracy, little need be said about it, in some cases; it tells its own tale. Then again, the photographic reproduction of an author's diagram may even prove a gain in accuracy; some intermediate perils are avoided. I believe, in fine, that the graphic method has a great future before it, not only in science, but in other domains; and the sooner we set about developing its capabilities to the utmost, the better.

A. B. M.

Magnetism of Rock Pinnacles.

IT is well known that the Riffelhorn powerfully affects the compass, and the like has been observed on other peaks in Switzerland; but I have never seen any record of similar observations in this country.

Four years ago, on a visit to the Lizard, accident drew attention to a strong influence on the compass exhibited by a crag on the moors near Kynance. I have taken the opportunity of a visit this year to ascertain whether that were a solitary case. I find that such influence, though not general, is by no means uncommon. Most of the rocks in which it was observed were serpentine; it occurred also in hornblende schist; there were no sufficient opportunities of testing the other rocks of the district. The influence was exhibited only in rather prominent crags, but among them often in lower adjacent blocks, as well as in the absolute summits. At a few yards' distance it was always imperceptible.

I saw no traces in any case of the crag having been struck by lightning. This was the only point to which I gave attention; but it would be natural also to inquire if all kinds of rock can possess the property, if wet or weather affects it, and if it be temporary or permanent.

I used a common pocket compass, taking the bearings of some distant object, first a few feet off, then in four surrounding positions as near as the compass could be held to the stone I was testing. The effects varied from no deviation or slight, to cases where the needle swung completely round while still a foot or two away. Among the strongest noted were some crags north of Kynance Cove, and some on a headland about a quarter of a mile south of Coverack, both consisting of serpentine. Any one whose holidays take him to a rocky neighbourhood, may find interest in carrying out similar observations.

Cockfield, July 28. E. HILL.

The Aurora Australis.

THE following report of a brilliant Aurora, seen in the Indian Ocean, will be interesting to many of your readers :—

THE AURORA AUSTRALIS.—When sailing along the Indian Ocean from the Cape of Good Hope to Australia, and in about the vicinity of St. Paul's Island, longitude 76° 17′ east, latitude 4 1°22′ south, an Aurora Australis of remarkable grandeur was seen by those on board the ship *Isle of Arran*. Describing it yesterday, Captain Carse said his chief officer and he had a beautiful view of the phenomenon on two nights (April 28 and 29). It was a very fine sight, the streams of light in spraylike form shooting upward for fully thirty degrees, lighting up with wonderful brightness the whole southern part of the heavens. Some very bad weather was experienced by the ship in the locality of St. Paul's. High confused seas prevailed with a strange continuance of easterly winds.—*Herald*, May 23.

No report was received that this was seen in any part of Australia, and I have seen no report that the brilliant Aurora seen in the northern hemisphere on March 30 was seen in this part of the world. H. C. RUSSELL.

P.S.—I got position and date from Captain Carse.

Absence of Butterflies.

THE most common butterflies—as, for instance, *Pieris Brassicæ, Coleas Rhamni, Vanessa Urticæ*—were very rare hereabouts this spring too (*cf.* NATURE, vol. l. p. 225), and the same has been observed at Frankfort-on-Maine. As for *Pieris*, this scarcity might have been predicted with certainty last autumn, as, here and at Frankfort, the cabbage-plants in fields and gardens were almost exempt from their usual ravagers, the caterpillars of the said species. If the extraordinary dryness of last year's summer should be connected with these facts, it cannot have acted through the damage done to the food-plants, but must have operated more directly upon the insects themselves. D. WETTERHAN.

Freiburg, July 28.

A STRANGE LIGHT ON MARS.

SINCE the arrangements for circulating telegraphic information on astronomical subjects was inaugurated, Dr. Krueger, who is in charge of the Central Bureau at Kiel, certainly has not favoured his correspondents with a stranger telegram than the one which he flashed over the world on Monday afternoon :—

"Projection lumineuse dans région australe du terminateur de Mars observée par Javelle 28 Juillet 16 heures Perrotin."

This relates to an observation made at the famous Nice Observatory, of which M. Perrotin is the Director, by M. Javelle, who is already well known for his careful work. The news therefore must be accepted seriously, and, as it may be imagined, details are anxiously awaited ; on Monday and Tuesday nights, unfortunately, the weather in London was not favourable for observation, so whether the light continues or not is not known.

It would appear that the luminous projection is not a light outside the disc of Mars, but in the region of the planet not lighted up by the sun at the time of observation. The gibbosity of the planet is pretty considerable at the present time. Had there been evidence that the light was outside the disc, the strange appearance might be due to a comet in the same line of sight as the planet. If we assume the light to be on the planet itself, then it must either have a physical or human origin ; so it is to be expected that the old idea that the Martians are signalling to us will be revived. Of physical origins we can only think of Aurora (which is not improbable, only bearing in mind the precise locality named, but distinctly improbable unless we assume that in Mars the phenomenon is much more intense than with us), a long range of high snow-capped hills, and forest fires burning over a large area.

Without favouring the signalling idea before we know more of the observation, it may be stated that a better time for signalling could scarcely be chosen, for Mars being now a morning star, means that the opposition, when no part of its dark surface will be visible, is some time off.

The Martians, of course, find it much easier to see the dark side of the earth than we do to see the dark side of Mars, and whatever may be the explanation of the appearances which three astronomers of reputation have thought proper to telegraph over the world, it is worth while pointing out that forest fires over large areas may be the first distinctive thing observed on either planet from the other besides the fixed surface markings.

THE INTERNATIONAL GEOLOGICAL CONGRESS.

THE sixth meeting of this Congress will be held at Zurich, commencing on August 29. The Congress was founded at Philadelphia in 1876, the first meeting being held at Paris in 1878 ; subsequent meetings have been—Bologna, 1881 ; Berlin, 1885 ; London, 1888 ; Washington, 1891. As one result of discussions at the Paris meeting, committees were appointed in different countries to draw up reports on classification, nomenclature, &c. At Bologna these reports were received and discussed, the greater part of the time being thus spent. An additional committee was then appointed to prepare a geological map of Europe ; this work is still in progress, but the committees on nomenclature, &c., have practically lapsed, and but little attention has been paid to such subjects at the more recent meetings. At the Washington Congress a committee was appointed to report on the Bibliography of Geology. Lists of bibliographies for each country were to be prepared, and printed in the report of the Washington meeting ; but the volume has recently appeared without such lists. It is hoped that the committee will submit a report on this important subject at Zurich.

Prof. E. Renevier, of Lausanne, is nominated President of the Zurich meeting. He has been an active member of the Congress from the commencement, and the excellent arrangements for the forthcoming meeting are no doubt largely due to his powers of organisation. Prof. A. Heim, of Zurich, is Vice-President ; Prof. H. Golliez, of Lausanne, is Secretary ; M. C. Escher-Hess, of Zurich, is Treasurer. This apparently exhausts the list of officers of the organising committee, democratic Switzerland dispensing with "president of honour," "honorary members of committee," &c., which have largely figured in the lists of previous Congresses, even in that of Washington. Not having such honorary lists upon which to draw for funds, the subscription for membership is double that previously charged, but is even now only 25 francs.

The arrangements made for the Zurich meeting differ somewhat from those of previous sessions. There will be no formal discussion on nomenclature, classification, &c. ; but, after transacting general business, the Congress will divide into three sections, meeting simultaneously. The subjects for discussion will be : (1) General and Tectonic Geology ; (2) Stratigraphy and Palæontology ; (3) Mineralogy and Petrography. Amongst the papers promised are: K. von Zittel, Palæontology; M. de Bertrand, Structure of the Western Alps; A. Heim, Geology of the Environs of Zurich; A. Michel-Lévy, the Unification of Petrographical Nomenclature; E. Suess, Tectonic Geology. There will also be papers on glacial geology; and Captain Marshall Hall will submit a proposal for an international survey and record of glaciers.

At the Zurich meeting, however, papers and discussions will form but a comparatively small part of the work. Excursions have always played a prominent part in the arrangements for the various meetings; but hitherto they have been mainly made after the close of the Congress. At Zurich the Congress will practically divide into five excursion sections, starting on September 3, traversing the Alps in different directions, and all converging on Lugano, where the closing meeting will be held on September 14. These excursions would alone make the Zurich meeting memorable; they have been planned to include the most interesting districts of the Swiss Alps, and to facilitate the study of many intricate problems concerning the structure of the mountains and the petrographical nature of the rocks. After investigation of the northern flanking ranges of folded secondary rocks, the central crystalline zone will be crossed, and in some cases glacial phenomena can be well studied. Prof. Heim will conduct a party over the country which he has so well described, starting from St. Gall and crossing the Alps of Glarus, the Vorder Rhein, and the eastern Lepontine Alps; Prof. Schmidt will conduct the party from Schwtz over the St. Gotthard; Prof. Baltzer, starting at Lucerne, will take a line some miles further west; Prof. Schardt, starting at Bulle, will traverse the western end of the Bernese Alps and part of the Pennine Alps, and will reach Lugano by the Simplon. These four excursions are for pedestrians only, and those only are invited who are accustomed to long walks and climbing, hard beds, and frugal living. A more elaborate circular tour in the Alps will be conducted by MM. Ruffieux and Ruchonnet, of Lausaunne; this will traverse a wider district, and the work will be done with less fatigue. Profs. Renevier and Golliez will be the scientific directors of this tour.

Supplementary excursions will start from Lugano after September 14, one of which, conducted by Profs. Bruckner, Du Pasquier, and Penck, will study the glacial phenomena of the Italian Lakes, thence by the Tyrol to Munich, and finally to the Lake of Constance.

Before the Congress there will be excursions in the Jura—five for pedestrians—as follows: French Jura, M. Schardt; Vaudois Jura, M. Jaccard; Bernese Jura, M. Rollier; Bâle and the Argovian Jura, M. C. Schmidt; Argovian Jura and Soleure, &c., M. Murlberg. There will also be a long circular tour in the Jura by MM. Ruffieux and Ruchonnet, with MM. Renevier and Gollitz as scientific directors; the latter part of this will be much devoted to glacial questions, and will therefore be preparatory to the special glacial excursion starting from Lugano.

Arrangements have been made for inclusive charges for all these excursions. For the pedestrian tours, they are 50 or 60 francs for the Jura excursion of five or six days each, and 300 francs for the circular Jura tour of fourteen days.

For the longer excursions in the Alps, after the Congress, the prices are from 150 to 250 francs for the pedestrian tours of eight to thirteen days, and 400 francs for the circular tour of thirteen days.

A guide-book to the various excursions is in preparation. This will contain about 300 pages of text, and will be amply illustrated by plates and sections; it will form a most useful handbook to the geology of Switzerland. A new geological map will also be published, on the scale of 1 : 500,000; this will be a reduction of the official maps of the Swiss Geological Survey, which is now completed.

Special guide-books to the important geological collections at Lausanne and Zurich are in preparation. As usual at such meetings, geological maps and other publications, photographs, specimens, &c., will be exhibited.

W. TOPLEY.

THE DISCS OF JUPITER'S SATELLITES.

THE discussion which is now taking place between two well-known observers—namely, Profs. Pickering and Barnard—as to the forms which the satellites of the planet Jupiter assume at various times, is one not only of absorbing interest, but, moreover, of a nature somewhat delicate, for the bodies in question are so minute as to baffle any but the very best and trustworthy observers. Such observations, then, to be of any value at all, must be either made in the clearest of atmospheres with a moderately large aperture, or in a moderately clear atmosphere with a very large aperture. Considering these two conditions, one would doubtless think that the larger the instrument the more chance there would be of finding out the shape of a body, and with a very clear atmosphere in addition these chances would be very greatly increased. On the other hand, however, we have the facts still in our mind of Schiaparelli's wonderful observing powers, which enabled him to notice the doubling of the canals of Mars with his small aperture long before they were declared "double" by other observers. In this case one would have thought that such an observation would have been more easily observed with large apertures than with the small telescope which was at his disposal.

Let us, however, turn to the facts at hand with regard to the satellites that are now under discussion; but first a few words with regard to the instrumental equipment employed and the observing stations.

Prof. Pickering's observations have been made at the Observatory that is situated near Arequipa, in Peru, at an altitude of more than eight thousand feet, where the sky during a large part of the year is nearly cloudless. The telescope employed has shown that there is a remarkable degree of steadiness in the atmosphere, and night after night atmospheric conditions prevail, which, as he says, "occur only at rare intervals, *if ever*, in Cambridge." Several of the diffraction rings surrounding the brighter stars are visible, close doubles in which the components are much less than a second apart are readily separated, and powers can be constantly employed which are so high as to be *almost useless* in Cambridge. In fact, he says that in many researches the gain is as great as if the aperture were doubled. The aperture of the refractor employed is 13 inches.

Prof. Barnard has made his observations, on the other hand, with the now well-known 36-inch refractor of the Mount Hamilton Observatory, a description of which here would be unnecessary; suffice it to be mentioned that Prof. Burnham has increased the number of double stars by about 200 during his brief use of this instrument, most of which are beyond the reach of the majority of telescopes.

Turning now to the observations of the satellites themselves, we find the first account of Prof. Pickering's observations in the March number of *Astronomy and Astro-Physics* for the year 1892.

On October 8, a series of measurements was made of the diameters of the satellites. On the next evening it was noticed that the disc of the first was not circular but very elliptical. Early observations on the tenth confirmed the measurements made on the eighth, but after an examination of the other satellites the first was again measured, when, as Prof. Pickering says, "to my astonishment, instead of showing an elliptical disc, it showed one that was perfectly circular, precisely like the other satellites." He further goes on to say that the disc gradually began to lengthen again and assume the elliptical form. From these observations it was concluded that the first satellite had the form of a prolate spheroid or ellipsoid, or, in other words, was egg-shaped. A week later each of the other satellites had been recorded to some extent elliptical. Curious to relate, the three outer satellites, according to the observations, appeared *shortened* equatorially, not *lengthened*, showing that they did not seem to revolve round their minor axes.

It was not surprising to notice that Prof. Pickering was at first rather sceptical about the truth of these observations, and assuming that they might be produced optically or otherwise, he employed every method which would eliminate such ambiguity. These researches gave a negative result. It occurred to him, also, that the effects seen might be due to light and dark spots, suitably placed upon the surface, but during the time of the satellites' transits, and when they were about to disappear, no such spots were seen, although some surface markings on the first, third, and fourth satellites have been discovered.

The results to be gathered from the observations made up to this time may be summed up as follows :—

(1) The first satellite is a prolate ellipsoid revolving about one of its minor axes in a period of 13h. 3m. ; and (2) the discs of the second, third, and fourth satellites at regular intervals assume the forms of ellipses, and these periodic changes are presumably produced, as is thought, by rotations upon their axes.

The second contribution on the form of the satellites appeared in the May number of the same journal for the following year, and Prof. Pickering opens with the statement that "what have appeared to be most natural suppositions have been found so frequently to be contradicted by the facts, that it seemed best to take nothing for granted with regard to them." The observations here deal first with the direction and period of rotation, giving as a result a probable retrograde motion of rotation for the first satellite.

With regard to the change of forms, it was noticed that the first satellite on January 13 appeared distinctly shortened equatorially when at its minimum phase, the phenomenon lasting thirty-four minutes ; while the second satellite is occasionally described as appearing long, like the first. At the maximum phase the second, like the two outer satellites, has appeared round ; and the third, at some of its minima retains the elliptical phase for a longer time than at others. Thus, for instance, it remained short for the three days, January 13, 14, and 15, consecutively.

The next account of further observations are contained in a long paper entitled "The Rotation of Jupiter's Outer Satellites," which appeared in the following June number. The observations here are given more in detail, but we will confine ourselves to the main points, commencing with those relating to the largest and most easily observed of the group, *i.e.* the third. This satellite, according to Prof. Pickering, presents an elliptical phase twice during its revolution in its orbit at an interval of about thirty-four hours after passing conjunction. When on the eastern side it presents an elliptical disc, and the inclination of the major axis to the orbital planes is clearly marked and has been measured on several occasions, the mean value being $-10^{\circ}\cdot5$ P. angle. We have here also some important observations of details visible on this disc of the satellite, which, as Prof. Pickering says, "can without much difficulty be made out."

A careful study shows that the marking usually appears forked, and is sometimes turned to the right and sometimes to the left, and at other times it is seen double, appearing like the letter X turned on one side. Another appearance of the markings on the surface of the same satellite is as if an equatorial belt on one side had been drawn out in both directions of the poles, its breadth increasing as the limb is approached, being in fact trumpet-shaped. A measurement of the position angle of the axis of the belt gave $+15^{\circ}\cdot5$.

Special precautions were taken to find out whether the belt were a genuine phenomenon, or an illusion due either to the instrument or the observer, but these resulted in it being declared real. The observations for the determination of the rotation of this satellite implied a period of rotation coinciding with that of the revolution of the satellite in its orbit.

A recapitulation of the facts relating to the third satellite observed up to this time may be made here :—

Two observers see the disc flattened at regular intervals, and agree upon direction of flattening. Both see a belt in same position, direction, and character of detail, and both remark that the observations are not very difficult, but quite evident when attention is called to them.

The details in the other satellites seem to be more difficult to see than those on the third. The direction of the bands (one or two) in the first satellite lies in an approximately north and south line, while on only one occasion there was detail detected on satellite II., and this consisted simply of a small patch or spot.

The observed facts with regard only to the forms of these discs are :—

The shape of the first is elongated. The regularly recurring changes of shape of the discs of the outer satellites (caused apparently by rotation). The change of position angle of the major axis of the third, and probably of the fourth in different parts of their orbits.

The peculiar behaviour of satellite III., which in October and November was recorded as shortened in the polar direction, but which was afterwards recorded upon two nights as perfectly round, when it should have exhibited its maximum ellipticity. The frequently recorded lengthening (equatorially) of satellite II., which is not corroborated by recent observation. Apparent irregularities in period and ellipticity of the second and, perhaps, the fourth, and the occasional irregular non-elliptical shape of the disc of the third.

Such, then, is the sum total of the observations which up to that time had been made by Prof. Pickering, and we will now turn our attention to the re-examination of the satellites by Prof. Barnard with the help of the great Lick refractor. (*Astronomy and Astro-Physics* for April, 1894).

He commences by telling us that the satellites I., III., and IV. often undergo singular transformations of apparent form during certain stages of their transits across the face of Jupiter, but he had never "seen any of these moons other than round when off the disc of the planet."

In the latter end of the year 1893 to the beginning of 1894, with a power of 1000 diameters, and sometimes higher, he made numerous observations, with the object of detecting, if present, deviations from the disc forms.

The results showed that no such deformations were observed, and Prof. Barnard is inclined to think that the surface markings of the satellites themselves, when near the edges of the discs, might readily cause apparent distortions in these satellites, as they certainly do so when the satellites are in transit, especially when very high magnifying powers on a small telescope are employed. It is curious, he adds, that such deformations should escape detection with our great telescope, even with the most casual observations, considering how conspicuous are the distortions recorded at Arequipa. It is of interest to note one or two remarks accompanying some of the observations, thus :—

	h. m.	
1893 Dec. 3	...	I. is near transit, following, it appears slightly elongated towards Jupiter.
1893 .. Dec. 11	9 18	... I., II., III., each is round, IV. seems a little deficient on following side, as if a slight phase existed, &c.
1894 ... Jan. 28 ...	6 50	... I., II., III. are round, IV. is slightly deficient on following side, as if a slight phase or a dark area existed in it.

The time referred to above is Standard Pacific time, 8 hours slow on Greenwich.

The notes, however, are generally of the following type, a few of which may be mentioned here.

	h. m.	
1893 ... Aug. 28 ...	14 30	... All four are round.
Sept. 3 ...	13 0	... All four are round.
Sept. 24 ...	12 48	... III. is perfectly round.
Sept. 25 ...	15 0	... All four are round and clearly defined.
Oct. 1 ...	16 40	... I. and III. perfectly round.
Nov. 6	11 54	... III. is beautifully round.
	14 40	... III. is perfectly round.
Dec. 10 ...	9 25	... All four are round. North Pole of III. is white.

These observations show that either the satellites on the whole appear generally round, or that the Lick observers have been so unfortunate as to observe them just at those times when the circular discs were to be seen. This seems at first thought to be very improbable, for the reason, as Prof. Barnard himself remarks, that the Arequipa observations indicate distortions that are apparently so very conspicuous.

In the June number of *Astronomy and Astro-Physics* (p. 423), Prof. Pickering gives in reply a short note to the observation made by Prof. Barnard. There are here, also, some measures of the position angle of the elongation of the first satellite as secured by himself and Mr. Douglas upon six different nights, a copy of which is below.

I. Satellite.

Time	P.A.	Dev.	Obs.	Diff.	Corr.
				°	
1892, Nov. 28 ..	100·5	3·7			
,, ,, ...	108·3	8·7	P	+ 7·8	+ 0·7
Dec. 26 ...	100·0	7·6	D		
,, ,, ..	106·1	4·9	P	+ 6·1	− 1·0
,, 29 ...	103·8	5·0	D		
,, ,, ..	116·8	3·2	P	+ 13·0	+ 5·9
1893, Jan. 1 ...	90·0	6·0	D		
,, ,, ...	95·7	3·4	P	+ 5·7	− 1·4
,, 13 ...	99·2	4·2	D		
,, ,, .	104·8	3·7	P	+ 5·6	− 1·5
,, 17 .	92·4	3·8	P		
,, ,,	97·9	3·2	D	+ 4·6	− 2·5
		± 4·8		+ 7·1	± 2·2

Each measure is the mean of six readings, taken alternately in opposite directions. These measures show that the observations are fairly concordant, only that there seems to be a mean personal correction of about 7°·1. The first column gives the date of observation, the second the observed position-angle of the major axis of the disc, the third the average deviation of the readings which combined give the individual measures, the fourth the observers, the fifth the differences between these results, and the sixth these differences corrected by the constant angle 7°·1.

In the last column, the mean 2°·2 indicates the average difference between the corrected measure of the two observers upon any night, which shows a remarkable accordance between the measures.

There can be no doubt that there was some peculiarity about this satellite that was under measurement at the time, a peculiarity which, as Prof. Pickering says, was apparent when it was not in transit, but which vanished at regular intervals of 6h. 32m. Why Prof. Barnard has not been able to witness what seems to be a very distinct phenomenon, if it be not really "personal," seems to raise considerable surprise. Although Prof. Pickering does not deny the existence of the equatorial belts, yet he will not accept it as an explanation of the changes of form noticed, for he says, "such a belt could not have produced the effects observed by us in Arequipa."

A further investigation on the forms of the discs has recently been made by Prof. Schaeberle (*The Astronomical Journal*, No. 321, p. 70), with the intention of detecting, if possible, the rapid change of phase which Prof. Pickering's observations so strongly advocate. The results showed, however, that, by tabulating the ratios of the measured major and minor axes of the several elliptical discs, a practically constant form for the outline was always obtained. We may mention here that to Profs. Campbell and Schaeberle the first satellite appears round only when "it is near to or projected on the disc of Jupiter, and elongated in the direction of the planet's equator in all other positions."

In judging between the weights that ought to be applied to observations made at Arequipa and Mount Hamilton, a fact here is mentioned that is by no means insignificant in showing the superiority, in this case at any rate, of the Mount Hamilton observations over those made at Arequipa.

The observations in question relate to the abnormal forms of the shadows of the satellites, the true forms of which were observed at the Lick Observatory by Prof. Schaeberle and by other observers at different places and times.

The shadows of these satellites as they pass before the disc of Jupiter become at times apparently distorted to observers on the earth's surface, owing to the oblique illumination of the satellites in some positions of the earth, and to the spherical nature of Jupiter's surface.

These distortions reach sometimes very considerable proportions, more considerable, in fact, than the changes of shapes of the satellites, as observed by Prof. Pickering. This being so, it is curious indeed that from Arequipa we have, as far as is known, no mention of such shadow distortions at all, and as Prof. Schaeberle remarks, "one would naturally suppose that an observer, after having discovered, as he believed, a periodic variation in the form of a satellite, would seek to verify his results by examinations of the satellite's shadow during its transit across the disc of the planet"

An idea of the size of the distortions alluded to may be gathered from Prof. Schaeberle's statements that, at the time of the Arequipa observations in January of last year, the longest (longitudinal) diameter of every shadow just after the ingress on the visible disc of Jupiter was "more than twice the breadth of the shadow, while at egress just the reverse condition of things existed."

Such, then, is the present state of affairs. Prof. Pickering sees these small bodies regularly changing their shapes; Prof. Barnard sees them always perfectly round; while Profs. Schaeberle and Campbell see them only round when near to or projected on the disc, and at all other times constantly elongated.

The only conclusion that can be drawn, if one is at liberty to draw any at all, is that in the estimation of the shapes of such small bodies a great amount of personal error is liable to creep in, and the estimation of such must be left for future determination.

It would be interesting, however, to know how the observations would differ, if Prof. Barnard and Schaeberle had the use of the Arequipa instrument at a favourable opportunity, and Prof. Pickering the Mount Hamilton refractor.

W. J. S. LOCKYER.

GEOLOGY AND SCENERY IN IRELAND.[1]

MR. R. WELCH, of Belfast, well-known as a photographer of Irish scenery, has of late years utilised his intimate knowledge of the country, and his keen judgment as an artist, in the preparation of special series of photographs illustrating archæological and scientific features. The brilliant exposures of volcanic and sedimentary rocks along the coast of Co. Antrim have led him to form a group of pictures which might serve as a companion to any ordinary text-book of geology; and he is rapidly extending the series by additions from the counties of Down, Donegal, and even from the far south-west. As I have had the pleasure of assisting Mr. Welch in the production of his first geological catalogue, I can make no comment on its character as a publication; but I need not hesitate to point out what valuable aid is being given to science by the recording of the physical features of Ireland, not haphazard in a series of general landscapes, but with a special geological eye. The excursions of the Belfast Naturalists' Field Club have been the means of calling attention to exposures in places outside the ordinary tourist-track; and the officers of the Geological Survey of Ireland have always been willing to give information as to suitable illustrative localities.

Two samples will show something of the detail and the range of these photographic records. Fig. 1 shows one of the fine quarry-sections on Cave Hill, Belfast. The chalk below, with lines of flints, and the basaltic lavas of the upper plateau, are always an effective contrast; but at this point dykes of dolerite are numerous, cutting through both series. The large one in the centre of the picture is columnar in its upper portion, and has a somewhat wavy course. A smaller sinuous dyke climbs towards it from the right. In the left of the original photograph, a delicate bifurcating intrusive sheet is clearly seen near the top of the horizontal lavas. Fig. 2 is a still more specialised illustration. The whole stream of Glenariff is seen pouring into a pot-hole some four feet across, and the smooth sides of the hole, and the swirl of waters in its still active portion, have been admirably rendered. On the left, the rock, which is a red Triassic sandstone, shows the grooving and smoothing action of the stream. It would be interesting to photograph this spot again after an interval of twenty years.

FIG. 1.—A Quarry Section on Cave Hill, Belfast.

The reproduction of such views as these in the form of lantern-slides makes them still more valuable to teachers. It is pleasant to know that Co. Antrim has its geological features now recorded for us more completely than those of any other county in the British Isles: and Mr. Welch may be congratulated on undertaking this and other scientific missions in the midst of more immediately popular professional work. The recen

[1] A Catalogue of Geological Irish Views, by R. Welch, 49 Lonsdale Street, Belfast.

visit of the Geologists' Association to Ireland did much to direct attention to the geological features, as well as to the scenic beauties, of the eastern coast; it may be hoped that Mr. Welch's photographic series will form an introduction and an inducement to another visit, this time to the fascinating variety of igneous rocks and Mesozoic strata in the north.

GRENVILLE A. J. COLE.

FIG. 2 — Pot-Hole excavated in Triassic Sandstone, Glenariff.

NOTES.

WE are pleased to learn that Prof. Prestwich, F.R.S., has been made Foreign Member of the R. Accademia dei Lyncei, Rome, for geology and palæontology.

WE regret to hear of the death, from typhoid fever, of Prof. G. H. Williams, of Baltimore. The United States has of late years produced a band of admirable petrographers, amongst whom Prof. Williams has long held a foremost place. His early death will be lamented by a large circle of friends in Europe.

WE are sorry to have to record the death, at the age of sixty-six, of the Rev. Edward Hale, who had been for some years the senior science master of Eton College. Mr. Hale died on July 25.

THE annual meeting of the Institution of Mechanical Engineers was opened at Manchester on July 31, and is proceeding. Prof. Kennedy is presiding.

THE sixty-second annual meeting of the British Medical Association is taking place at Bristol under the presidency of Dr. E. Long Fox, who delivered his presidential address at the evening meeting of Tuesday last.

THE British Pharmaceutical Conference began its annual meeting at Oxford on Tuesday, July 31, when Mr. N. H. Martin, of Newcastle-on-Tyne, took the chair, and delivered an address.

THE autumn meeting of the Iron and Steel Institute of Great Britain, which this year takes place at Brussels, from August 20 to 24, will probably be very well attended, about 500 members having already intimated their intention of being present. The arrangements for the meeting are being organised by an influential local reception committee, of which M. Gillon, president of the Society of Engineers of Liege, is chairman, in conjunction with the general secretary of the Institute, Mr. Bennett H. Brough. During the meeting, excursions will be made to the Antwerp Exhibition, the Mariemont Collieries, the Couillet Steel Works at Charleroi, the works of the Cockerill Company at Seraing, and the Angleur Steel Works at Liege. The programme of papers to be read and discussed is a long one, there being no less a number than ten arranged for. The first on the list is, "On the Use of Caustic Lime in the Blast Furnace," by Sir Lowthian Bell. Other papers are to be contributed by Messrs. R. A. Hadfield, T. W. Hogg, H. C. Jenkins, W. G. M'Millan, John Parry, and D. Selby-Bigge, respectively, and there are to be two papers of local interest, written by Belgian engineers. Their titles are, "On the Coal-Mining Industry of Belgium," by M. Briart, President of the Society of Engineers of Hainaut; and "On the Iron and Steel Industries of Belgium," by M. A. Gillon, President of the Society of Engineers of Liège.

THE Medical Congress which is to be held in Calcutta from December 24 to 29 next, and to which we briefly referred in our issue of July 5, is, according to present arrangements, to be divided into six sections, viz.: I. Medicine and Pathology. II. Surgery, including Ophthalmology. III. Obstetrics and Diseases of Women and Children. IV. Public Health. V. Medico-legal Medicine and Insanity. VI. Pharmacology. It is hoped that medical men from countries other than India will co-operate to make the Congress a success. Special efforts are being made to secure the comfort of visitors.

THE programme of the one hundred and eleventh meeting of the Yorkshire Naturalists' Union has been issued. The meeting will be held on August 6, at South Cave, for the investigation of the neighbourhood of Drewton Dale, Weedley Springs, and Wold Dale. The sciences of geology, botany, vertebrate zoology, entomology, and conchology will be officially represented by members told off for the purpose; and if the weather be favourable, the meeting will, no doubt, prove as popular as those on former occasions.

THE eighth meeting of the International Ophthalmological Congress will be held at Edinburgh in the second week of this month, under the presidency of Dr. Argyll Robertson. It is thought that about 300 ophthalmic surgeons will be present. The last meeting took place at Heidelberg in 1888.

THE spring of next year will see established at Earl's Court an exhibition, on a large scale, devoted to the products of India.

THUNDERSTORMS occurred over the southern and midland parts of England on Sunday, accompanied by heavy falls of rain, amounting to nearly one inch in several places. Over the southern and south-western parts of England, as well as in the south of Ireland, the total rainfall during July has greatly exceeded the average, in many places being double the usual amount, while at Jersey the total was about seven inches, which is nearly three times the average for July, and it is the heaviest fall in that month during the last twenty-nine years. In the east of Scotland and north-east of England the rainfall for the month was rather less than the average.

WE have received from Dr. W. Doberck, a copy of the observations and researches made at the Hong Kong Observatory in the year 1893. The meteorological observations are given for every hour, while the means and various deductions from them have been carefully arranged in tables in a convenient form for future use. The mean temperature during the last ten years was 71°·3, the maximum was 93°·9, and the minimum 32°·0. The average rainfall for a period of thirty years was 90·17 inches; rain mostly falls between May and August. Dr. Doberck gives a useful summary of the climate investigated from ten years' observations. There is a well-marked variation of climate; the winter is cool, its mean temperature being about 60°, while in summer it rises a little above 80°; at this season Europeans suffer much from the excessive dampness of the air. The solar radiation is very considerable in all months; the maximum during 1893 was 154°, in August. Much attention is paid to the study and prediction of typhoons; telegrams giving information about them were issued on eighty-seven days, and with a view to the systematic study of these storms, observations are regularly extracted from ships' logs. During the year no less than 672 logs with entries during typhoons were received, and these were supplemented by observations made at about forty land stations. These various useful researches, in addition to the regular astronomical and magnetical observations, try the powers of the small staff to the utmost, and Dr. Doberck states that the work is much hampered by want of sufficient office accommodation.

THE *Lancet* states that Dr. Bornand, the eminent Swiss consultant lately deceased at Berne, bequeathed his fortune (which was considerable) to the Académie de Lausanne for the endowment of a chair of Embryogeny in that school. His *armamentarium chirurgicum* and his microscopical instruments he also presented to the Académie, while his magnificent library become property of the *bibliothèque cantonale* of his native Canton de Vaud.

WE learn from the *Academy*, that the Pengelly Memorial Fund now amounts to about £1360; and the committee have determined to proceed immediately with the erection of a lecture theatre, as part of the proposed addition to the Natural History Museum at Torquay, of which Mr. Pengelly was the founder.

A CIRCULAR has been sent to us announcing the proposed formation of a society, whose headquarters are to be located at Sydney, to be called "The Palæographical Society of Australasia." The following are among the objects which the society is being established to promote:—"To collect, illustrate, and place on record, examples of all systems of old time written characters, whether in the form of pictograms, symbolisms, or phonograms, as also representations of the various mnemonic aids to memory used by so many savage and barbarous peoples. To undertake the collection and formation of a library, to consist of works treating of or connected with Palæography and kindred sciences, as also collections of photographs and other exact copies and illustrations of rock inscriptions, cave paintings, &c. To afford a means of communication and co-operation between those interested in the science of Palæography, who are now unable to obtain this mutual aid. To assist students as far as possible in the work of deciphering new or unknown characters." The Society will, it is announced, be formed as soon as the initial membership reaches a hundred; when, therefore, that number of intending members send in their names, &c., to one or other of the gentlemen named below, a meeting will be called for the purpose of electing officers, passing of rules, &c. The subscription fee is to be one pound per annum. It is intended to establish a periodical as organ of the society, in which will appear original articles on the science of Palæography, with illustrations of various scripts. Further particulars may be obtained from Dr. A. Carroll, Kogarah, Sydney, N.S.W.; or Mr. Elsdon Best, Wellington, New Zealand.

A NUMEROUSLY attended meeting of the Essex Field Club was held last Saturday, in the Navestock district, under the conductorship of the Rev. S. Coode Hore and Prof. R. Meldola, F.R.S. Alighting at Brentwood Station, the party were driven to the site of an ancient entrenchment, which the conductors had identified with the "alate temple of the Druids," described by Dr. Stukeley in the last century. A *fac-simile* of Stukeley's figure, made by Mr. Walter Crouch, was handed round for inspection. Nothing of these ancient remains is now to be seen, excepting a circular depression, and a fosse connected with it, situated in a field bordering the road. From this spot the party proceeded to Navestock Park, the estate of Lord Carlingford, where they were most hospitably entertained at luncheon by Mr. and Mrs. D. P. Sellar, of Dubrook. An ordinary meeting of the Club was held after luncheon, and a discussion took place respecting the proposed cession of certain Essex parishes to Hertfordshire and Cambridgeshire, under the Parish Councils Act. A resolution protesting against this cession was unanimously passed, and a copy ordered to be sent to the Essex County Council and to the Essex Members of Parliament. The members next proceeded to inspect an ancient earthwork in a wood near the park, which earthwork is entered as a camp in the ordnance map. It consists of a well-defined rampart and ditch, and is of an oblong form, with a spur at one angle. The site is now known as "Fortification Wood," but was formerly known as the "Defence of Navestock." The party next proceeded towards the Roding Valley, and were conveyed to Curtismill Green, an outlying fragment of old Hainhault Forest, which, with Epping Forest, formerly constituted the Forest of Waltham. Here they were shown an upright stone, which the conductors had identified as "Richard's Stone," one of the boundary stones set up at the time of the perambulation of the Essex Forest in 1641-1642. Standing by this stone, marking the extreme north-eastern extension of the old forest, Prof. Meldola gave a short account of the history of the perambulation, and stated that with his colleague, Mr. Coode Hore, and Mr. William Cole, the hon. secretary, and his brothers, they had now found five out of the seven boundary stones referred to in the perambulation. The fragment of primitive forest between "Richard's Stone" and the "Navestock Stone" was much admired, as far as time permitted an inspection, and a desire was expressed that steps should be taken for securing the permanent preservation of all these interesting boundary marks, the more especially as the forest of Hainhault has, with the exception of a few isolated patches, been entirely cultivated out of existence. From "Richard's Stone" the party drove through some of the most picturesque parts of the county to South Weald, where, at the "Tower Arms," tea was awaiting them. After tea another meeting was convened for the purpose of hearing a most interesting paper by Mr. Coode Hore, in which he gave a series of notes on the history of Navestock in Saxon and Norman times, and made reference to the prehistoric remains visited in the course of the day.

THE annual report of the Director of the Royal Botanic Garden, Calcutta, for the year 1893-94, has just reached us. During the year the Herbarium was enriched by more than 16,000 specimens, and the Garden in return sent out numerous specimens to various botanical institutions in different parts of the world. Reference is made to a great storm which raged for nearly the whole of three days in the month of May, and the damage done was so great that for about six weeks after its occurrence the whole of the out-door labour staff was engaged in making repairs. A more suitable platform for Colonel Kyd's monument was erected, the roads in the grounds were generally improved, and the gardens are reported to have been maintained in a high state of efficiency.

M. L. CAYEUX (*Bull. Soc. Géol. France*) describes radiolarians from rocks in Brittany which are generally admitted to be pre-Cambrian. They occur in siliceous bands in the "Phyllades de Saint Lô." The evidence for the pre-Cambrian age of these beds is stated by Dr. Barrois. Many of the radiolarians described belong to the genera still existing.

A PAPER on the "Shasta-Chico Series," of N. California and Oregon (*Bull. Geol. Soc. Amer.*), by Messrs. J. S. Diller and T. W. Stanton, is interesting as discussing the limits of the Cretaceous and Jurassic formations on the Pacific Coast. The series has a maximum thickness, on Elder Creek, Tehama Co., California, of 30,000 feet; the whole set of beds graduating into one another as one continuous series. It was formerly supposed that the lower (Knoxville) beds graduate into the Mariposa beds—the highest Jurassic; the authors contend that there is both a physical and palæontological break between them. The highest Cretaceous rocks are not here represented, and the Téjon beds, which probably are not the oldest Eocene, rest unconformably upon the Chico series. In Middle and Southern California the Téjon beds are believed to be conformable to the Chico beds.

PROF. H. F. OSBORN discusses the characters and faunal relations of the Laramie Mammals (*Bull. Amer. Mus. Nat. Hist.* vol. v., p. 311), and shows that they are more nearly related to the Puerco (Eocene) mammals than they are to those of the Jurassic series. This is specially illustrated by the evolution of the teeth. In the same volume, there are papers by Prof. Osborn, Dr. J. L. Wortman, and Ch. Earle, on the Lower Miocene mammalia of North America. The White River deposits have a maximum thickness of about 800 feet, and they represent a great period of time, during which the Titanotheriidæ, Rhinocerotidæ, Equidæ, and Oreodontidæ underwent considerable modification, amounting in some cases to changes of true generic significance.

A NEW design for large spectroscopic slits is described by Mr. Wadsworth in the current number of the *American Journal of Science*. Of the various forms of double motion spectroscope slits which have been designed, the two forms in most common use are the parallel ruler form, as fitted to most German instruments, and that form in which the jaws slide in guides, and are moved simultaneously in opposite directions by a right and left hand screw. The first form is convenient but somewhat bulky, and makes it difficult to determine the exact width of the slit. The second form, in which the screw is necessarily at one side of the jaw, gives rise to a twisting strain tending to make the slit wider at one end than at the other, an objection which becomes very serious in slits above 5 cm. in length. The author's new form, designed for Prof. Langley, has the advantage of giving a central thrust on both jaws while keeping the slit accurately centred. This is accomplished by making the milled head move the whole jaw system along the slit plate by means of a nut screwed to the latter, while another screw on the same shaft, but of double the pitch, moves the nearer jaw independently in the opposite direction. Thus the centre of the slit remains fixed, the jaws opening out from it. A spring provides for the return motion, and takes up all back lash in the screw. The graduated head gives by its motion over a graduated drum the whole number of turns and fractions of a turn, enabling the width of the slit to be determined at a glance. The thrust being central, there is no tendency to twist the jaws in their guides. The slit has a clear opening of 10 cm.

IT appears that the public in Brooklyn, U.S.A., are making use of the stray current from the electrical tramways, driving motors and lighting lamps, by connecting the terminals to the metallic framework of the overhead railways and to the water-pipes; while it is proposed in one of the suburban telephone exchanges to utilise the above current, and do away with the batteries. The loss of energy on the American lines where the current is supplied by a trolley wire, and the return takes place by the rail, is very considerable, and the above use of the stray current is much more likely to draw the attention of the tramway companies to these losses than the corrosion of the water- and gas-pipes, the damage to which we have on previous occasions referred.

ACCORDING to the *Pioneer Mail*, Allahabad, the anthropometrical system of identification has already proved of practical use in Bengal. Previous convictions against six men, who had been sentenced in districts beyond Calcutta, were traced by its means.

Engineering for July 27 is a special number, and is, for the most part, taken up with a description (with illustrations) of the various mills and appliances used in the manufacture of cotton at or near Manchester, in which city the Institution of Mechanical Engineers is at present holding its summer meeting. This section of the number is, in fact, specially designed for the use of those who are taking part in the meeting of the Institution.

PART 2 of vol. xv. of the *Journal* of the Sanitary Institute contains, besides Proceedings of the Institute, notes on sanitation abroad, &c., an article by Dr. Louis Parkes, entitled "The Possibility of the Spread of Disease through the River Waters supplied to London," being a review of the evidence given by the bacteriological witnesses before the Royal Commission on Metropolitan Water Supply, 1893.

THE August number of *Natural Science* contains the following articles:—"The Evolution of the Thames," Dr. J. W. Gregory; "Some Account of the Gall-making Insects of Australia," W. W. Froggatt; "Books of Reference in the Natural Sciences," C. Davies Sherborn; "Some Reforms in the Oxford University Museum," E. S. Goodrich; "Hertwig's 'Preformation or New Formation,'" P. Chalmers Mitchell; and a special illustrated supplement on "Taxidermy as a Fine Art." The process illustrations in this supplement, and in the article by Mr. Goodrich, are for the most part very successful.

THE "Proceedings of the Physical Society of London," vol. xii. part 4, has just been issued.

THE August part of *Science Gossip* has a portrait of Dr. Ludwig Mond, F.R.S., the munificent donor of the new laboratory for physical and chemical research in connection with the Royal Institution, to which we referred at length in our issue of July 5.

ANOTHER remarkable nitrogen compound, nitramide NO_2NH_2, is described in the current *Berichte* by its discoverers, Drs. Thiele and Lachman, of Munich. A short time ago, these chemists showed that by the action of sulphuric and nitric acids upon urethane a nitro-derivative, nitrourethane $NO_2 . NHCOOC_2H_5$, was produced. When this substance is dissolved in water, and the concentrated solution is mixed with a large excess of a concentrated solution of caustic potash in methyl alcohol, and the mixture cooled by ice, a potassium salt of the composition $NO_2 . NK . COOK$ is deposited in crystal plates. If these crystals are placed in water they instantly decompose with great rise of temperature into potassium carbonate and nitrous oxide. If, however, they are placed in a mixture of ice and sulphuric acid, carbon dioxide is evolved, and the new substance nitramide is produced. It may be extracted by means of ether, and upon evaporation of the latter it is left behind in the form of clear colourless prisms. The crystals melt at 72°, but the least trace of moisture lowers the melting point very considerably. Nitramide is readily soluble in water, ether, and alcohol, but difficultly soluble in benzene. The aqueous solution reacts strongly acid. Nitramide is volatile, considerably so even at the ordinary temperature. It is an unstable substance, and decomposes on mixing with copper oxide or lead chromate, or even on admixture with powdered glass, great rise of temperature occurring in each case. The products of decomposition are nitrous oxide and water. When heated rapidly above its melting point it explodes. Nitramide is instantly decomposed by alkalies, not only by caustic alkalies but also by carbonates, ammonia, borax, and even sodium acetate, in the cold, with evolution of nitrous oxide. It would thus appear to be incapable of forming salts, at any rate in solution. The crystals explode violently, with production of flame, when a drop of caustic soda or potash is allowed to fall upon them. The ethereal solution of the crystals yields with ammonia a precipitate of an ammonium salt, but it decomposes almost immediately with evolution of gas. Concentrated sulphuric acid or hot water similarly provoke violent decomposition. Upon reduction a substance endowed with powerful reducing properties is produced, which would appear to be hydrazine $\begin{matrix} NH_2 \\ | \\ NH_2 \end{matrix}$. The discoverers of this interesting substance are continuing the study of its reactions, and are attempting to prepare it in a purely inorganic manner.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*), a Hygian Snake (*Elaps hygiæ*) from South Africa, presented by Mr. J. E. Matcham; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. J. A. Brand; a Common Paradoxure (*Paradoxurus typus*) from India, presented by Mr. E. Stallard; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Miss Champneys; an Indian Cobra (*Naia tripudians*) from India, presented by Mr. Angus M. Kinloch; two Slowworms (*Anguis fragilis*), British, presented by Mr. T. E. Gunn; two —— Opossums (*Didelphys*, sp. inc.) from South America, a Common Cassowary (*Casuarius galeatus*) from Ceram, a Hawk-headed Parrot (*Deroptyus accipitrinus*) from Brazil, two Hamadryads (*Ophiophagus elaps*) from India, deposited; a Pleasant Antelope (*Tragelaphus gratus*), bred in Germany, purchased; a Thar (*Capra jemlaica*), a Red Deer (*Cervus elaphus*), three Cairo Spiny Mice (*Acomys cahirinus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SPECTROSCOPIC VELOCITIES OF BINARIES.—The determination of the elements of double-star orbits from spectroscopic measurements has been attempted by two methods. That due to Dr. Wilsing, which is a very convenient one, is only applicable to cases of small eccentricities; another method, developed by Dr. Rambaut, is not subject to this limitation, but is rather elaborate. In No. 3242 of the *Astronomische Nachrichten*, Prof. R. Lehmann-Filhés works out a method somewhat akin to that of Dr. Rambaut, but which he claims to have discovered independently, and which does not require difficult calculations or constructions. If both components of a spectroscopic double are bright enough to give a measurable spectrum, as is the case with β Aurigæ and ζ Ursæ Majoris, the velocities as determined from the displacement of the lines in the spectrum are taken as relative, and the investigation then deals with the motion of one mass with respect to the other considered as stationary. If, on the contrary, only one of the components gives a measurable spectrum, as in the case of Algol and α Virginis, the motion must be referred to the centre of gravity of the system, the radial velocity of which must be determined and subtracted from the observed velocities. The period of the star is easily determined by observing a considerable number of periodic variations, and all observations can then be reduced to a single revolution by adding or subtracting multiples of the period. These spectroscopic velocities are then plotted as ordinates with the times as abscissæ, and a wavy curve is thus obtained showing the maximum and minimum velocities relative to the solar system. If these velocities are referred to the centre of gravity of the system, the areas of the curve above the axis of abscissæ must be equal to those below, *i.e.* the total displacements must neutralise each other. This gives a condition which the curve must fulfil, and which serves to control the observed velocities. Another condition is that the area intercepted between the maximum positive ordinate and the next point of intersection with the axis of abcissæ must be equal to the area of the curve between that point and the maximum negative ordinate, this representing the motion of the star from the ascending to the descending node. Prof. Lehmann-Filhés gives simple formulæ for determining the various elements of the orbit from the corrected curve. Comparing his method with that of Dr. Rambaut for the case of β Aurigæ, he finds 0·158 for the eccentricity, where the latter found 0·156, and 57°·93 for the longitude of the ascending node, against Dr. Rambaut's 57°·43, showing differences which are well within the errors of observation. The real daily motion is found to be 90°·726, corresponding to a period of 3·968 days. The apparent semi-major axis of the orbit comes out as 7,516,000 English miles, which agrees very closely with the value obtained by Dr. Rambaut, viz. 7,500,000.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE annual summer meeting of the Institution of Naval Architects was held last week, at Southampton, commencing on Tuesday, July 24, and concluding on the Friday following.

The President of the Institution, Lord Brassey, occupied the chair during the sittings, which were held in the theatre of the Hartley Institute. There were only seven papers set down for reading during the three sittings that were held for business purposes, the meeting being, perhaps, rather more of a social nature than usual. The following is a list of the papers:—

(1) "On the Harbour and Docks of Southampton," by John Dixon, Dock and Marine Superintendent of the London and South Western Railway Company.

(2) "On the Importance of Economy of Fuel in very Fast Vessels, and on the advantages to be derived from Heating the Feed-water," by J. A. Normand, of Havre.

(3) "On the Influence of Circulation on Evaporative Efficiency of Water Tube Boilers," by J. I. Thornycroft.

(4) "On the Design of Mail Steamers, with special reference to their use for War Purposes," by J. H. Biles.

(5) "On a Rapid Method of Calculating Wetted Surfaces," by Archibald Denny.

(6) "Recent Experience with Cylindrical Boilers and the Ellis and Eaves Suction Draught," by F. Gross.

(7) "The Ventilation of Steamships, with special reference to the Removal of Explosive and Foul Gases from Bulk Oil Steamers," by S. H. Terry and J. F. Flannery.

Mr. Dixon's paper does not call for extended reference at our hands; it was intended chiefly as a guide to members who were about to visit the Southampton Docks in the afternoon, and was excellently designed for this purpose. Perhaps the most generally interesting part of the paper was contained in the appendices, in which a brief history was given of the various steamship companies that used the docks at Southampton. In a note attached to the paper, some interesting historical details were given. Although Southampton is a very ancient town, its importance was not great in the early days of this century. In the year 1811, we learn that the chief trade was with Jersey, Guernsey, Alderney, and Sark. Several sloops were running between these islands and Southampton. There was also a carpet and a silk manufactory, as well as mills for manufacturing blocks and pumps for the Navy. The number of houses in the town then was 1582, and the population was under 8000. The ship-building industry, however, goes back to very early days, Mr. Dixon stating that in the reign of Henry V. the famous ships *Grace Dieu* and *Holy Ghost* were built at Southampton; this was about the year 1414. One of the vessels was built by Robert Berd, and the other by William Soper; and it is curious to notice that one of the well-known yacht-designers of the district is now a Mr. Soper. Each of the ships referred to cost about £500. During the last century, and in the early days of this century, a very large number of ships for the Royal Navy were built in this district. At a small place called Bucklers Hard, now seldom heard of, a number of famous ships were constructed. This is on the little river Exe, which flows through the New Forest and past Beaulieu Abbey to the Solent. Three ships of the British Fleet which were at Trafalgar, were built there, the most celebrated being Nelson's *Agamemnon* and the *Swiftsure*. Another interesting historical fact stated by Mr. Dixon, was that the timbers of the celebrated American frigate *Chesapeake* were used, when that vessel was broken up, in the construction of a mill at Wickham, near by. The building still exists, and is known as "Chesapeake Mill." The late Admiral of the Fleet, Sir Provo W. Parry Wallis, who died only a short time ago, in 1813 took the *Chesapeake* into Halifax, after her encounter with the *Shannon*.

M. Normand's paper was one of considerable value, and, though short, contained a good deal of useful information. The well-known scientific attainments of French naval architects are excellently represented in M. Normand's firm, and from the Havre yard have been turned out some of the torpedo boats which have been most worthy to be placed in competition with the productions of the Thames builders, Thornycroft and Yarrow. M. Normand is an original designer, his conclusions being based on scientific deduction. He is not content, as some other constructors of fast vessels are, to simply follow the lead of others, ignorantly copying whatever they may see to be successful. As is usually the case with scientific workers, M. Normand is generous in giving information to others, even to his competitors; although he would probably be the first to acknowledge his indebtedness in this respect to the two leading torpedo boat-builders of this country. Indeed, the interchange of information in this way across the channel has always been a pleasant feature in the rivalry of the builders of these beautiful little craft. Torpedo boats are not supposed to be economical vessels, and it has been said that "the mission of a torpedo boat is to run a trial trip." There certainly was a great deal of truth in this remark in the old days of premium for speed, when a boat might earn for her builders several thousand pounds over her contract price if she could scramble through her six runs on the mile without breaking down. In such a case, as there was no restriction in regard to coal burned, economy of fuel was little thought about, and indeed in the ultimate work for which torpedo boats are designed, should they ever be brought to the stern realities of war, it would be a small matter whether much or little coal were burned to attain the high speed. To get to the scene of operation, however, a torpedo boat might have to run a long distance, and in that case her radius of action in regard to coal stowage would be a serious consideration. Moreover, trial trips of torpedo boats now extend over a considerable length of time, and the amount of coal that has to be carried has become an important factor in regard to the total weight, which, of course, in turn governs the speed to a large extent. M. Normand has recognised these facts; he tells us that in his last torpedo boats he has found, by the official trials, that the coal burned per I.H.P. per hour ranged from 1·1 lb. up to 15 knots, and to somewhat less than 2 lb. at 25 knots. These figures seem very low, and the author is certainly within the mark in saying that the consumption is not more than two-thirds of that of a number of similar craft. Another interesting and valuable piece of information, given us by M. Normand, is that the total weight of engines and boilers of the boats above alluded to, is about 48 lb. per maximum I.H.P. and even this extremely light machinery is further reduced in weight, notably in the case of the *Forban*, now under construction at Havre; a vessel, it will be remembered, which is expected to reach a speed of 30 knots an hour, although we believe the contract speed is 29 knots. It may be mentioned here, that Mr. Yarrow has under construction, for the Russian Government, a vessel which is guaranteed to make 30 knots. M. Normand further tells us in his paper, that in high-speed vessels a reduction in the weight of any part of the ship allows the whole displacement to be reduced by about 4½ times the weight saved, if the speed, steaming distance, weight of armament, and general conditions remain unchanged. The author attributes the remarkable economy of his engines to several causes, but more particularly to the feed-heater that he uses. This, he informs us, gives an economy in fuel of at least 20 per cent. The figures seem somewhat startling, but they are vouched for by the author, and have been obtained on official trials. The principle of this feed-heater was enunciated for the first time in 1886 by the author's brother, M. Benjamin Normand. It is a direct application of the first law of thermodynamics. The heating steam is taken, in the ordinary compound engine, at mid-stroke from the low-pressure cylinder by a special valve. In three or four stage expansion engines it is taken direct from the low-pressure casing, all the work previously given in the engine by the heating steam being a direct gain. The author ascribes the economy of 20 per cent., before mentioned, to two causes, viz.: (1) That which results from the number of thermal units saved by using, for heating the feed, steam which has already done work. This may amount to from 10 per cent. to 14 per cent., according to the pressure. (2) That which results from the better circulation of the water in the boiler, a greater proportion of that water being at a boiling temperature. As a practical example of the advantages of this heater, it may be stated that simply by putting it into use, the revolutions of the engine in one vessel were increased from 305 to 335 per minute.

A short discussion followed the reading of this paper, in which both Mr. Thornycroft and Sir Nathaniel Barnaby took part. The chief point of interest was the statement by Mr. Thornycroft, that in the case of the *Daring*, a torpedo boat destroyer recently built by his firm, he believed the weight of machinery per I.H.P. was even less than that stated by M. Normand.

Mr. Thornycroft's paper, like that which preceded it, contained a good deal of valuable information in a small compass.

It dealt especially with one feature in the boiler which has been invented by the author. This steam generator, it will be remembered, consists chiefly of three horizontal cylinders arranged, in cross section, in the form of a triangle. Two of the cylinders are placed in the wings of the furnace, whilst the third, which is above, at the apex of the triangle, the fire-grate forming the base. The top cylinder is connected to the two wing cylinders by two series of curved pipes, which are so arranged as to deliver into the top cylinder at its upper part; they thus deliver above the water-level of the boiler, which is about half-way up the top cylinder. Connecting the top cylinder with the two wing cylinders, respectively, are two external pipes; the whole, of course, is enclosed by a smoke-jacket, and the steam generation occurs in the connecting pipes. The method of working of the Thornycroft boiler is as follows:—The heat from the furnace playing on the pipes or tubes, which connect the top cylinder to the two wing cylinders, causes generation of steam, the flow of which is upwards. As is nearly always the case when steam is generated in small pipes, a great deal of water is also carried upwards with the steam. This water is delivered into the top cylinder, and from thence is free to flow downwards to the two wing cylinders, from whence it can rise again through the generating tubes, and so on in continuous cycle so long as there is water to be evaporated. The success of a water-tube boiler in practical working may be said to be dependent on its circulation, so that when rapid evaporation takes place, and water is quickly driven away from the heating surface, other water should be there to flow in to take its place. Mr. Thornycroft has always claimed that this circulation is most effectually attained by having the steam-generating tubes deliver in the upper part of the top cylinder. The principle has been questioned, and in order to set the matter at rest experimentally, the author had made a boiler purely on his system, and also one in which the design was so modified as to bring the generating tubes into the top cylinder below the water surface. If we have made our explanation clear, it will be seen, as stated by the author, that in either boiler, pressure in the lower vessel is that due to the full depth of water in the boiler, in addition to the steam pressure, and reduction of density in the generating tubes will be available for causing circulation; whilst reduction in pressure in the wing cylinder below that due to the head of water in the boiler, will reduce the circulation. In fact, the circulation of water in the boiler is governed by variations of pressure. In order, therefore, to measure these variations, Mr. Thornycroft had recourse to a water gauge connecting the top and bottom cylinders, the height of the column of water showing the greater or lesser pressure in the wing cylinder. The results of the trials were shown by a diagram in which curves were assigned to each series of experiments. When the steam-generating tubes were arranged as in the normal Thornycroft boiler, as the rate of evaporation increased, the height of the water in the gauge-glass showed a steady and comparatively small pressure in the wing cylinder. Thus, when the evaporation was increased from 3 lb. to 20 lb. per square foot of heating surface per hour, from and at 212° Fahr., the fall was about 2 inches of water. With the boiler having tubes delivering below the water-level when the evaporation was raised from 3 lb. per hour per square foot of heating surface to about 15 lb., the fall in pressure in the wing cylinder was from 3 inches to 7 inches, roughly. Thus it will be seen that the circulation of water in a boiler of this class, where the tubes deliver above water-level, must be more energetic than when the tubes deliver below water-level. In both of these experiments, what are called the down-comer tubes, that is to say, the two tubes at the ends of the cylinders provided for completing the circuit of circulation, were in use. The utility of these tubes has, however, been questioned, and in order to throw light on this point, Mr. Thornycroft next made a series of experiments with a boiler in which the tubes delivered below the water-level, and the down-comer tubes were out of use. The results were interesting and instructive. The reduction in pressure in the wing cylinder was extremely rapid as the evaporation increased; after a time, however, the curve reached its lowest point, and then suddenly bent upwards, showing an increase in the pressure. This last phenomenon Mr. Thornycroft attributed to the fact that the steam, instead of rising uniformly in the tube, as it would when the evaporation was moderate, was driven out at the lower end; and this, of course, would tend still more to check the circulation. The diagram is well worthy of study on the part of those interested in any class of boiler design, and it may be found in the *Transactions* of the Institution.

In the discussion which followed the reading of this paper, the most interesting feature was a description, by Mr. Pilcher, of the device used by Mr. Maxim in making the boiler of his flying machine. This boiler, it may be stated, is a marvel of lightness. It is a Thornycroft boiler with very small generating tubes about ⅜ inch in diameter; it is said to have given off steam equivalent to 300 I.H.P. at a pressure of 300 lb. to the square inch; the weight of the boiler itself being but 3 lb. per I.H.P. With the small diameter tubes it was found impossible to keep up circulation sufficient to prevent the destruction of the boiler, and, in order to aid the natural circulation, Mr. Maxim introduced what may be described as injector circulation. He carried the feed-pipe of the boiler into the down-comer tube, covering the orifice of his feed-pipe by a conical valve, which was attached to a long spindle, and, working through a stuffing-box, was carried outside the pipe. The valve was kept closed by means of an external spiral spring, so adjusted as to give a pressure of 50 lb. to the square inch on the valve. The feed-pump naturally would overcome this additional pressure, so that the pressure in the feed-water on the boiler side of the pump would be 50 lb. above the boiler pressure, and thus 350 lb., the boiler pressure being 300 lb. It will be seen, therefore, that, on the hydraulic pressure opening the valve, the feed-water would be injected with some velocity into the boiler, and thus would set up a circulating current. In this way it was found that the boiler in the flying machine could be made to work very perfectly.

Prof. Biles, in his paper, described a method by which he proposed to transform mail steamers into war vessels in the event of hostilities. Details were worked out by the author, and given in the paper; but into these we need not enter. The most noticeable feature was a long recess in the side of the ship, into which the author proposed to pack an armoured belt when the vessel was required to take up its warlike *rôle*.

The scope of Mr. Denny's paper is described by its title. Mr. Morrish, of the Admiralty, in the discussion which followed, gave a formula used by Mr. Froude at Haslar, which appeared to us even more simple than the method described by Mr. Denny. We must refer our readers to the *Transactions* for these formulæ.

Mr. Gross gave details of certain trials made with the system of burning fuel in steam boilers, referred to in the title of his paper. A very good result in regard to economy of fuel was obtained with one vessel referred to; the consumption being 1·3 lb. per I.H.P. per hour of South Wales coal for the main engines. We fail to see, however, in what respect "suction" draught differs from "forced" draught in regard to economy. As Sir Edward Harland humorously stated in the discussion: "If one wishes to remove a person from a certain position, it does not much matter whether one gives him a pull by the nose, or applies pressure from behind." There may, of course, be some occult virtue in "suction" as compared to pressure, but we certainly have never heard it satisfactorily accounted for.

The last paper was read by Mr. Terry. It is remarkable how those tank steamers which carry oil in bulk may be freed from the insidious vapours which always arise whenever a little of these hydrocarbon oils are present. Mr. Terry tells us—and he is confirmed in this by Mr. Martell, Lloyd's chief surveyor, who has naturally had thorough opportunities of seeing these matters in practical work—that, in the same spaces that have been occupied by petroleum, rice, and other perishable food, cargoes have been carried without detriment. So successful have the results been, that it is now proposed to carry even tea in these tank steamers.

We cannot deal with the many pleasant excursions that were really the leading feature of the meeting. The proprietors of the various mail steamers, the London and South-Western Railway Company, and those gentlemen who had estates in the neighbourhood, seemed to vie with each other in entertaining the members of the Institution. On Friday morning a visit was paid to Portsmouth Dockyard, where many interesting features were shown by Admiral Fane, the superintendent, and the officers of the permanent staff. In the afternoon an excursion was made round the Isle of Wight, on board the *Frederica*, a vessel of 1509 tons, and about 6000-h.p., which had been lent by the London and South-Western Railway Company for the purpose.

ON THE NEWTONIAN CONSTANT OF GRAVITATION.[1]

I.

IT is probably within the knowledge of most of those present that Sir Isaac Newton, by his great discovery of gravitation and its laws, was able to show that a single principle, ideally simple, viz. that every particle in the universe attracts any other particle towards itself with a force which is proportional to the product of their masses divided by the square of the distance between them, would completely and absolutely account for the three laws of planetary motion which Kepler had given to the world.

Newton also showed that a spherical body, whether uniformly dense or varying in density according to any law from the centre to the surface, would attract bodies outside with the same force that it would do if it could all be concentrated at its centre, *i.e.* that all the attractions varying in amount and direction produced by particles in all parts of a sphere need not be considered separately, but may be treated in this simple way.[2]

Nevertheless, though Newton's great discovery is sufficient to bring the whole of the movements of the planets and their satellites, whether their simple Keplerian motions or the disturbances produced by their mutual gravitation, the motions of comets, of binary stars, of the tides, or the falling apple, under the domain of a single and simple principle, though it enables one to compare the masses of the sun, the planets and their satellites, and of those binary stars whose parallax has been determined, one thing can never be made known by astronomical research alone, though we may know that twenty-eight suns would be required to make one Sirius; that the sun is equal to 1048 Jupiters, that Jupiter is more than double all the rest of the solar system put together, or that the moon is 1/80 of the earth; no observations of these bodies can ever tell us how many tons of matter go to make up any one of them.

Though we know from first principles of dynamics, by the mere consideration of centrifrugal force, that the whole sun attracts each ton of the earth with a force equal to a weight here of a little more than one pound, and that if it were not for this, every ton of the earth would continue its journey into space in a straight line for ever, and though we know in the same way that the whole earth attracts each ton in the moon with a force equal to the weight of ten ounces and no more, we cannot tell by any astronomical observation whatever, how many tons there are in all.

Newton showed that to complete his law and to put in the numerical constant (the Newtonian Constant of Gravitation) that would convert his proportion into an equality, two methods are available: we may either make observations on the disturbance of the earth's gravitation by the action of isolated parts of it, we may either find the relative attraction of an isolated mountain or the strata above the bottom of a deep mine, or we may make an artificial planet of our own and find the attraction which it exerts.

The Newtonian Constant will be known if we know the force of attraction between two bodies which we can completely measure and weigh. Employing the C.G.S. system of measurement, the Newtonian Constant is equal to the force of attraction in dynes between two balls weighing a gramme each, with their centres one centimetre apart. Of course it may be referred to pounds and inches or tons and yards, but as soon as all the quantities but G in Newton's equation

$$\text{Force} = G\,\frac{\text{Mass} \times \text{Mass}}{\text{Distance}^2}$$

are known, no matter in what units the quantities are measured, G is known. The conversion of its numerical value from one system of measurement to another is of course a mere matter of arithmetic.

Of the first method of finding G, depending on the attraction of a mountain first attempted by Bouguer at the risk of his life in the hurricanes of snow on Chimborazo, of the experiments of Maskelyne, of Airy and of others, I cannot now find time to speak; I can only refer to Poynting's essay on the subject. It is the second method with an artificial planet that I have to describe to-night.

[1] A [illegible] at the R[illegible] J[illegible], by Prof. C. V. [illegible] F.R.S.

[2] [illegible] difficulty of proving this, and not [illegible] that delayed the publication of [illegible]

Now let me give some idea of the minuteness of the effect that has to be measured. Is a wall built true by the aid of a plumb-line vertical, or does it lean outwards? Newton's principle shows that the plumb-bob is attracted by the wall, yet it hangs vertically. The attraction is so small that it cannot be detected in this way. Even the attraction of a whole mountain requires the most refined apparatus to detect it. Do two marbles lying on a level table rush together? According to Newton's principle they attract one another; yet if they were a thousand times smoother than they are, no movement of attraction could be detected.

Leaving matters of common experience, let us go into the physical laboratory where instruments of the highest degree of precision and delicacy (at least so they are called) are found on every table. What precautions are taken to prevent the attractions of the fixed and moving parts from interfering with the result which they are constructed to measure? None. The attractions are so small, that in no apparatus in use for the measurement of electrical, magnetic, thermal, or other constants are they ever thought of, or is any provision necessary to prevent their falsifying the result. Nevertheless, the attractions exist, and if only the means are delicate enough they can be detected and measured. The Rev. John Mitchell was the first to devise a successful method. He was the first to invent the torsion balance with which Coulomb made his famous electrical researches, and which bears Coulomb's name. He devised and he made apparatus for this purpose, but he did not live to make any experiments.

After his death Cavendish remodelled Mitchell's apparatus and performed the famous Cavendish experiment. By means of the apparatus, of which for the second time I show a full-size model in this theatre, Cavendish measured the force of attraction between two balls of lead, one 12 and the other 2 inches in diameter, and with their centres 8·85 inches apart. The same experiment has since been made by Reich, by Baily, and more recently by Cornu and Baille with greatly superior apparatus of one quarter of the size. All these observers actually determined the attraction between masses which could be weighed and measured, and thus found with different degrees of accuracy the value of G.

Let me explain now that this G, the gravitation constant, or as I prefer to call it, for the sake of distinction, the Newtonian Constant of Gravitation, has nothing to do with that other quantity generally written *g*, which represents the attraction at the earth's surface. This is a purely accidental quantity, which depends not only upon G, but also upon the size of the earth, its mean density, the latitude, the height above the sea, and finally upon the configuration and the composition of the neighbouring districts. *g* is eminently of a practical and useful character; it is the delight of the engineer and the practical man; it is not constant, but that he does not mind. It is of the earth, arbitrary, incidental, and vexatious. Prof. Greenhill should spell his name with a little *g*. G, on the other hand, represents that mighty principle under the influence of which every star, planet, and satellite in the universe pursues its allotted course; it may possibly also be the mainspring of chemical action. Unlike any other known physical influence, it is independent of medium, it knows no refraction, it cannot cast a shadow. It is a mysterious power, which no man can explain; of its propagation through space, all men are ignorant. It is in no way dependent on the accidental size or shape of the earth; if the solar system ceased to exist it would remain unchanged. I cannot contemplate this mystery, at which we ignorantly wonder, without thinking of the altar on Mars' hill. When will a St. Paul arise able to declare it unto us? Or is gravitation, like life, a mystery that can never be solved?

Owing to the universal character of the constant G, it seems to me to be descending from the sublime to the ridiculous to describe the object of this experiment as finding the mass of the earth or the mean density of the earth, or, less accurately, the weight of the earth. I could not lecture here under the title that has always been chosen in connection with this investigation. In spite of the courteously expressed desire of your distinguished and energetic secretary, that I should indicate in the title that, to put it vulgarly, I had been weighing the earth, I could not introduce as the object of my work anything so casual as an accidental property of an insignificant planet. To the physicist this would be equivalent to leaving some great international conference to attend to the affairs of a county council, I might even say of a parish council. That is the business of the geologist. The object of these investigations is to find the value of G. The earth has no more to do with the investigation than the table has upon which the apparatus is supported. It does interfere and occasionally, by its attraction, breaks even the quartz fibres that I have used. The investigation could be carried on far more precisely and accurately on the moon, or on a minor planet, such as Juno; but as yet no means are available for getting there.

I shall not have time to-night to describe the work of former investigators, and for this there is little need, since it is all collected in Poynting's Adams prize essay "On the Mean Density of the Earth," published this year. I cannot even find time to explain in more than the merest outline what I have done to develop the apparatus of Cavendish, so that he would hardly recognise in my glorified bottle-jack the balls and lever which have made his name famous. The following table, given by Poynting, however, represents the results of the labours of investigators up to the present time.

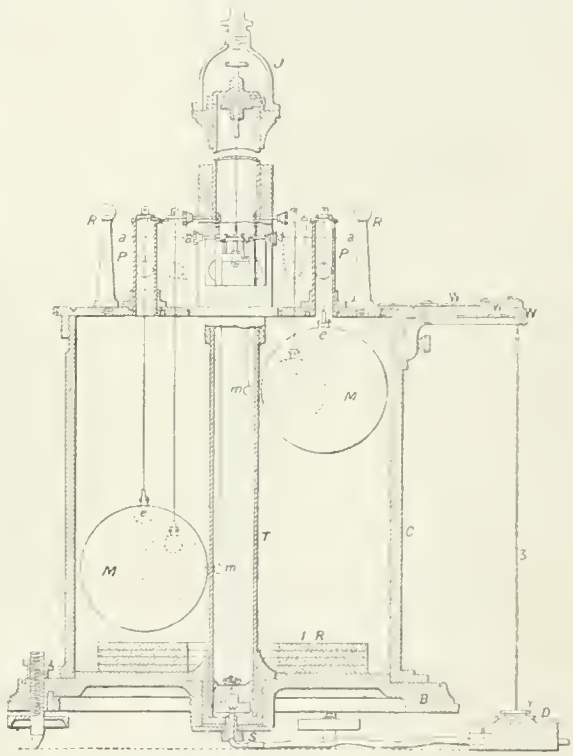
Summary of Results hitherto obtained.

Approximate date	Experimenter	Method	Result
1737–40	Bouguer	Plumb-line and pendulum	Inconclusive
1774–76	Maskelyne and Hutton	Plumb-line	4·5–5
1855	James & Clarke	,,	5·316
1821	Carlini	Mountain pendulum	4·39–4·95
1880	Mendenhall	,,	5·77
1854	Airy	Mine pendulum	6·565
1883	Von Sterneck	,,	5·77
1885	Von Sterneck	,,	About 7
1797–98	Cavendish	Torsion balance	5·448
1837	Reich	,,	5·49
1840–41	Baily	,,	5·674
1852	Reich	,,	5·583
1870	Cornu and Baille	,,	5·56–5·50
1889	Boys	,,	In progress
1879–80	Von Jolly	Common balance	5·692
1878–90	Poynting	,,	5·493 (5·46–5·52)
1884	König, Richarz, and Krigar Menzel	,,	In progress
1886–88	Wilsing	Pendulum balance	5·579
1889	Laska	,,	In progress

In connection with this table I cannot lose the opportunity of quoting Newton's extraordinary prophecy, marvellous in that without any direct knowledge he gave a figure which was nearer the truth than that found by many of the experimenters that came after him. The passage is as follows:—

"Unde cum Terra communis suprema quasi duplo gravior sit quam aqua, et paulo inferius in fodinis quasi triplo vel quadruplo aut etiam quintuplo gravior reperiatur; verisimile est quod copia materiæ totius in Terra quasi quintuplo vel sextuplo major sit quam si tota ex aqua constaret; præsertim cum terram quasi quintuplo densiorem esse quam Jovem jam ante ostensum sit." (Newton's "Principia," 2nd edition, 1714, p. 373, line 10.)

I have placed on the wall the diagram of the apparatus which I showed in action when lecturing here upon quartz fibres five years ago. With this I was able, for the first time, to show to an audience the effect of the very small attraction exerted between a two-inch cylinder of lead and a little one weighing only a gramme or fifteen grains. The apparatus which I have to describe to-night is the same in principle, the main distinction being that it is so designed and constructed that I can tell precisely where every gravitating particle is placed. In the design of this apparatus I have been, as everyone will admit, bold—most would have preferred the word reckless; but knowing the truth of the principles which I had developed, and having faith and confidence in the quartz fibre, I deliberately chose to reduce all the dimensions to an extent which caused the forces, and especially the couples, to be insignificant in comparison with any which had been within the reach of the experimenter hitherto. The whole difficulty of Cavendish, Reich, and Baily had been to measure so minute an effect; instead of increasing this, I diminished it enormously, being satisfied that I should be able to make a proportionately more accurate measure by so doing. Cornu reduced the dimensions to one-quarter; I have reduced the chief one to one-eightieth. Cavendish had a force equal to 1/3650 grain's weight to measure; I have less than a five-millionth. By the use of the long lever, Cavendish had the effect of a force of 1/100 grain's weight on an arm an inch long; I have less than a twelve-millionth of a grain on an arm of that length. His forces were fourteen hundred times as great as mine; his couples or twisting forces were a hundred and twenty thousand times as great. One advantage gained by the use of small apparatus, in which alone the attracting balls can be made large compared with the length of the beam, is the increased sensibility, the greater angle of deflection produced by the attractions when the period of oscillation is the same. This is more especially the case in my apparatus where the two sides are at different levels. But the greatest advantage is in a direction whence it might least be expected. In spite of every endeavour that may be made to keep the air quiet, to exclude draughts, to keep all the apparatus at one temperature in a vault of constant temperature, infinitesimal differences must exist; one side of the apparatus must be hotter than the other, though no thermometer could be made which would detect the difference. In consequence of this difference of temperature the air circulates, and so creates a draught which blows upon the mirror and the suspended balls. Now I have shown that in apparatus geometrically similar these disturbances are likely to be in the proportion of the seventh power of the linear dimensions, while the gravitational couples vary only as the fifth power; the relative disturbances are therefore likely to be in the proportions of the squares of the linear dimensions, so that if we make our apparatus ten times as large, the mirror is likely to be one hundred times as unsteady. In addition to this, the time needed to bring the apparatus to a steady state is far greater with large apparatus. After making the geometrical measures I leave my apparatus, small as it is, three days, if possible, before observing deflections and periods.



By permission of the *Engineer.*]

Fig. 1.

The diagram (Fig. 1) is a vertical section through the apparatus. B and C represent an accurately turned brass box with a lid L, which can be made to turn round insensibly by the action of the wheels W W. The lid carries two tubular pillars, P P, from the tops of which the balls, M M, hang by phosphor-bronze wires, being definitely held in place by geometrical clamps on the heads of the pillars. The lid also carries two supporting pillars, R R. In the centre tube the "beam mirror," N, hangs by means of a quartz fibre from an adjustable torsion head surmounted by a bell jar, and from the ends of the mirror the two gold balls, *m m*, hang by separate quartz fibres. Four rings of india-rubber are placed on the base to prevent destruction of the apparatus in case the balls should drop by any accident. Now it is evident that if the lid is turned from the position in which it is shown, that is, with all four balls in one plane, in which position the attractions do not tend to twist the central torsion fibre at all, then these attractions will produce a couple increasing with the angle up to a certain point (65° in therefore, is such that a great number of measures which are difficult, and can at the best only be made with a second quality degree of accuracy, are of so little consequence that this degree is more than abundant. The final result depends directly upon a few measures which, as I hope to show, can be made with facility and most accurately. These are the horizontal distance from centre to centre of the wires by which the lead balls are suspended, the horizontal distance between the centres of the quartz fibres by which the gold balls are suspended, the angle through which the mirror is deflected, the masses of the lead but not of the gold balls, and the natural time of oscillation of the mirror when the balls are suspended and when a thin cylinder of small moment of inertia, but of the same weight as the balls, is suspended axially in their stead.

Before going more into detail and showing how the operations are carried out so that all the quantities may be known with a sufficient degree of accuracy, it will be convenient to project upon

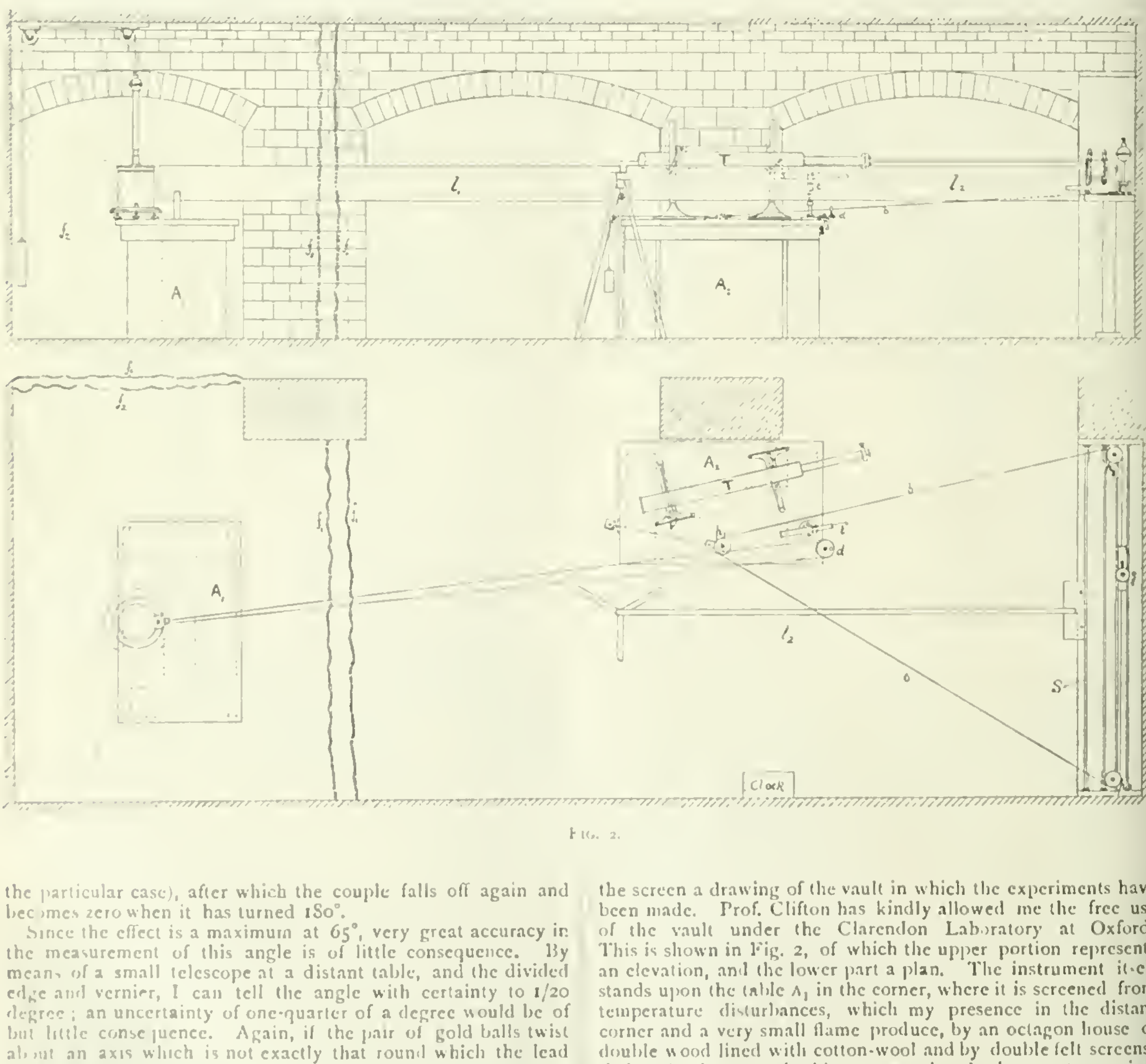


FIG. 2.

the particular case), after which the couple falls off again and becomes zero when it has turned 180°.

Since the effect is a maximum at 65°, very great accuracy in the measurement of this angle is of little consequence. By means of a small telescope at a distant table, and the divided edge and vernier, I can tell the angle with certainty to 1/20 degree; an uncertainty of one-quarter of a degree would be of but little consequence. Again, if the pair of gold balls twist about an axis which is not exactly that round which the lead balls are carried, if there is any small eccentricity of the gold or lead balls, then eccentricity in the common plane removes the gold balls from a position of minimum effect, eccentricity across the plane removes them from a position of maximum effect, and if the levels of the gold balls are not precisely the same as those of the lead balls, again the departure is from a position of maximum effect. All these three eccentricities can be determined with an accuracy of 1/1000 inch. Errors of 1/100 inch would make a barely perceptible effect upon the result. The design, the screen a drawing of the vault in which the experiments have been made. Prof. Clifton has kindly allowed me the free use of the vault under the Clarendon Laboratory at Oxford. This is shown in Fig. 2, of which the upper portion represents an elevation, and the lower part a plan. The instrument itself stands upon the table A_1 in the corner, where it is screened from temperature disturbances, which my presence in the distant corner and a very small flame produce, by an octagon house of double wood lined with cotton-wool and by double felt screens, f_1 f_2. On the second table, A_2, are placed a large astronomical telescope, T, through which the large scale, S, is seen by reflection from the mirror in the apparatus, a small reading telescope, *t*, to read the angle of the lid and vernier, a pulley-wheel, p_1, and a driving-wheel, *d*. The pulley-wheel p_1 keeps the cord *b* which passes round p_2 and p_3, and is attached to the cart, *c*, always tightly stretched, so that the observer at the telescope can always keep a little flame carried by the cart immediately behind the particular division under observation.

The driving wheel d is made with a very large moment of inertia, and the handle is near the axis, so that its motion is necessarily steady. A very light cord passes round this, across the room, and after passing through a hole in the screen passes also round the little wheel D (Fig. 1), and thus serves to drive the train W W, and so carry the lid and balls round almost insensibly. Two hundred and thirty turns of d are required to move the lead balls from the + to the − position. I generally turn the handle 130 times, and then when the mirror is approaching an elongation, turn the handle the remaining 100 times, finally stopping when the lid reading, as observed in the small telescope, is correct. The large scale, S, is 9 feet long, and is divided into 50ths of an inch. There are 4800 divisions.

Two beams, l_1 l_2, are seen in Fig. 2. The upper surfaces of these are straight, and are adjusted by screws until they are truly level. These are used when the true optical distance from the mirror to the scale is being measured. A steel tape, on which I engraved a fine line near each end, rests upon the beams. At one end a slider carrying a microscope is placed so as to see a fine line at the centre of the mirror accurately in focus, while at the other a corresponding slider is placed so that a projecting brass rod rests against the scale. At the same time cross lines engraved upon the plate-glass bases are placed exactly over the lines engraved on the steel tape. When afterwards the microscope is focussed upon the end of the brass rod, the distance between the cross lines, as measured by a scale, is the amount that has to be added to the distance between the engraved lines upon the tape, in order to obtain the distance from the scale to the mirror.

Overhead wheels are shown in Fig. 2, fastened to the roof above the apparatus, and again close to the end wall These serve many purposes, as will appear later. Among others, the middle one of each carries a cord fastened at one end to a crossbar joined at its ends by guys to the pillars R of the lid (Fig. 1), and at the other to heavy balance-weights to counterbalance the balls M M and part of the lid. Thus the friction is greatly reduced, and the tremor set up by rotating the lid is in a corresponding degree slight.

All time observations are made chronographically upon a drum by the Cambridge Scientific Instrument Company. This is placed in the adjoining vault. Two time-markers record with their points less than 1/100 inch apart, one of them marking every second of the clock, with special marks for minutes and half-minutes, and the other every depression of the key at my right hand. The late Prof. Pritchard kindly lent me an astronomical clock for the purpose, to which I fitted time-marking contacts; but into the details of these I must not enter. He also allowed me to make use of one of his assistants to keep me informed of the rate of the clock from time to time.

I have up to the present spoken vaguely of the large lead balls and of the small gold balls, but have given no indication as to how they are made and how I can be sure of the truth of their form and their homogeneity. Mr. Munro, whose capacity for turning accurate spherical work is well known, made for me two moulds of hard cast-iron, which I have on the table. One of these is for a 4¼-inch lead ball, and one for a 2¼-inch lead ball. Each mould is made in two halves, so truly as to shape and size that the thin steel disc that was used as a template would distinctly rattle when in its place, but when a strip of cigarette-paper was inserted on one side it could not be got in at all. The upper half of each of these moulds is provided with a cylindrical steel plunger accurately fitting a central hole in the mould, and with its end turned to the same spherical surface when it is pressed home upon its shoulder. The lower half of each mould has a ¾-inch central cylindrical hole, into which the lug of the brass ball holder exactly fits. There is also a small hole at the side which can be stopped with a brass plug. The balls are made as follows:—The interior of the mould is smoked and then screwed up as tight as possible. It is then heated until a piece of lead upon it begins to melt. The necessary quantity of pure lead melted in an earthen pot is then carefully skimmed and poured in until the cylindrical neck is full. The mould is then made to rest upon a cold iron slab, and a blowpipe is directed upon the upper part so that it cools from below upwards, and not from the surface inwards; more lead is added to keep the neck full. As soon as the lead in the neck solidifies the plunger is inserted, and the whole is placed in a hydraulic press. The plunger is forced down upon its seat, the lead, already free from bubbles and vacuous cavities, is compressed until at last the excess of solid metal flows through the small side hole in the form of wire. The ball is thus made true in form, necessarily homogeneous, which no alloy is likely to be, and definite in size. When cold it can be lifted from the mould, when after cutting off the wire which projects from its equator, it is ready for weighing.

The small gold balls are made by melting the required quantity of pure gold in a hole in a bath brick, and, as in the case of the lead, letting it cool from below upwards, so as to avoid cavities. It is then inserted in a pair of polished hemispherical hardened steel dies, which Mr. Colebrook made for the purpose, and beaten, being turned between each blow, and annealed once or twice until a perfect polished sphere, without a mark upon it, is the result. I make these in pairs of exactly the same weight, and, as in the case of the lead balls, thus obtain truth of form, accuracy of size, and homogeneity all in a very perfect—more than sufficiently perfect—degree. These are each suspended from a quartz fibre of the necessary length, to the other end of which a hook and eye is fastened. Into the very important details of these operations it is impossible, for want of time, for me to enter. The gold balls are ·2 and ·25 inch in diameter, and a

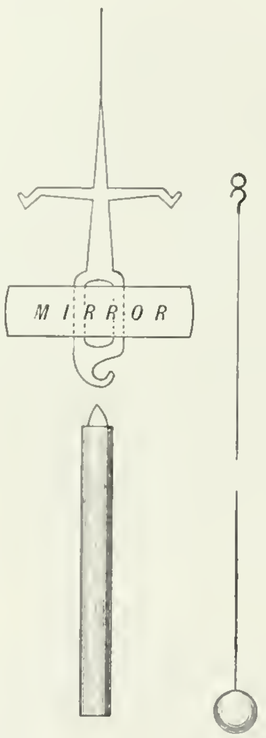


FIG. 3.

pair of gold cylinders were made in a similar tool ·25 inch in diameter, and about the same length.

Perhaps the most important detail in the whole apparatus is the "beam mirror," which is of the form shown in Fig. 3. It is necessary, as far as possible, to reconcile the following incompatible conditions. It should be as light as possible, have as small a moment of inertia as possible, the optical definition should be as perfect as possible, and, almost most important of all, the form should be such that the resistance offered by the viscosity of the air should be reduced to the smallest possible degree. By cutting the middle portion out of an optically perfect round mirror all these conditions are realised in some degree, and the optical definition is actually more perfect in the horizontal direction than that due to the whole disc. This is fastened to a cross-shaped support of gilt copper. The ends of the mirror have vertical grooves of microscopic fineness cut in their thickness, so that the quartz fibre hanging from the cross-arm above may rest definitely in them. The central hook is for the purpose of hanging the "counterweight," *i.e.* a slender silver cylinder of exactly the same weight as the gold balls with their fibres and hooks. By this means the unknown moment of inertia of the mirror may be eliminated with the fibre equally stretched in both cases, a most necessary condition, for I have found that the torsional rigidity is seriously affected by variation in stretching.

Means are provided by which I can effect the transfer of the gold balls from the beam to the side hooks or the reverse, or change their places without opening the window; but these and numerous other important details I must pass over.

Unfortunately accidents are liable to happen, and, as I know by dearly-bought experience, the gold balls may sometimes be precipitated down the central tube. I have recovered them sometimes by an india-rubber tube, let down through the window aperture, sucking at the other end until they closed the open end, when they could be drawn up. Latterly I have made use of a magnetised tuning-fork to pick up a very small fragment of iron tied to a silk line, by means of which I could draw up a diaphragm with anything that might have fallen upon it.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE following list of Royal Scholarships, Medals and Prizes awarded July, 1894, in connection with the Royal College of Science, London, has just been issued:—First Year's Royal Scholarships: Robert Sowter, Arthur Ormiston Allen, Henry Thomas Davidge, John Bousfield Chambers. Second Year's Royal Scholarships: Robert William Forsyth, William Longshaw. Medals and Prizes: "Edward Forbes" Medal and Prize of Books for Biology, George Stephen West; "Murchison" Prize of Books for Geology, John James Green, Francis Chambers Harrison; "Murchison Medal," not awarded; "Tyndall" Prize of Books for Physics, Part I., Robert Sowter; "De la Beche" Medal for Mining, John Ball; "Bessemer" Medal and Prize of Books for Metallurgy, Charles Howard Sidebotham; "Frank Hatton" Prize of Books for Chemistry, John Thomas. Prizes of Books given by the Department of Science and Art: Mechanics, Harold Rigby Cullen; Astronomical Physics, Francis Richard Penn, Robert Sowter; Practical Chemistry, Bouchier Mervyn Cole Marshall; Mining, John Ball; Principles of Agriculture, William Wilson.

THE Council of the City and Guilds of London Institute have conferred the Fellowship of the Institute upon Dr. W. E. Sumpner, who was awarded the Diploma of Associate of the Institute in 1887, and has since, by many original and valuable researches, contributed to the advancement of the electrical industry.

SCIENTIFIC SERIALS.

American Journal of Science, July.—Spiral goniometry in its relation to the measurement of activity, by Carl Barus. One type of the spiral goniometer consists of a "dial" in the form of a circular plate, on one half of which a series of concentric semicircles are traced, and an "index" in the form of another plate, bounded on one side by a semicircle, and on the other by two symmetric confluent spirals, traced so that equal increments of angle correspond to equal radial increments. These two parts are mounted on the same axis in such a manner as to be capable of revolving independently. When they are connected by a spring and made to actuate a dynamometer, the angle between the fundamental diameters of the dial and index can be read off by counting the number of semicircles visible on the revolving disc. These will be apparently drawn out into circles, and can be counted at any speed. This gives a means for measuring the activity of motors. In another form, the index outline is not a spiral but a diameter, and the semicircles are cut off in the outline of a spiral.—On some methods for the determination of water, by S. L. Penfield. This difficult operation may be considerably facilitated by the use of special forms of bulb tubes, which enable the analyst to separate the expelled water from the mineral, and weigh it in a closed tube. Two bulbs are blown half-way along the length of the tube, and kept cool by a strip of wet cloth. The water is driven up into the first of these. After it is all expelled, the glass is fused down upon the substance, and the end containing the substance is pulled off. The water is then weighed in the remaining part of the tube. For cases where the water is only expelled with difficulty, the author uses a kind of charcoal furnace, protecting the glass by a sheet of platinum foil. For entirely decomposing a mineral by fusion with sodium carbonate, the substance is placed in a platinum boat inside the combustion tube, and a sheet of platinum is wrapped round the outside. The tube must be well supported, as it is apt to fuse, but it does not leak even at a full white heat. The method is accurate, and superior to the use of porcelain or platinum. The latter is found at high temperatures to permit of the passage of gases through its substance.—The detection of alkaline perchlorates associated with chlorides, chlorates, and nitrates, by F. A. Gooch and D. Albert Kreider. The chlorates are destroyed by treating with the strongest hydrochloric acid and evaporating to dryness. The nitrates are decomposed by a saturated solution of manganous chloride in the strongest hydrochloric acid, the manganese being then eliminated by sodium carbonate. The perchlorates are then tested for by fusing with anhydrous zinc chloride.

American Meteorological Journal, July.—Changes in the definitions of clouds since Howard, by H. H. Clayton. The author quotes extracts from various authorities to show that there has been a gradual evolution since Howard. Thus a distinction between high and low cirro-stratus and high and low cirro-cumulus has been established, and the lower forms called alto-stratus and alto-cumulus. The stratus has been separated into fog and low sheet clouds, and two distinct forms of rain cloud recognised. He agrees with Hildebrandsson that ten terms, all compounded of Howard's four fundamental types, would fully meet the requirements of practical meteorology.—The newspaper weather maps of the United States, by R. De C. Ward. The history of the publication of these maps is given, together with specimens of those now issued. At present only four daily papers in the United States print weather maps regularly. The *New York Herald* was the first paper to issue them in the United States, and it occasionally prints them now, to illustrate special weather conditions.—Psychrometer studies, by H. A. Hazen. This paper is a criticism of the introduction to the tables recently published by Dr. J. Hann, of Vienna, and has especial reference to the difficulty found in using the wet and dry bulb thermometers when the temperature is near or below the freezing point. Prof. Hazen states that nearly all the difficulty vanishes when the thermometers are well ventilated.—List of cloud photographs and lantern-slides, by R. De C. Ward. A list of typical cloud forms, classified according to the international system, has been prepared, with an explanation of each, for use in lectures. The photographs are chiefly from pictures taken by Riggenbach and Manucci, during various positions and conditions.

Wiedemann's Annalen der Physik und Chemie, No. 8.—On the mechanical effects of waves upon resonators at rest, by Peter Lebedew. The case of electromagnetic waves is the first dealt with. Instruments called magnetic and electric resonators, respectively, were constructed in such a manner that they could be suspended by quartz fibres parallel to the planes of their coils. One of these was arranged so as to resound to the magnetic, the other to the electric components of the waves only. It was found that both resonators behaved in the same way. When "tuned" to a higher pitch, they were attracted by the incident wave system; when tuned lower, they were repelled, the maximum effects occurring when most closely approaching perfect resonance. The phenomena can be explained by supposing that the excitation of electric resonators obeys the laws governing all elastic vibrations, and that the laws of Coulomb and Ampère with respect to the relation between impulse and motion also apply to electric oscillations. The experiments are analogous to attempts to elucidate the molecular forces attending the propagation of light.—On the velocities of sound in air, gases, and vapours for simple tones of different pitches, by James Webster Low. From experiments performed with a Quincke interference tube, it appears that, contrary to the results obtained by Kundt, Regnault, König, and others, for closed tubes, the velocity of sound in air and in carbonic acid is the same for notes of different pitch and intensity when they are propagated in open space.—On the seat of the electric charge in condensers, by A. Kleiner. The experiments were performed chiefly on mica condensers, one coating of which consisted of pure mercury, and the other of tinfoil. The discharges obtained after the coatings had been taken off and replaced were about 5 per cent. less than those from the undisturbed condenser.

When the mica sheet was split in two, approximately equal discharges were obtained from the original condenser and the condensers formed with each of the parts, thus exhibiting the analogy with a magnet when broken into parts.—On the magnetisation of iron cylinders, by O. Grotrian. The parts of an iron cylinder not too short in comparison with its diameter, magnetised by a homogeneous field in the direction of the axis, are very differently magnetised when saturation has not been reached, the outside parts being much more strongly magnetised than the axial ones.

SOCIETIES AND ACADEMIES

LONDON.

Chemical Society, June 21.—Dr. H. E. Armstrong, President, in the chair.—The following papers were read: A specimen of early Scottish iron, by Miss M. D. Dougal.—The interaction of sulphide with sulphate and oxide of lead, by J. B. Hannay. The two equations—$PbS + PbSO_4 = 2Pb + 2SO_2$ and $PbS + 2PbO = 3Pb + SO_2$—given by Percy, to represent the reactions occurring in lead smelting, are insufficient. A much more complex reaction occurs, since metallic lead when formed attacks the remaining sulphate, producing litharge, which in turn reacts with the sulphide; further, some of the sulphide is removed by solution in the metallic lead, whilst some is volatilised as the compound PbS,SO_2.—The mineral waters of Cheltenham, by T. E. Thorpe.—The oxidation of tartaric acid in presence of iron, by H. J. H. Fenton. Tartaric acid is oxidised by certain agents in presence of a trace of ferrous salt with formation of a new crystalline dibasic acid, $C_4H_4O_6, 2H_2O$; it is a powerful reducing agent, and forms crystalline salts.—The supposed relation between the solubility of a gas and the viscosity of its solvent, by T. E. Thorpe and J. W. Rodger. From the results of their own experiments on the viscosity of solutions of gases, the authors are led to modify the conclusions of Winkler respecting the relation between solubility and viscosity.—The specific character of the fermentative functions of yeast cells, by A. J. Brown. Pasteur's view of the cause of the exhibition of the fermentation functions of yeast cells is that it is a starvation phenomenon brought about by lack of free oxygen during the life of the cells in a fermentable liquid. The fermentative power was measured by Pasteur as the ratio of yeast to sugar; the author finds, however, that there is no direct constancy of proportion between the weight of yeast formed and of sugar fermented. Pasteur's experiments are consequently insufficient, and his theory unproven.—Observations on the influence of temperature on the optical activity of organic liquids, by P. Frankland and J. MacGregor. The authors have measured the rotatory powers of methylic and ethylic salts of active glyceric and diacetylglyceric acids at various temperatures; the percentage increase in rotation as the temperature rises is greater for the methylic than for the ethylic salts.—The maximum molecular deviation in the series of the ethereal salts of active diacetylglyceric acid, by P. Frankland and J. MacGregor.—The preparation of sulphonic derivatives of camphor, by F. S. Kipping and W. J. Pope. The sulphonic chlorides and bromides of camphor and its halogen derivatives are best prepared by treating the ammonium salts of the corresponding sulphonic acids with phosphoric chloride.—Dextro-rotatory camphorsulphonic chloride, by F. S. Kipping and W. J. Pope.—On the combination of chlorine with carbon monoxide under the influence of light: preliminary notice, by G. Dyson and A. Harden. There is a well-marked period of photochemical induction in the amount of chemical action occurring when light acts on a moist mixture of equal volumes of carbon monoxide and chlorine.—Solution and pseudo-solution, part ii., by S. E. Linder and H. Picton.—Solution and pseudo-solution, part iii., by H. Picton and S. E. Linder. The continuation of previous work on solutions is described in these two papers.

PARIS.

Academy of Sciences, July 23.—M. Lœwy in the chair.—On the photographs of the moon obtained with the great *coudé* equatorial of the Paris Observatory, by MM. Lœwy and Puiseux. The difficulties met with in taking these lunar photographs are detailed, and an account is given of the methods used in overcoming them. Further, the photographs obtained are discussed and compared with maps and previous photographs.—On a new series of sulphophosphides, the thiohypophosphates, by M. C. Friedel. The iron, aluminium, zinc, copper, lead, silver, mercury, and tin salts are described. The series is viewed as consisting of salts of the general type $P_2S_6M'_4$.—On two menhirs found in Meudon wood, by M. Berthelot. Two previously undescribed sandstone menhirs have their characteristics given in detail.—On the reduction of any differential system whatever to a completely integrable form, by M. Riquier. The conclusions of this memoir are summarised as follows:—"Being given a differential system involving any number of unknown functions and any number of independent variables, simple eliminations, together with differentiations, allow, in general, of putting them into a completely integrable form, of which the order is nearly always superior to one, and approximates to a linear and completely integrable form of the first order."—On the specific inductive capacity of glass, by M. F. Beaulard. The influence of the time of charging has been studied by the ballistic method and k calculated for an instantaneous charge, the author finds $k = 3{\cdot}9$.—On the electrolysis of copper sulphate, by M. A. Chassy. With a neutral saturated solution of copper sulphate at 100° and a current density of a hundredth of an ampère per square centimetre, a bright red deposit of cuprite in forms derived from the cube and octahedron is obtained. By lowering the temperature, diminishing the concentration, or augmenting the current density, varying proportions of metallic copper can be obtained along with the red crystals. In determinations of current by electrolysis of copper sulphate it is necessary, in order to avoid serious error, to acidulate and pass the current through cold dilute solutions.—On manganese steel, by M. H. Le Chatelier. The anomalous results found previously by the author in studying the electric resistance of (13 per cent.) ferromanganese are explained by the formation of two allotropic varieties of the metal. The temperature of transformation is 740°, that temperature at which soft iron passes from the magnetic to the non-magnetic state.—On metaphthalodicyanacetic ether, by M. Locher.—Organo-metallic combinations of borneol, camphor, and monochlor-camphor with aluminium chloride, by M. G. Perier. The compounds having the formulæ

$$(C_{10}H_{18}O)_2Al_2Cl_6,\ (C_{10}H_{16}O)_2Al_2Cl_6, \text{ and } (C_{10}H_{15}ClO)_2Al_2Cl_6$$

have been obtained in crystalline condition. They are very unstable in air, and are readily acted on by water with production of the original constituents.—On a new acid, isocampholic acid, by M. Guerbet.—Action of phosphorus pentachloride on tetrachloroquinone, by M. Et. Barral.—On essence of Pelargonium from Réunion, by MM. Ph. Barbier and L. Bouveault.—On the condensation of formaldehyde with alcohols of the fatty series in presence of hydrochloric acid, by M. C. Favre.—On the existence of hydroxyl in green plants, by M. A. Bach.—On the presence of several distinct kinds of chlorophyll in the same vegetable species, by M. A. Étard.—Researches on the causes of the toxicity of the serum of blood, by MM. Mairet and Bosc. The authors demonstrate the following conclusions:—(1) Blood serum has both toxic and coagulating properties. (2) The coagulating properties are destroyed by heat or by the addition of sodium chloride or sulphate. (3) The symptomatic effects produced by intravenous injections of pure serum are mostly due to the toxic properties of the serum, the coagulating effects making themselves felt only near the limit of the toxic action. (4) The alcoholic extract has no toxic or coagulating properties, these being only shown by the precipitate. (5) By partial precipitation with alcohol, the toxic and coagulating substances may be separated. (6) Both belong to the albumenoids.—On the structure of the membrane of Corti, by MM. P. Coyne and Cannieu.—On the metamorphoses of *Cecidomyia destructor*, Say, and on the puparium or larval envelope before its transformation into a chrysalis, by M. A. Laboulbène.—On the origin of "sphères directrices," by M. Leon Guignard.—The radical tubercles of *Arachis hypogea*, L., by M. Henri Lecomte.—Influence of the distribution of humidity in the soil on the development of chlorosis of the vine on a calcareous soil, by MM. F. Houdaille and M. Mazade.—On a magnetic perturbation, by M. Moureaux.

BERLIN.

Physiological Society, June 8.—Prof. du Bois Reymond, President, in the chair.—Dr. J. Munk gave an account of an experiment made on a dog as to the nutritive value of gelatine. Up to the present it was only known that gelatine alone could not make good the need for proteids, but that a diet of gelatine with some proteid leads to a reduction of proteid metabolised. Dr. Munk had propounded the question, how far can gelatine take the place of proteids? and had carried on an experiment of four days' duration. After the dog had been placed in nitrogenous equilibrium on a diet of meat-meal, rice and fat containing 9½ grms. of nitrogen in the form of proteid, five-sixths of this nitrogen was replaced by nitrogen in the form of gelatine: the animal continued in nitrogenous equilibrium. It appears from this that by the administration of gelatine the nitrogen necessary as proteids can be reduced far below the minimum metabolised in starvation, without any commencing metabolism of tissue nitrogen. Dr. Munk made a further communication on metabolism. It is known that the administration of carbohydrates to dogs leads to a saving of proteids. Recently it has been supposed that this saving is determined by the possibility that the carbohydrates lessen the putrefactive changes which proteids undergo in the intestine, so that they are absorbed unchanged in larger quantities. Since it is known that proteids are absorbed very rapidly from the intestine of dogs, and that the absorption is complete in about six hours, Dr. Munk gave a dog at one time 100 grms. sugar along with his meal of proteid, and at another time the proteid meal in the morning and the 100 grms. sugar later on after an interval of thirteen hours, when presumably there would be little or no proteid in the intestine. In both these experiments he noticed the same saving of proteids. In the first there was additionally a falling off of the ethereal sulphates in the urine, evidencing diminished putrefaction of proteids in the intestine. In the second case, where the sugar was given separately from the proteids, the ethereal sulphates were very slightly lessened in amount, so that here apparently there was no diminution of the putrefactive changes, and still the carbohydrates had saved the proteids. These experiments do not support the view recently put forward.—Prof. König gave an account of his experiments on Dr. Zumft for determining the position of the layers of the retina which are sensitive to light.

June 22.—Prof. du Bois Reymond, President, in the chair.—Dr. Marcuse gave an account of experiments on frogs in studying pancreatic diabetes. After having satisfied himself that extirpation of the pancreas in frogs leads in most cases, at latest after two days, to a distinct diabetes, he investigated the effect on this of total extirpation of the liver. Although the frogs lived from two to five days after the operation, no diabetes was observed in any one case. Notwithstanding the numerous hypotheses as to the influence of the liver and pancreas on the sugar of the blood, it is not as yet possible to offer a satisfactory explanation of the above observations. Prof. Zuntz had recently endeavoured by a lengthy series of experiments to determine whether any one alone of the food-stuffs, proteids, fats, or carbohydrates can be regarded as the source of muscular energy. The experiments were made on a dog, which can be fed and nourished quite well on either proteids or fats or carbohydrates (rice and sugar), and showed that each one of the above three food-stuffs suffices to provide the energy necessary for the work done by the muscles. Comparative experiments made to determine which of the three food-stuffs can be most advantageously employed for supplying this energy, have not as yet led to any decisive result. This important research is to be continued.

Gottingen.

Royal Society of Sciences.—In the *Nachrichten*, No. 2, 1894, the following papers are published:—A. von Koenen: On the age of the mineral veins of the Harz Mountains.—J. Disse: On epithelial buds in the olfactory region of mammalia.—W. Voigt: On media without internal forces, and on a mechanical interpretation of the Maxwell-Hertz equations thereby furnished.—J. Bohls: Notes on the capture and natural history of *Lepidosiren* in Paraguay.—E. Ehlers: On *Lepidosiren paradoxa* (Fitz) and *articulata* (nov. spec.) from Paraguay.—P. Günther: Gauss's researches in the theory of the elliptic functions.—Robert Fricke: An application of the ideal theory to the substitution groups of the automorphous functions.—E. Riecke: The theorem of the thermodynamic potential of a heterogeneous system in equilibrium, with an application to van der Waal's theory and to the law of the boiling-point.—W. Felgentraeger: Whiston's isoclinal chart and the secular change of magnetic inclination in the east of England.—W. Nernst and R. Abegg: On the freezing-point of dilute solutions.—C. Fromme: On the self-induction and electrostatic capacity of resistance coils, and their influence on magnetic phenomena.—F. v. Dalwigk: On a substitute for Dirichlet's principle.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—London Matriculation Directory, No. xvi., June, 1894 (London).—Practical Work in General Physics: W. G. Woollcombe (Oxford, Clarendon Press).—Smithsonian Institution Report of the U.S. National Museum, 1892 (Washington).—Die Wissenschaftlichen Grundlagen der Analytischen Chemie: W. Ostwald (Leipzig, Engelmann).—Verzeichniss der Elemente der bisher berechneten Cometenbahnen: Dr. J. G. Galle (Leipzig, Engelmann).—Studien über Docoglosse und Rhipidoglosse Prosobranchier: Dr. B. Haller (Leipzig, Engelmann).—Psychologie des Grands Calculateurs et Joueurs d'Échecs: A. Binet (Paris, Hachette).—A Dictionary of the Economic Products of India: Prof. J. Watt, 6 Vols. (Calcutta).—Gesammelte Werke von H. Hertz: Band 3. Die Prinzipien der Mechanik (Leipzig, Barth).

Pamphlets.—Demonstration du Principe de l'Equivalence: M. G. Mouret (Niort, Lemercier).—Bericht uber die Thätigkeit des Königlich Preussischen Meteorologischen Instituts in Jahre 1893: W. von Bezold (Berlin).—A Short Guide to the Larmer Grounds, Rushmore, &c.: Lieut.-General Pitt-Rivers.—The Consumption of Steam and Water in Steam-Engines. W. I. Ellis (J. Heywood).

Serials.—Quarterly Journal of Microscopical Science, July (Churchill). Mathematical Gazette, No. 2 (Macmillan).—Physical Society of London, Proceedings, Vol. xii. Part 4 (Taylor and Francis)—Longman's Magazine, August (Longmans).—Good Words, August (Isbister).—Sunday Magazine, August (Isbister).—Zeitschrift für Physikalische Chemie, xiv. Band, 3 Heft (Leipzig, Engelmann).—Journal of the Sanitary Institute, July (Stanford).—Transactions and Proceedings of the New Zealand Institute, 1893, Vol. xxvi. (Wellington).—Humanitarian, August (Hutchinson).—Century Illustrated Magazine, August (Unwin).—New Science Review, Vol. 1, No. 1 (26 Henrietta Street).—English Illustrated Magazine, August (198 Strand).—Chambers's Journal, August (Chambers).—Proceedings of the Edinburgh Mathematical Society, Vol. xii. (Williams and Norgate).—Quarterly Journal of the Geological Society, Vol. L. Part 3, No. 199 (Longmans).—Geological Journal, August (Stanford).—National Review, August (Arnold).—Contemporary Review, August (Isbister).

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THURSDAY, AUGUST 9, 1894.

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.*]

Wilde's Theory of the Secular-Variation of Terrestrial Magnetism.

IN a recent communication to the Royal Society, contained in the *Proceedings* for March, pp. 210-217, Mr. Henry Wilde, F.R.S., believes that he has cited additional facts in support of his theory of the secular variation of terrestrial magnetism. Wilde first proposed his theory[1] to the Society, June 19, 1890. He had it separately printed, in addition with other papers, in three languages, and the pamphlet was scattered far and wide. It was issued in the form of a reprint from the *Transactions* (though it never appeared in the *Transactions*), and contained such surprisingly good agreements between theory and observations that several eminent men of science, without examining the pamphlet very carefully, and believing that it bore the stamp of the Royal Society, were misled into thinking that Wilde had really achieved some remarkable results.

Having been engaged in the United States Coast and Geodetic Survey as magnetic computer for five years, and being aware of the difficulty in reconciling the secular variation of the magnetic declination for various places on the earth's surface with each other, under the assumption of one period for the whole earth, and that at the same time the orbit described during that period by the north end of a free magnetic needle should be a single closed curve, I undertook to show the fallacy both of Wilde's theory and of the supposed agreement with observations. The result of my investigation was read before the Philosophical Society of Washington, February 27, 1892, and was published in the *American Journal of Science*, vol. xliii., June 1892. The conclusions of that paper were :—

(1) Wilde's theory is physically impossible.

(2) Wilde's mechanism (magnetarium) does not agree in principle with his theory as outlined.

(3) The results from the magnetarium do not represent the facts of terrestrial magnetism.

(4) Wilde's theory is but a modification of Halley's.

In proving (3), I showed that Wilde, in the case of the London results, only got out of his mechanism what he had actually put in. In the case of Cape of Good Hope and St. Helena, such apparently good results were obtained because the law of the secular variation for these two stations, within the period of observation and within the large probable error of the magnetarium results, is not very dissimilar from that for London. So to get a good correspondence for Cape of Good Hope and St. Helena, it was only necessary to turn the crank a few times more. I, moreover, showed from facts stated in the very *Bulletin* of the Coast Survey, which Wilde has cited in his late communication, as giving additional proof of his theory, that in order to satisfy perfectly the three stations, London, Cape of Good Hope, and St. Helena, it would seem that his inner electrodynamic sphere would have to make one complete differential revolution in 960 years (as he has deduced) for the first two stations, but that for St. Helena it would have to move more rapidly and perform a revolution in 780 years. I therefore proposed to Wilde to try to turn out with his magnetarium the secular variation of the magnetic declination for stations which exhibit a vastly different law from that of London, viz. stations in the United States. It is remarkable that although he evidently possesses records of secular-variation stations in the United States, he has thus far made no published attempt to reproduce them with his magnetarium. The point insisted upon was that he should turn out the secular variation at the various stations conjointly, not separately. Is it not strange that he has made no attempt in the four years since he first constructed his magnetarium, to give us the secular variation for other portions of the earth than simply for the three stations given in the first communication, and now in the last one for a station which lies not far from one of these, and so has a similar law of variation? Why does not Wilde read off from his magnetarium the declinations at other stations, *e.g.* Paris, New York City, St. John's, Newfoundland, Peking, &c., when he turns out the secular variation at London?

But I shall now ignore my own paper, with its conclusions, and exhibit the fallacy of Wilde's theory on the basis of the results given in his last communication.

(1) The annual change of the dip at London for the last fifty years has been steadily decreasing, indicating the approach of a minimum. A formula established by myself on the basis of the London dip observations, 1576–1890, which represents the observations many times better than the magnetarium results, predicts this epoch of minimum dip about the middle of the next century.[1] This phase of minimum dip is advancing steadily from the East, and has already set in in Western Russia. The decrease of annual change of dip is borne out by numerous stations in Europe, all indicating the near approach of a minimum dip phase. Now *Wilde's* magnetarium results give a steady *increase* of annual change of dip, in consequence of which his minimum dip for London does not occur until after the year 2200.

(2) On p. 216 of the last communication, Wilde says : "On working the inclination (at St. Helena) backwards on the magnetarium chronologically, it will be seen from the Table VI. that about the year 1747 the dip changed the sign from south to north. As no observations were made on the dip at St. Helena previous to the year 1825, there is no record of this interesting fact, nor has it hitherto been deduced from theory." Unfortunately for Wilde, we have record of observations for this period, which, instead of giving a dip of 0° in 1747, give a dip of 9° to 10° (south end dipping)! To show how poorly his results agree with observation for periods where he does not possess the records himself, I give the following table :—

Date.	Observer.	Observed inclination.	Wilde inclination.	Observation theory.
		°	°	°
1700	Hansteen chart	11·5 S.	3·9 N.	−15·4
1754·3	La Caille	9·00	0·5 S.	− 8·5
1771·4	Ekeberg	13·00	3·5	− 9·5
1775·4	Cook	11·42	4·0	− 7·4
1780	Hansteen chart	10·5	5·1	− 5·4
1825·0	Duperry	14·93	14·7	− 0·2
1840·1	Ross	18·27	18·5	+ 0·2
1842·3	Belcher	17·00	19·0	+ 2·0
1846·8	Smythe	19·39	20·5	+ 1·1
1890·1	U.S.C. & G.S.	29·65	33·8	+ 4·1
,,	,,	31·18	33·8	+ 2·6

Wilde only had the observations 1825–1880, and it will be seen that for this short interval the correspondence between theory and observation is very good.

But before this interval the divergence is so great as to completely vitiate the Wilde magnetarium results. Likewise with 1890, the divergence becomes marked again. The first observation for 1890 was made at Jamestown, the second at Longwood, St. Helena. The first station agrees in locality more closely with preceding observations than the second.[2]

Wilde concludes with a reproduction of the observations of declination and inclination at Ascension Island for the epoch 1834–1890. During this interval the correspondence is very good, but he does not tell us whether he obtained the results separately or conjointly with London, Cape of Good

[1] "That the principal phenomena of terrestrial magnetism, and of the secular changes, could be explained on the assumption of an electrodynamic substance (presumably liquid or gaseous) rotating within the crust of the earth in the plane of the ecliptic, and a little slower than the diurnal rotation." A complete differential revolution of this electrodynamic substance is performed in 960 years, which period, according to Wilde, constitutes the secular-variation period.

[1] *Science*, vol. xx. No. 505.

[2] From a paper, soon to be published, on the secular-variation curves as described, in the course of time, by a freely suspended magnetic needle at various portions of the earth's surface, it would appear as though the inclination at St. Helena never becomes zero as Wilde's theory would demand.

Hope, and St. Helena. But even if the latter were the case, to give convincing proof of the correctness of his theory, he would at the same time have to reproduce the observations at points widely distant from these stations. We would like to ask Wilde to turn out the Ascension declinations and inclinations, say, from 1700-1834. L. A. BAUER.

Friedenau, bei Berlin, July 21.

Time-Gauge of Niagara.

IN the summer of 1890, I had the opportunity of spending some months in Canada, where I devoted what time I had to spare to the later geology of the country.

The time-gauge of the Niagara Falls struck me, and naturally led to further investigation.

We are fairly justified in the assumption, from historical sources in Egypt and elsewhere, that no distinguishable change of climate has occurred for, say, four thousand years. Our first knowledge of Britain, nearly two thousand years ago, would indicate that the climate of the south coast was then, at least in summer, a few degrees higher than now. Restore the conditions, reafforest the country lying north, and we should probably find this state of affairs restored. Four thousand years is a good stretch in the mind to seven thousand, so we may safely assume the "Glacial Epoch" must be put back an indefinite time beyond that.

Now we find, looking at the superficial geology of the lakes, that Erie must be dissociated from the other four. There is every reason to believe it was a river basin draining by the Wabash and Maumee valleys into the Mississippi. Ontario again in pre-glacial times drained by Syracuse into the Atlantic. During the Ice Age these drainage valleys were blocked, as was possibly the present discharge by the St. Lawrence past Montreal. In post-glacial times, on the retiring of the ice, Ontario stood at a much higher level, and probably discharged over the Niagara ridge into Erie.

It is well known that an old river channel exists, passing from above Niagara and tending west of Queenstown to Ontario. It has been assumed that flowing out of Erie the channel divided, one branch flowing west, the other east of Queenstown, and that owing to erosion at the extremity, one (the western) became closed, while the other survived as the Niagara.

If this were the case, there must have been, for a time, two falls over the escarpment near Queenstown, but there is absolutely no evidence of there having been a fall at the extremity of the western branch.

What seems to have happened was that for an indefinite time Ontario discharged westward into Erie, which again drained into the Upper Mississippi. A slight change of level may have occurred, or a local flood have carried away some of the débris closing the Lower St. Lawrence, and Ontario found a way of escape to the east. A rapid erosion of the old valley must have occurred with the result of lowering Erie sufficiently to reverse its outfall, when the river took the lowest channel, and first flowed, as now, over the escarpment.

The time-gauge represents then, not the close of the glaciated period, but the epoch when Ontario returned to its pre-glacial discharge. The intermediate period, when it flowed into Erie, has apparently left only the old western channel as evidence of what may well have been a protracted period

Shanghai, June 22. THOS. W. KINGSMILL.

Late Appearance of the Cuckoo.

ON Friday last, July 27, as I was walking along the Sion Vista in Kew Gardens, towards the river, I heard, far off to my left, the cry of a cuckoo. There was but one cry, and that had not the duplication of the first sound which usually marks his later utterances with us. Clearly though I had heard it, I might almost have doubted the testimony of my ears if I had not, on turning suddenly to the direction from which the sound had come, *seen* the bird rise quickly and fly across the river.

August 1. E. HUBBARD.

Height of Barometer.

CAN any of your readers refer me to the maximum and minimum *uncorrected* heights of the barometer, which have been hitherto recorded (1) in England, (2) in any part of the world? It would, of course, be necessary to know the height of the place of observation above sea-level in the case of the minimum, at least. KARL PEARSON.

University College, London, August 5.

Magnetisation of Rock Pinnacles.

MR. HILL will be glad to find that systematic observations on the magnetism of rock masses have been taken for the very district he mentions in his letter of July 28.

In vol. x., part 2, of the *Journal* of the Royal Institution of Cornwall, there appears a short paper on "The Magnetism of the Lizard Rocks," by Mr. Thomas Clark. In this he gives not only the results obtained, but his method of procedure. A subsequent paper (printed in vol. xi., part 2, of the *Journal*), on "The Magnetic Rocks of Cornwall," gives the results of his experiments, and is accompanied by a map of the county showing the position of its magnetic rocks. I understand that Mr. Clark is continuing his research in this direction.

If similar observations were taken throughout the whole of the country, especially in the neighbourhood of the coast, doubtless they would yield results of great value to commerce as well as to science. M. M. S.

IF Mr. Hill will refer to *Alpine Journal*, vol. xiii. p. 439, he will find mention of a magnetic peak in the Black Coolins: the mountain bears the name Bidein Druim nan Ramh.

Eccles, August 5. JAMES HEELIS.

THE BRITISH ASSOCIATION.

OXFORD, AUGUST 8.

THE sixty-fourth meeting of the British Association, and the fourth which has been held at Oxford, may now be fairly said to have begun. The reception-room was opened at 2 p.m. on Monday last, and at the moment of the opening of the doors there was an unexampled rush to obtain places in the Sheldonian Theatre for the President's address and the evening lectures. The places in the theatre have been filled with extraordinary quickness, and it is to be feared that late-comers, who have not availed themselves of the offer of the Local Secretaries to engage seats beforehand by letter, will be disappointed in the places which they obtain. This is an unusual occurrence, and demands some explanation. The Sheldonian Theatre is the largest building now standing in Oxford. The old Corn Exchange was larger, and could have comfortably accommodated the audience which assembled to hear Lord Salisbury on Wednesday night. But unfortunately it is no longer existent. It has been pulled down, with the other civic buildings, to make room for larger successors, which are only half completed, and the Local Committee must regret, without being able to remedy, the circumstance that the only available place of meeting is insufficient for the needs of the Association.

Lord Salisbury's address is fully reported in another part of this issue. Many of those who know Lord Salisbury only as a politician and as Minister for Foreign Affairs, will be surprised at the wide range of thought and reading displayed in this address, and more still at the keen critical faculty displayed in his handling of the diverse topics which he passes under review. Possibly the whole of his audience will not entirely agree with his views on current scientific problems, and his concluding remarks on the present position of the Darwinian theory offer almost a repetition of the controversy which made the last meeting at Oxford so famous four-and-thirty years ago. The two other evening addresses are not likely to fall far short in interest of the opening meeting. As is usual, Thursday morning is devoted to the addresses of the Presidents of Sections, and three of these are reported at length in this issue. The addresses at Oxford differ necessarily in one respect from those which are delivered at many other centres at which the Association meets. Oxford has in its relations to science a historical interest, as well as a more present interest in virtue of its being a seat of learning. It will accordingly be found that many of the Sectional Presidents touch upon the history of science as exemplified by Oxford, and enlarge upon its needs as an instrument of culture and education. Oxford indeed, though it is not generally supposed to be a scientific University, has a past which it may look on with pride. Few may remember that Roger Bacon, an early devotee and martyr to science, lived and worked at Oxford, and that this is the sex-centenary of the reputed year of his death. A second period, mentioned by Prof. Dixon in his opening address, is that of Robert Boyle and his colleagues, among whom was for a short time the illustrious Harvey, a band of men who were virtually the founders of the Royal Society.

The proceedings of the Sections derive great interest from the unusual number of communications by eminent foreign men of science. The proceedings of some of the Sections have already been indicated in previous numbers of NATURE; those of others are not even now settled into definite shape. In Section A (Mathematical and Physical Science), besides the joint meetings with Section G, which have already been mentioned, there are, amongst other important papers set down for Thursday, one on "Preliminary Experiments proving the Electrification of Air by the Subtraction of Water from it," by Lord Kelvin and Magnus McLean; another, by Lord Kelvin and Alexander Galt, on "Leyden Jar Discharges through Divided Channels," and a third, by Prof. G. Quincke, on "The Formation of Soap Bubbles by the Contact of Alkaline Oleates with Water." On Saturday Prof. Everett reads on "Some Jointed Frames or Linkages," and Dr. P. H. Schoute on "The Order of the Groups related to the Anallagmatic Displacements of the Regular Bodies in n-dimensional space." On Monday there is a paper by Lord Rayleigh, of which the title is not yet published, and others follow by Prof. H. H. Turner, Prof. Viriamu Jones, Mr. F. H. Newall, and Prof. O. J. Lodge.

In Section D, the Department of Botany, which meets by itself in Magdalen College School, has some very interesting matter. There are important papers by Prof. D. H. Campbell, of the University of California, and Prof. F. O. Bower, on "The Morphology of Vascular Cryptogams"; by Prof. E. Strasburger, on "Chromosomenzahl"; by Dr. Leopold Kny, on "Correlation between Root and Shoot"; by Prof. Green, on "Influence of Light on Diastase," and by Prof. Dukinfield Scott on "The Structure of Fossil Plants and their bearing on Botanical Problems."

The Anthropological Section, of which some account has been given in an earlier number, will devote the greater part of Friday and Monday to discussions on Early Man in Western Europe, in which M. Emile Cartailhac and Comte Goblet d'Alviella will take a leading part; and on Tuesday and Wednesday, various papers on Ethnography will range from North Africa to Australia.

At the soirée in the University Museum, on Thursday evening, there will be a few interesting exhibits, chief among which will be Prof. Henrici's linkage models, exhibitions by the Cambridge Scientific Instrument Company, by Prof. Everett, and demonstrations of anthropometrical methods, by Dr. J. G. Garson.

INAUGURAL ADDRESS BY THE MOST HON. THE MARQUIS OF SALISBURY, K.G., D.C.L., F.R.S., CHANCELLOR OF THE UNIVERSITY OF OXFORD, PRESIDENT.

MY functions are of a more complicated character than usually is assigned to the occupants of this chair. As Chancellor of the University it is my duty to tender to the British Association a hearty welcome, which it is my duty as President of the Association to accept. As President of the Association I convey, most unworthily, the voice of English science, as many worthy and illustrious Presidents have done before me; but in representing the University I represent far more fittingly the learners who are longing to hear the lessons which the first teachers of English science have come as visitors to teach. I am bound to express on behalf of the University our sense of the good feeling towards that body which is the motive of this unusual arrangement. But as far as I am personally concerned, it is attended with some embarrassing results. In presence of the high priests of science I am only a layman, and all the skill of all the chemists the Association contains will not transmute a layman into any more precious kind of metal. Yet it is my hard destiny to have to address on scientific matters probably the most competent scientific audience in the world. If a country gentleman, who was also a colonel of Volunteers, were by any mental aberration on the part of the Commander-in-Chief to be appointed to review an army corps at Aldershot, all military men would doubtless feel a deep compassion for his inevitable fate. I bespeak some spark of that divine emotion when I am attempting to discharge under similar conditions a scarcely less hopeless duty. At least, however, I have the consolation of feeling that I am free from some of the anxieties which have fallen to those who have preceded me as Presidents in this city. The relations of the Association and the University are those of entire sympathy and good will, as becomes common workers in the sacred cause of diffusing enlightenment and knowledge. But we must admit that it was not always so. A curious record of a very different state of feeling came to light last year in the interesting biography of Dr. Pusey, which is the posthumous work of Canon Liddon. In it is related the first visit of the Association to Oxford in 1832. Mr. Keble, at that time a leader of University thought, writes indignantly to his friend to complain that the honorary degree of D.C.L. had been bestowed upon some of the most distinguished members of the Association: "The Oxford Doctors," he says, "have truckled sadly to the spirit of the times in receiving the hodge-podge of philosophers as they did." It is amusing, at this distance of time, to note the names of the hodge-podge of philosophers whose academical distinctions so sorely vexed Mr. Keble's gentle spirit. They were Brown, Brewster, Faraday, and Dalton. When we recollect the lovable and serene character of Keble's nature, and that he was at that particular date probably the man in the University who had the greatest power over other men's minds, we can measure the distance we have traversed since that time; and the rapidity with which the converging paths of these two intellectual luminaries, the University and the Association, have approximated to each other. This sally of Mr. Keble's was no passing or accidental caprice. It represented a deep-seated sentiment in this place of learning, which had its origin in historic causes, and which has only died out in our time. One potent cause of it was that both bodies were teachers of science, but did not then in any degree attach the same meaning to that word. Science with the University for many generations bore a signification different from that which belongs to it in this assembly. It represented the knowledge which alone in the Middle Ages was thought worthy of the name of science. It was the knowledge gained not by external observation, but by mere reflection. The student's microscope was turned inward upon the recesses of his own brain; and when the supply of facts and realities failed, as it very speedily did, the scientific imagination was not wanting to furnish to successive generations an interminable series of conflicting speculations. *That* science—science in our academical sense—had its day of rapid growth, of boundless aspiration, of enthusiastic votaries. It fascinated the rising intellect of the time, and it is said —people were not particular about figures in those days—that its attractions were at one time potent enough to gather round the University thirty thousand students, who for the sake of learning its teaching were willing to endure a life of the severest hardship. Such a state of feeling is now an archæological curiosity. The revolt against Aristotle is now some three centuries old. But the mental sciences which were supposed to rest upon his writings have retained some of their ascendency even till this day, and have only slowly and jealously admitted the rivalry of the growing sciences of observation. The subject is interesting to us, as this undecided state of feeling coloured the experiences of this Association at its last Oxford visit, nearly a generation later, in 1860. The warmth of the encounters which then took place have left a vivid impression on the minds of those who are old enough to have witnessed them. That much energy was on that occasion converted into heat may, I think, be inferred from the mutual distance which the two bodies have since maintained. Whereas the visit of 1832 was succeeded by another visit in fifteen years, and the visit of 1847 was succeeded by another visit in thirteen years, the year 1860 was followed by a long and dreary interval of separation, which has only now, after four-and-thirty years, been terminated. It has required the lapse of a generation to draw the curtain of oblivion over those animated scenes. It was popularly supposed that deep divergences upon questions of religion were the motive force of those high controversies. To some extent that impression was correct. But men do not always discern the motives which are really urging them, and I suspect that in many cases religious apprehensions only masked the resentment of the older learning at the appearance and claims of its younger rival. In any case there is something worthy of note, and something that conveys encouragement, in the difference of the feeling which prevails now and the feeling that was indicated then. Few men are now influenced by the strange idea that questions of religious belief depend on the issues of physical research. Few men, whatever their creed, would now seek their geology in the books of their religion, or, on the other hand, would fancy that the laboratory or the microscope could help them to penetrate the mysteries which hang over the nature and the destiny of the soul of man. And the old learning no longer contests the share in education which is claimed by the new, or is blind to the supreme influence which natural knowledge is exercising in moulding the human mind.

A study of the addresses of my learned predecessors in this office shows me that the main duty which it falls to a President to perform in his introductory address, is to remind you of the salient points in the annals of science since last the Association visited the town in which he is speaking. Most of them have been able to lay before you in all its interesting detail the history of the particular science of which each one of them was the eminent representative. If I were to make any such attempt I should only be telling you with very inadequate knowledge a story which is from time to time told you, as well as it can be told, by men who are competent to deal with it. It will be more suitable to my capacity if I devote the few observations I have to make to a survey not of our science but of our ignorance. We live in a small bright oasis of knowledge surrounded on all sides by a vast unexplored region of impenetrable mystery. From age to age the strenuous labour of successive generations wins a small strip from the desert and pushes forward the boundary of knowledge. Of such triumphs we are justly proud. It is a less attractive task—but yet it has its fascination as well as its uses—to turn our eyes to the undiscovered country which still remains to be won, to some of the stupendous problems of natural study which still defy our investigation. Instead, therefore, of recounting to you what has been done, or trying to forecast the discoveries of the future, I would rather draw your attention to the condition in which we stand towards three or four of the most important physical questions which it has been the effort of the last century to solve.

Of the scientific enigmas which still, at the end of the nineteenth century, defy solution, the nature and origin of what are called the elements is the most notable. It is not, perhaps, easy to give a precise logical reason for the feeling that the existence of our sixty five elements is a strange anomaly and conceals some much simpler state of facts. But the conviction is irresistible. We cannot conceive, on any possible doctrine of cosmogony, how these sixty five elements came into existence. A third of them form the substance of this planet. Another third are useful, but somewhat rare. The remaining third are curiosities scattered haphazard, but very scantily, over the globe, with no other apparent function but to provide occupation for the collector and the chemist. Some of them are so like each other that only a chemist can tell them apart: others differ immeasurably from each other in every conceivable particular. In cohesion, in weight, in conductivity, in melting point, in chemical proclivities they vary in every degree. They seem to have as much relation to each other as the pebbles on a sea beach, or the contents of an ancient lumber room. Whether you believe that Creation was the work of design or of inconscient law, it is equally difficult to imagine how this random collection of dissimilar materials came together. Many have been the attempts to solve this enigma; but up till now they have left it more impenetrable than before. A conviction that here was something to discover lay beneath the persistent belief in the possibility of the transmutation of other metals into gold, which brought the alchemy of the Middle Ages into being. When the immortal discovery of Dalton established that the atoms of each of these elements have a special weight of their own, and that consequently they combine in fixed ponderable proportions from which they never depart, it renewed the hope that some common origin of the elements was in sight. The theory was advanced that all these weights were multiples of the weight of hydrogen—in other words, that each elementary atom was only a greater or a smaller number of hydrogen atoms compacted by some strange machinery into one. The most elaborate analyses, conducted by chemists of the highest eminence—conspicuously by the illustrious Stas—were directed to the question whether there was any trace in fact of the theoretic idea that the atoms of each element consist of so many atoms or even of so many half-atoms of hydrogen. But the reply of the laboratories has always been clear and certain—that there is not in the facts the faintest foundation for such a theory.

Then came the discovery of the spectrum analysis, and men thought that with an instrument of such inconceivable delicacy we should at last find out something as to the nature of the atom. The result has been wholly disappointing. Spectrum analysis in the hands of Dr. Huggins and Mr. Lockyer and others has taught us things of which the world little expected to be told. We have been enabled to measure the speed with which clouds of blazing hydrogen course across the surface of the sun; we have learnt the pace—the fabulous pace—at which the most familiar stars have been for ages approaching to or receding from our planet, without apparently affecting the proportions of the patterns which as far as historical record goes back they have always delineated on the evening sky. We have received some information about the elementary atoms themselves. We have learnt that each sort of atom when heated strikes upon the ether a vibration, or set of vibrations, whose rate is all its own; and that no one atom or combination of atoms in producing its own spectrum encroaches even to the extent of a single line upon the spectrum that is peculiar to its neighbour. We have learnt that the elements which exist in the stars and specially in the sun are mainly those with which we are familiar upon earth. There are a few lines in excess to which we can give no terrestrial name; and there are some still more puzzling gaps in our list. It is a great aggravation of the mystery which besets the question of the elements, that among the lines which are absent from the spectrum of the sun, those of nitrogen and oxygen stand first. Oxygen constitutes the largest portion of the solid and liquid substance of our planet, so far as we know it; and nitrogen is very far the predominant constituent of our atmosphere. If the earth is a detached bit whirled off the mass of the sun, as cosmogonists love to tell us, how comes it that in leaving the sun we cleaned him out so completely of his nitrogen and oxygen that not a trace of these gases remains behind to be discovered even by the sensitive vision of the spectroscope?

All these things the discovery of the spectrum analysis has added to our knowledge; but it has left us as ignorant as ever as to the nature of the capricious differences which separate the atoms from each other, or the cause to which those differences are due.

In the last few years the same enigma has been approached from another point of view by Prof. Mendeléeff. The periodic law which he has discovered reflects on him all the honour that can be earned by ingenious, laborious, and successful research. He has shown that this perplexing list of elements can be divided into families of about seven, speaking very roughly: that those families all resemble each other in this, that as to weight, volume, heat, and laws of combination, the members of each family are ranked among themselves in obedience to the same rule. Each family differs from the others; but each internally is constructed upon the same plan. It was a strange discovery—strangest of all in its manifest defects. For in the plan of his families there were blanks left; places not filled up because the properly constituted elements required according to his theory had not been found to fill them. For the moment their absence seemed a weakness in the Professor's idea, and gave an arbitrary aspect to his scheme. But the weakness was turned into strength when, to the astonishment of the scientific world, three of the elements which were missing made their appearance in answer to his call. He had described beforehand the qualities they ought to have; and gallium, germanium, and scandium, when they were discovered shortly after the publication of his theory, were found to be duly clothed with the qualities he required in each. This remarkable confirmation has left Mendeléeff's periodic law in an unassailable position. But it has rather thickened than dissipated the mystery which hangs over the elements. The discovery of these co-ordinate families dimly points to some identical origin, without suggesting the method of their genesis or the nature of their common parentage. If they were organic beings all our difficulties would be solved by muttering the comfortable word "evolution"—one of those indefinite words from time to time vouchsafed to humanity, which have the gift of alleviating so many perplexities and masking so many gaps in our knowledge. But the families of elementary atoms do not breed; and we cannot therefore ascribe their ordered difference to accidental variations perpetuated by heredity under the influence of natural selection. The rarity of iodine, and the abundance of its sister chlorine, cannot be attributed to the survival of the fittest in the struggle for existence. We cannot account for the minute difference which persistently distinguishes nickel from cobalt, by ascribing it to the recent inheritance by one of them of an advantageous variation from the parent stock.

The upshot is that all these successive triumphs of research, Dalton's, Kirchhoff's, Mendeléeff's, greatly as they have added to our store of knowledge, have gone but little way to solve the problem which the elementary atoms have for centuries presented to mankind. What the atom of each element is, whether it is a movement, or a thing, or a vortex, or a point having inertia, whether there is any limit to its divisibility, and, if so, how that limit is imposed, whether the long list of elements is final, or whether any of them have any common origin, all these questions remain surrounded by a darkness as profound as ever. The dream which lured the alchemists to their tedious labours, and which may be said to have called chemistry into being, has assuredly not been realised, but it has not yet been refuted. The boundary of our knowledge in this direction remains where it was many centuries ago.

The next discussion to which I should look in order to find unsolved riddles which have hitherto defied the scrutiny of science, would be the question of what is called the ether. The ether occupies a highly anomalous position in the world of science. It may be described as a half-discovered entity. I dare not use any less pedantic word than entity to designate it, for it would be a great exaggeration of our knowledge if I were to speak of it as a body or even as a substance. When nearly a century ago Young and Fresnel discovered that the motions of an incandescent particle were conveyed to our eyes by undulation, it followed that between our eyes and the particle there must be something to undulate. In order to furnish that something, the notion of the ether was conceived, and for more than two generations the main, if not the only, function of the word ether has been to furnish a nominative case to the verb "to undulate." Lately, our conception of this entity has received a notable extension. One of the most brilliant of the services which Prof. Maxwell has rendered to science has been the discovery that the figure which expressed the velocity of light, also expressed the multiplier required to change the measure of static or passive electricity into that of dynamic or active electricity. The interpretation reasonably affixed to this discovery is that, as light and the electric impulse move approximately at the same rate through space, it is probable that the undulations which convey them are undulations of the same medium. And as induced electricity penetrates through everything, or nearly everything, it follows that the ether through which its undulations are propagated must pervade all space, whether empty or full, whether occupied by opaque matter or transparent matter, or by no matter at all. The attractive experiments by which the late Prof. Hertz illustrated the electric vibrations of the ether will only be alluded to by me, in order that I may express the regret deeply and generally felt that death should have terminated prematurely the scientific career which had begun with such brilliant promise and such fruitful achievements. But the mystery of the ether, though it has been made more fascinating by these discoveries, remains even more inscrutable than before. Of this all-pervading entity we know absolutely nothing except this one fact, that it can be made to undulate. Whether outside the influence of matter on the motion of its waves, ether has any effect on matter or matter upon it, is absolutely unknown. And even its solitary function of undulating ether performs in an abnormal fashion which has caused infinite perplexity. All fluids that we know transmit any blow they have received by waves which undulate backwards and forwards in the path of their own advance. The ether undulates athwart the path of the wave's advance. The genius of Lord Kelvin has recently discovered what he terms a labile state of equilibrium, in which a fluid that is infinite in its extent may exist, and may undulate in this eccentric fashion without outraging the laws of mathematics. I am no mathematician, and I cannot judge whether this reconciliation of the action of the ether with mechanical law is to be looked upon as a permanent solution of the question, or is only what diplomatists call a *modus vivendi*. In any case it leaves our knowledge of the ether in a very rudimentary condition. It has no known qualities except one, and that quality is in the highest degree anomalous and inscrutable. The extended conception which enables us to recognise ethereal waves in the vibrations of electricity has added infinite attraction to the study of those waves, but it carries its own difficulties with it. It is not easy to fit in the theory of electrical ether waves with the phenomena of positive and negative electricity, and as to the true significance and cause of those counteracting and complementary forces, to which we give the provisional names of negative and positive, we know about as much now as Franklin knew a century and a half ago.

I have selected the elementary atoms and the ether as two instances of the obscurity that still hangs over problems which the highest scientific intellects have been investigating for several generations. A more striking but more obvious instance still is Life—animal and vegetable Life—the action of an unknown force on ordinary matter. What is the mysterious impulse which is able to strike across the ordinary laws of matter, and twist them for a moment from their path? Some people demur to the use of the term "vital force" to designate this impulse. In their view the existence of such a force is negatived by the fact that chemists have been able by cunning substitutions to produce artificially the peculiar compounds which in nature are only found in organisms that are or have been living. These compounds are produced by some living organism in the performance of the ordered series of functions proper to its brief career. To counterfeit them—as has been done in numerous cases—does not enable us to do what the vital force alone can effect—to bring the organism itself into existence, and to cause it to run its appointed course of change. This is the unknown force which continues to defy not only our imitation but our scrutiny. Biology has been exceptionally active and successful during the last half-century. Its triumphs have been brilliant, and they have been rich enough not only in immediate result but in the promise of future advance. Yet they give at present no hope of penetrating the great central mystery. The progress which has been made in the study of microscopic life has been very striking, whether or not the results which are at present inferred from it can be taken as conclusive. Infinitesimal bodies found upon the roots of plants have the proud office of capturing and taming for us the free nitrogen of the air, which, if we are to live at all, we must consume and assimilate, and yet which, without the help of our microscopic ally, we could not draw for any useful purpose from the ocean of nitrogen in which we live. Microscopic bodies are convicted of causing many of the worst diseases to which flesh is heir, and the guilt of many more will probably be brought home to them in due time; and they exercise a scarcely less sinister or less potent influence on our race by the plagues with which they destroy some of the most valuable fruits of husbandry, such as the potato, the mulberry, and the vine. Almost all their power resides in the capacity of propagating their kind with infinite rapidity, and up to this time science has been more skilful in describing their ravages than in devising means to hinder them. It would be ungrateful not to mention two brilliant exceptions to this criticism. The antiseptic surgery which we owe chiefly to Lister; and the inoculation against anthrax, hydrophobia, and perhaps some other diseases, which we owe to Pasteur, must be recorded as splendid victories over the countless legions of our infinitesimal foes. Results like these are the great glory of the scientific workers of the past century. Men may, perhaps, have overrated the progress of nineteenth-century research in opening the secrets of nature; but it is difficult to overrate the brilliant service it has rendered in ministering to the comforts and diminishing the sufferings of mankind.

If we are not able to see far into the causes and origin of life in our own day, it is not probable that we shall deal more successfully with the problem as it arose many million years ago. Yet certainly the most conspicuous event in the scientific annals of the last half-century has been the publication of Mr. Darwin's work on the "Origin of Species," which appeared in 1859. In some respects, in the depth of the impression which it made on scientific thought, and even on the general opinion of the world, its momentous effect can hardly be overstated. But at this distance of time it is possible to see that some of its success has been due to adventitious circumstances. It has had the chance of enlisting among its champions some of the most powerful intellects of our time, and perhaps the still happier fortune of appearing at a moment when it furnished an armoury of weapons to men, who were not scientific, for use in the bitter but transitory polemics of the day. But far the largest part of its accidental advantages was to be found in the remarkable character and qualifications of its author. The equity of judgment, the simple-minded love of truth and the patient devotion to the pursuit of it through years of toil and of other conditions the most unpropitious—these things endeared to numbers of men everything that came from Charles Darwin, apart from its scientific merit or literary charm. And whatever final value may be assigned to his doctrine, nothing can ever detract from the lustre shed upon it by the wealth of his knowledge and the infinite ingenuity of his resource. The intrinsic power of his theory is shown at least in this one respect, that in the department of knowledge with which it is concerned it has effected an entire revolution in the methods of research. Before his time the study of living nature had a tendency to be merely statistical; since his time it has become predominantly historical. The consideration how any organic body came to be what it is occupies a far larger area in any inquiry now than the mere description of its actual condition; but this question was not predominant—it may almost be said to have been ignored—in the Botanical and Zoological study of sixty years ago.

Another lasting and unquestioned effect has resulted from Darwin's work. He has, as a matter of fact, disposed of the doctrine of the immutability of species. It has been mainly associated in recent days with the honoured name of Agassiz, but with him has disappeared the last defender of it who could claim the attention of the world. Few now are found to doubt that animals separated by differences far exceeding those that distinguished what we know as species have yet descended from common ancestors. But there is much less agreement as to the extent to which this common descent can be assumed, or the process by which it has come about. Darwin himself believed that all animals were descended from "at most four or five progenitors"—adding that "there was grandeur in the view that life had been originally breathed by the Creator into a few forms or one." Some of his more devoted followers, like Prof. Haeckel, were prepared to go a step farther and to contemplate a crystal as the probable ancestor of the whole fauna and flora of this planet.

To this extent the Darwinian theory has not effected the conquest of scientific opinion; and still less is there any unanimity in the acceptance of natural selection as the sole or even the main agent of whatever modifications may have led up to the existing forms of life. The deepest obscurity still hangs over the origin of the infinite variety of life. Two of the strongest objections to the Darwinian explanation appear still to retain all their force.

I think Lord Kelvin was the first to point out that the amount of time required by the advocates of the theory for working out the process they had imagined could not be conceded without assuming the existence of a totally different set of natural laws from those with which we are acquainted. His view was not only based on profound mechanical reasoning, but it was so plain that any layman could comprehend it. Setting aside arguments deduced from the resistance of the tides, which may be taken to transcend the lay understanding, his argument from the refrigeration of the earth requires little science to apprehend it. Everybody knows that hot things cool, and that according to their substance they take more or less time in cooling. It is evident from the increase of heat as we descend into the earth, that the earth is cooling, and we know by experiment, within certain wide limits, the rate at which its substances, the matters of which it is constituted, are found to cool. It follows that we can approximately calculate how hot it was so many million years ago. But if at any time it was hotter at the surface by 50° F. than it is now, life would then have been impossible upon the planet, and therefore we can without much difficulty fix a date before which organic life on earth cannot have existed. Basing himself on these considerations Lord Kelvin limited the period of organic life upon the earth to a hundred million years, and Prof. Tait in a still more penurious spirit cut that hundred down to ten. But on the other side of the account stand the claims of the geologists and biologists. They have revelled in the prodigality of the ciphers which they put at the end of the earth's hypothetical life. Long cribbed and cabined within the narrow bounds of the popular chronology, they have exulted wantonly in their new freedom. They have lavished their millions of years with the open hand of a prodigal heir indemnifying himself by present extravagance for the enforced self-denial of his youth. But it cannot be gainsaid that their theories require at least all this elbow-room. If we think of that vast distance over which Darwin conducts us from the jelly-fish lying on the primeval beach to man as we know him now; if we reflect that the prodigious change requisite to transform one into the other is made up of a chain of generations, each advancing by a minute variation from the form of its predecessor, and if we further reflect that these successive changes are so minute that in the course of our historical period—say three thousand years—this progressive variation has not advanced by a single step perceptible to our eyes, in respect to man or the animals and plants with which man is familiar, we shall admit that for a chain of change so vast, of which the smallest link is longer than our recorded history, the biologists are making no extravagant claim when they demand at least many hundred million years for the accomplishment of the stupendous process. Of course, if the mathematicians are right, the biologists cannot have what they demand. If, for the purposes of their theory, organic life must have existed on the globe more than a hundred million years ago, it must, under the temperature then prevailing, have existed in a state of vapour. The jelly-fish would have been dissipated in steam long before he had had a chance of displaying the advantageous variation which was to make him the ancestor of the human race. I see, in the eloquent discourse of one of my most recent and most distinguished predecessors in this chair, Sir Archibald Geikie, that the controversy is still alive. The mathematicians sturdily adhere to their figures, and the biologists are quite sure the mathematicians must have made a mistake. I will not get myself into the line of fire by intervening in such a controversy. But until it is adjusted the laity may be excused for returning a verdict of "not proven" upon the wider issues the Darwinian school has raised.

The other objection is best stated in the words of an illustrious disciple of Darwin, who has recently honoured this city by his presence—I refer to Prof. Weismann. But in referring to him, I cannot but give, in passing, a feeble expression to the universal sorrow with which in this place the news was received that Weismann's distinguished antagonist, Prof. Romanes, had been taken from us in the outset and full promise of a splendid scientific career.

The gravest objection to the doctrine of natural selection was expressed by Weismann in a paper published a few months ago, not as agreeing to the objection, but as resisting it; and therefore his language may be taken as an impartial statement of the difficulty. "We accept natural selection," he says, "not because we are able to demonstrate the process in detail, not even because we can with more or less ease imagine it, but simply because we must—because it is the only possible explanation that we can conceive. We must assume natural selection to be the principle of the explanation of the metamorphoses, because all other apparent principles of explanation fail us, and it is inconceivable that there could yet be another capable of explaining the adaptation of organisms without assuming the help of a principle of design."

There is the difficulty. We cannot demonstrate the process of natural selection in detail; we cannot even, with more or less ease, imagine it. It is purely hypothetical. No man, so far as we know, has ever seen it at work. An accidental variation may have been perpetuated by inheritance, and in the struggle for existence the bearer of it may have replaced, by virtue of the survival of the fittest, his less improved competitors; but as far as we know no man or succession of men have ever observed the whole process in any single case, and certainly no man has recorded the observation. Variation by *artificial* selection, of course, we know very well; but the intervention of the cattle breeder and the pigeon fancier is the essence of artificial selection. It is effected by their action in crossing, by their skill in bringing the right mates together to produce the progeniture they want. But in natural selection who is to supply the breeder's place? Unless the crossing is properly arranged, the new breed will never come into being. What is to secure that the two individuals of opposite sexes in the primeval forest, who have been both accidentally blessed with the same advantageous variation, shall meet, and transmit by inheritance that variation to their successors? Unless this step is made good, the modification will never get a start; and yet there is nothing to insure that step, except pure chance. The law of chances takes the place of the cattle breeder and the pigeon fancier. The biologists do well to ask for an immeasurable expanse of time, if the occasional meetings of advantageously varied couples from age to age are to provide the pedigree of modifications which unite us to our ancestor the jelly-fish. Of course the struggle for existence, and the survival of the fittest, would in the long run secure the predominance of the stronger breed over the weaker. But it would be of no use in setting the improved breed going. There would not be time. No possible variation which is known to our experience, in the short time that elapses in a single life between the moment of maturity and the age of reproduction, could enable the varied individual to clear the field of all competitors, either by slaughtering or starving them out. But unless the struggle for existence took this summary and internecine character, there would be nothing but mere chance to secure that the advantageously varied bridegroom at one end of the wood should meet the bride, who by a happy contingency had been advantageously varied in the same direction at the same time at the other end of the wood. It would be a mere chance if they ever knew of each other's existence—a still more unlikely chance that they should resist on both sides all temptations to a less advantageous alliance. But unless they did so, the new breed would never even begin, let alone the question of its perpetuation after it had begun. I think Prof. Weismann is justified in saying that we cannot, either with more or less ease, imagine the process of natural selection.

It seems strange that a philosopher of Prof. Weismann's penetration should accept as established a hypothetical process the truth of which he admits that he cannot demonstrate in detail, and the operation of which he cannot even imagine. The reason that he gives seems to me instructive of the great danger scientific research is running at the present time—the acceptance of mere conjecture in the name and place of knowledge, in preference to making frankly the admission that no certain knowledge can be attained. "We accept natural selection," he says, "because we must—because it is the only possible explanation that we can conceive." As a politician, I know that argument very well. In political controversy it is sometimes said of a disputed proposal that it "holds the field," that it must be accepted because no possible alternative has been suggested. In politics there is occasionally a certain validity in the argument, for it sometimes happens that some definite course must be taken, even though no course is free from objection. But such a line of reasoning is utterly out of place in science. We are under no obligation to find a theory, if the facts will not provide a sound one. To the riddles which nature propounds to us the profession of ignorance must constantly be our only reasonable answer. The cloud of impenetrable mystery hangs over the development and still more over the origin of life. If we strain our eyes to pierce it, with the foregone conclusion that some solution is and must be attainable, we shall only mistake for discoveries the figments of our own imagination. Prof. Weismann adds another reason for his belief in natural selection, which is certainly characteristic of the time in which we live. "It is inconceivable," he says, "that there should be another principle capable of explaining the adaptation of organisms without assuming the help of a principle of design." The whirligig of time assuredly brings its revenges. Time was, not very long ago, when the belief in creative design was supreme. Even those who were sapping its authority were wont to pay it a formal homage, fearing to shock the public conscience by denying it. Now the revolution is so complete that a great philosopher uses it as a *reductio ad absurdum*, and prefers to believe that which can neither be demonstrated in detail, nor imagined, rather than run the slightest risk of such a heresy.

I quite accept the Professor's dictum that if natural selection is rejected we have no resource but to fall back on the mediate or immediate agency of a principle of design. In Oxford, at least, he will not find that argument is conclusive, nor, I believe, among scientific men in this country generally, however imposing the names of some whom he may claim for that belief. I would rather lean to the conviction that the multiplying difficulties of the mechanical theory are weakening the influence it once had acquired. I prefer to shelter myself in this matter behind the judgment of the greatest living master of natural science among us, Lord Kelvin, and to quote as my own concluding words the striking language with which he closed his address from this chair more than twenty years ago: "I have always felt," he said, "that the hypothesis of natural selection does not contain the true theory of evolution, if evolution there has been in biology. . . . I feel profoundly convinced that the argument of design has been greatly too much lost sight of in recent zoological speculations. Overpoweringly strong proofs of intelligent and benevolent design lie around us, and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us through nature the influence of a free will, and teaching us that all living things depend on one everlasting Creator and Ruler."

SECTION A.

MATHEMATICS AND PHYSICS.

Opening Address by Prof. A. W. Rücker, M.A., F.R.S., President of the Section.

It is impossible for a body of English scientific men to meet in one of our ancient university towns without contrasting the old ideal of the pursuit of learning for its own sake with the modern conception of the organisation of science as part of a pushing business concern.

We are, as a nation, convinced that education is essential to national success. Our modern universities are within earshot of the whirr of the cotton-mill or the roar of Piccadilly. Oxford and Cambridge themselves are not content to be centres of attraction to which scholars gravitate. They have devised schemes by which their influence is directly exerted on every market-town and almost on every village in the country. University extension is but a part of the extraordinary multiplication of the machinery of education which is going on all around us. The British Association, which was once regarded as bringing light into dark places, is now welcomed in every large provincial town by a group of well-known men of science; and we find ready for the meetings of our Sections, not only the chapels and concert-rooms which have so often and so kindly been placed at our disposal, but all the appliances of well-designed lecture-rooms and laboratories.

I do not propose, however, to detain you this morning with a discourse on the spread of scientific education, but you will forgive me if I illustrate its progress by two facts, not perhaps the most striking which could be selected, but especially appropriate to our place of meeting. It is little more than thirty years since the two branches of science with which our Section deals, Mathematics and Physics, have been generally recognised as wide enough to require more than one teacher to cope with them in an educational institution of high pretensions and achievement. In 1860 the authorities of the Owens College, Manchester, debated whether it was desirable to create a Professorship of Natural Philosophy in addition to, and independent of, the Chair of Mathematics. It was thought necessary to obtain external support for the opinions of those who advocated this step. An appeal was made to Profs. De Morgan and Stokes. The former reported that a "course of experimental physics is in itself desirable"; the latter, that "there would be work enough in a large institution for a mathematician and a physicist."

In the end the Chair of Natural Philosophy was established, and the fact that our host of to-day, Prof. Clifton, was its first occupant reminds us how little we have advanced in time and how far in educational development from the days when propositions such as those I have cited were only accepted on the authority of the names of Stokes and De Morgan.

The other fact to which I would refer is that the Clarendon Laboratory, in which the meetings of Section A are to be held, though erected barely a quarter of a century ago, was the first laboratory in this country which was specially built and designed for the study of experimental physics. It has served as a type. Clerk Maxwell visited it while planning the Cavendish Laboratory, and traces of Prof. Clifton's designs can be detected in several of our university colleges.

But though our surroundings remind us of the improvement which has been effected in the equipment of our science, it would not be difficult to indicate weak points which should forthwith be strengthened. On these, in so far as they affect education, I will not dwell—and that for two reasons. In the first place, we meet to-day not as teachers, but as students; and, secondly, I think that whereas we have as a nation awoke—though late in the day—to the importance of education, we are not yet fully awake to the importance of learning. Our attitude in such matters was exactly expressed by one of the most eminent of the witnesses who gave evidence before the "Gresham Commission." In his opinion the advancement of knowledge must in a university in London be secondary to the higher instruction of the youth of London. If this be so—and I will not now dispute it—we shall surely all agree that somewhere or other, in London or out of it, included in our universities or separate from them, there ought to be institutions in which the advancement of knowledge is regarded as of primary and fundamental interest, and not as a mere secondary by-product thrown off in the course of more important operations.

It is not essential that in such an institution research should be the only task. Investigation may be combined with the routine work of an observatory, with teaching, with the care of standards, or with other similar duties. It is, however, essential that, if the advancement of knowledge is seriously regarded as an end worth attaining, it should not be relegated to a secondary place.

Time and opportunity must be found for investigation, as time and opportunity are found for other tasks. It is not enough to refer to research in a prospectus and then to leave it to be accomplished at odd times and in spare moments not claimed by more urgent demands. Those to whom the future of the higher learning in England is dear must plan and scheme to promote the life-long studies of men, as in the last quarter of a century they have struggled, with marked success, to promote the preparatory studies of boys and girls. That the assignment of a secondary position to research is the more popular view, and that the necessity for encouraging it has as yet hardly been grasped by many of those who control our modern educational movements is, I fear, too true. It is therefore a matter for congratulation that within the last year Oxford has established a research degree, and has thus taken an important step towards gathering within her fold workers of mature years who are able and willing, not merely to gain knowledge, but to add to it.

We may also note, with pleasure and gratitude, that the stream of private munificence has recently been in part directed to the advancement of learning. Sir Henry Thompson has generously offered a sum of £5000 to provide a large photographic telescope for the National Observatory at Greenwich. The new instrument is to be of 26 inches aperture and 22 feet 6 inches focal length, or exactly double the linear dimensions of that which has been previously employed. Mr. Ludwig Mond, too, has added to his noble gifts to science by the new research laboratories which he is about to establish in connection with the Royal Institution. Albemarle Street is thronged with memories of great discoveries. The researches of Lord Rayleigh and the remarkable results of Prof. Dewar's studies of matter at low temperatures are maintaining the great reputation which the Royal Institution has gained in the past, and all English physicists will rejoice that prospects of new and extended usefulness are opening before it.

Another hopeful, though very embarrassing fact is that the growth in the number of scientific workers makes it increasingly difficult to find the funds which are necessary for the publication of their work. Up to the present the author of a paper has had to submit it to criticism, but, when it has been approved by competent judges, it has been published without ado and without expense to himself. This is as it should be. It is right that due care should be exercised to prune away all unnecessary matter, to reduce as far as may be the necessary cost. It will, however, be a great misfortune if judgment as to what curtailment is necessary is in future passed, not with the object of removing what is really superfluous, but in obedience to the iron rule of poverty. Apart from all other disadvantages, such a course would add to the barriers which are dividing the students of different sciences. A few lines and a rough diagram may suffice to show to experts what has been attempted and what achieved, but there is no paper so difficult to master as that which assumes that the reader starts from the point of vantage which months or years of study have enabled the author to attain. Undue pruning will not make the tree of knowledge more fruitful, and will certainly make it harder to climb.

Connected also with the vast increase of scientific literature is a growing necessity for the publication of volumes of abstracts, in which the main results of recent investigations are presented in a concentrated form. English chemists have long been supplied with these by the Chemical Society. The Physical Society, though far less wealthy than its elder sister, has determined to undertake a similar task. We are compelled to begin cautiously, but in January next the first number of a monthly pamphlet will be issued containing abstracts of all the papers which appear in the principal foreign journals of Physics. In this venture the Society will incur grave responsibilities, and I avail myself of this opportunity to appeal to all British physicists to support us in a work, the scope of which will be rapidly extended if our first efforts succeed.

From this brief glance at what has been or is about to be done to promote the study of Physics, I must now turn to the discussion of narrower but more definite problems, and I presume that I shall be most likely to deserve your attention if I select a subject in which I am myself especially interested.

During the last ten years my friend Dr. Thorpe and I have been engaged upon a minute magnetic survey of the United Kingdom. The main conclusions at which we have arrived are about to be published, and I do not propose to recount them now. It is, however, impossible to give so long a time to a single research without having one's attention drawn to a number of points which require further investigation, and I shall perhaps be making the best use of this opportunity if I bring to your notice some matters in the practical and theoretical study of terrestrial magnetism which deserve a fuller consideration than has yet been given to them.

In the first place, then, there is little doubt that the instruments at present used for measuring Declination and Horizontal Force are affected with errors far greater than the error of observation.

We employed four magnetometers by Elliott Brothers, which were frequently compared with the standard instrument at Kew. These measurements proved that the instrumental differences which affect the accuracy of the declination and horizontal force measurements are from five to ten times as great as the error of a single field observation. The dip circle which two generations ago was so untrustworthy is, in our experience, the most satisfactory of the absolute instruments.

In most cases these comparisons extended over several days, but the Astronomer Royal has described in his recent report observations made at Greenwich for two years and a half with two horizontal force instruments. These differ between themselves, and the discrepancy is of the same order of magnitude as those we have detected.

If such differences exist between instruments of the Kew pattern, it is probable that they will be still greater when the magnetometers under investigation are of different types.

This point has been investigated by Dr. Van Rijckevorsel, who five years ago visited Kew, Parc St. Maur, Wilhelmshaven, and Utrecht, and, using his own instruments at each place, compared the values of the magnetic elements determined by himself with those deduced from the self-registering apparatus of the observatory.

The discrepancies between the so-called standards, which were thus brought to light, were quite startling, and prove the necessity for an investigation as to their causes.

Magneticians had long been aware that the instruments used by travellers should be compared at the beginning and end of a journey with those at some fixed observatory, to make sure that the comparatively rough usage to which they are subjected has not affected their indications. But Dr. Van Rijckevorsel's expedition first drew general attention to the fact that there are serious differences between the standard observatory instruments themselves.

The importance of a careful comparison between them was at once recognised. The Magnetic Sub-Committee of the International Meteorological Conference, held at Munich in the autumn of 1891, resolved that it is "necessary that the instruments employed for absolute measurements at the different observatories should be compared with each other and the results published." As far as I am aware nothing has been done to give effect to this resolution, but the necessity for such an international comparison is urgent. The last few years have been a period of unexampled activity in the conduct of local magnetic surveys. To cite instances from the north-west of Europe only, observations have recently been made on a more or less extended scale in the United Kingdom, France, Holland, North Germany, and Denmark.

It will be absurd if these surveys cannot be collated and welded into a homogeneous whole, because we are in doubt whether the indications of our standard instruments for the measurement of declination and dip differ by five or six minutes of arc.

If, however, an official international comparison of the magnetic standards in use in different countries is instituted it is probable that only one observatory in each country will take part in it.

It may fairly be left to each nation to determine for itself the relations between the results of measurements made in its own institutions. Apart, therefore, from all other reasons, we in England would only be able to make the best use of an international comparison if we had beforehand set our own house in order, and were able at once to extend the results of experiments made at Kew or Greenwich to Stonyhurst, Valentia, and Falmouth.

This we are not at the present moment in a position to do. As far as I know nobody has ever carried a magnetometer backwards and forwards between Kew and Greenwich to test the concordance of the published results. During the recent survey single or double sets of observations have been made at Stonyhurst, Falmouth, and Valentia, with instruments which have been compared with Kew, but these measurements, though amply sufficient for the purposes of our research, were not numerous enough to serve as a firm basis for determining the discrepancies between the various standards, so that the exact relations between these important sets of apparatus are still unknown.

The first point, therefore, to which I wish to draw the attention of the Section is the necessity for a full primary comparison between the standard magnetic instruments in use at our different observatories.

But, if this were satisfactorily accomplished, the question would arise as to whether it should be repeated at regular intervals. We have at present only a presumption in favour of the view that the standards which we know are discordant are nevertheless constant. A single instance may suffice to show how necessary it may be—at all events in the case of outlying and isolated observatories—to put this belief to the test.

In the most recent account of the work of the observatory of the Bombay Government at Colába, the dips are discussed for the period of twenty years between 1872 and 1892. During this interval the adjustment of the agate plates upon which the dip needle rolls has thrice been modified. In 1877 the plates were renewed. In 1881 and 1887 the dip circle was taken to pieces and rebuilt. In the intervals the dip as determined by several needles, but always with this circle, remained approximately constant, but after each overhauling it suddenly altered, increasing by 12′ on the first occasion, by 23′ on the second, and by 20′ on the third. Mr. Chambers states that he "can give no satisfactory account of this behaviour of the instrument," but suggests that "the needle gradually hollows out a depression in the agate plates on which it rolls, and that this characteristic of the dip circle" has not before been discovered owing to the reluctance of magnetic observers to interfere with the adjustments of instruments which are apparently working well.

I do not think that this explanation will suffice. Dr. Thorpe and I employed a new dip circle in the earliest part of our survey work, which has remained in accord with Kew for ten years. During that time the dip has been measured some 700 times with it. This corresponds, I believe, to more than the amount of work done with the circle at Colába in six years, which in turn is longer than some of the intervals in which the Colába instruments gave results erroneous to the extent of 20′. I feel, therefore, quite sure that the difficulties which have been experienced at Bombay are not due to any "characteristic [defect] of the dip circle." But, whatever the cause may have been, surely the lesson is that, if such things can happen in so well-known an institution, it is desirable that we should take the moderate pains required to assure ourselves whether smaller —but, possibly, not unimportant—errors are gradually affecting the results at any of our observatories.

This brings me to my next point, namely, that if we are to draw conclusions from the minor differences between measurements of secular or diurnal change made in the observatories, it is not only necessary that we should know whether the instruments are strictly comparable and constant, but the observations must be reduced by precisely the same methods.

In 1886 the late Mr. Whipple drew the attention of the British Association to the fact that there was a systematic difference between the diurnal ranges of declination at Greenwich and Kew. His results were based on the three years 1870–72. In 1890 two of my students, Messrs. Robson and S. W. J. Smith, extended the comparison to three more recent years (1883–6–7), and obtained results in complete accord with those of Mr. Whipple.

It is well known that the average daily oscillation of the magnet is affected by the magnetic weather. Sabine showed that magnetic storms do not merely buffet the needle now in this direction and now in that—they affect its average behaviour, so that the mean swing east and west is different according as we deduce it only from days of magnetic calm or include those of storm.

Mr. Whipple reduced the Kew observations by two methods,[1] one of which depended on the calmest days only, while the other included those which were moderately disturbed. Neither agreed exactly with the method in use at Greenwich, but the difference between the results deduced from them was so small when compared with the difference between either and that obtained at Greenwich, that it seemed possible that the diurnal variations, even at these closely neighbouring places, might differ appreciably. The question whether this is so has now been answered. In 1890, at the resquest of the Kew Committee, the Astronomer Royal undertook to select early in each year five quiet days in each of the preceding twelve months. It was also agreed that, whether they adopted other methods or not, the chief English magnetic observatories should determine the diurnal variations from these days alone. The Greenwich[2] and Kew observations for 1890 have therefore been worked up in exactly the same way, with the result that the discrepancy, which had persisted for twenty years, has entirely disappeared, and that the two diurnal ranges at the two observatories are in as close accord as could be expected.

If, therefore, we may judge from a single year, the cause of the difference lay in the choice of days. Greenwich will in future give us two diurnal variations, one obtained from the most quiet days only, the other from all days except those of violent storm, and in these we shall have most valuable data for studying the mean effect of disturbances on the diurnal variation.

To this satisfactory conclusion I have only one suggestion to add. The Astronomer Royal and M. Mascart now publish for the same stormy days the photographic traces by which the history of a magnetic storm is mapped. Is it possible for Greenwich and Paris also to agree in their choice of calm days for the calculation of the diurnal variation, so that a precise similarity of method may obtain not only between the English observatories, but between England and France?

The importance of co-operation between institutions engaged on the same tasks having been illustrated, I am glad to be able to announce that another step is about to be taken in the same direction. For some years, in spite, I believe, of great financial difficulties, the Cornwall Royal Polytechnic Society has maintained a magnetic observatory at Falmouth. The results of the observations have hitherto been printed in the Journal of

[1] Sabine's and Wild's.

[2] The Greenwich observations for subsequent years have not yet been published.

the Society only, but the Royal Society has now consented to publish them in the *Proceedings*. Before long, therefore, the Kew and Falmouth records, which are already worked up in the same way, will be given to the world side by side. Is it too much to hope that this may be the first step towards the production of a British Magnetic Year Book, in which observations whose chief interest lies in their comparison, may be so published as to be easily compared?

We owe to private enterprise another advance of the same kind. The managers of the new journal *Science Progress* have made arrangements with the Kew Committee for the yearly publication of a table showing the mean annual values of the magnetic elements as determined at the various magnetic observatories of the world. It will therefore in future be possible to get a general idea of the rate of secular change in different localities without searching through a number of reports in different languages, which can only be consulted in the rooms of the few societies or institutions to which they are annually sent. The present state of our knowledge of the secular change in the magnetic elements affords indeed very strong support to the arguments I have already adduced in favour of a comparison between the instruments of our magnetic observatories.

The whole question of the cause of this phenomenon has entered on a new stage. It has long been recognised that the earth is not a simple magnet, but that there are in each hemisphere one pole or point at which the dip needle is vertical, and two foci of maximum intensity. A comparison of earlier with later magnetic observations led to the conclusion that one or both of the foci in each hemisphere is in motion, and that to this motion—however caused—the secular change in the values of the magnetic element is due. Thus the late Prof. Balfour Stewart, writing in 1883, says, "While there is no well-established evidence to show that either the pole of verticity or the centre of force to the North of America has perceptibly changed its place, there is on the other hand very strong evidence to show that we have a change of place on the part of the Siberian focus."[1] The facts in favour of this conclusion are there discussed. The arguments are based, not on the results of any actual observations near to the focus in question, but on the behaviour of the magnet at points far distant from it in Europe and Asia. The westerly march of the declination needle, which lasted in England up to 1818, and the easterly movement which has since replaced it, are connected with a supposed easterly motion of the Siberian focus, which, it is added, "there is some reason to believe . . . . has recently been reversed." In opposition, therefore, to the idea of the rotation of a magnetic focus round the geographical poles which the earlier magneticians adopted, Stewart seems to have regarded the motion of the Siberian focus as oscillatory.

A very different aspect is put upon the matter by a comparison of the magnetic maps of the world prepared by Sabine and Creak for the epochs 1840 and 1880 respectively. Captain Creak, having undertaken to report on the magnetic observations made during the voyage of the *Challenger*, supplemented them with the unrivalled wealth of recorded facts at the disposal of the Hydrographic Department of the Admiralty. He was thus able, by a comparison with Sabine's map, to trace the general course of the secular changes all over the world for forty years. The negative results may be shortly stated. There is no evidence of any motion either of magnetic pole or focus. The positive conclusions are still more curious. There are certain lines on the surface of the earth towards which in the interval under consideration the north pole of the needle was attracted. From each side the compass veered or backed towards them. Above them the north pole of dip needle moved steadily down.

There are other lines from which, as tested by compass and dip circle, a north pole was in like manner repelled. The two principal points of increasing attraction are in China and near Cape Horn; the chief points of growing repulsion are in the North of Canada and the Gulf of Guinea.

I am sure that my friend Captain Creak would be the first to urge that we should not generalise too hastily from this mode of presenting the facts, but there can be no doubt that they cannot be explained by any simple theory of a rotating or oscillating pair of poles. *Prima facie* they suggest that the secular change is due not so much to changes at the principal magnetic points, as to the waxing and waning of the forces apparently exerted by secondary lines or points of attraction or repulsion.

All down the west coast of America, close—be it noted—to one of the great lines of volcanic activity, north hemisphere magnetism has since 1840 been growing in relative importance. Near Cape Horn a weak embryonic pole is developing of the same kind as the well-known pole at the other end of the continent near Hudson's Bay. Along a line which joins Newfoundland to the Cape of Good Hope, precisely the reverse effects have been experienced; while in the Gulf of Guinea a south hemisphere pole is growing within the tropics. Of course I do not suggest that these secondary systems can ever determine the principal phenomena of terrestrial magnetism, or reverse the magnetic states of the hemispheres in which they occur. These are no doubt fixed by the rotation of the earth. I do, however, wish to emphasise the fact that they show that either secular change is due to the conjoint action of local causes, or that if some single agent such as a current system within the earth, or a change of magnetic conditions outside it, be the primary cause, the effects of this cause are modified and complicated by local peculiarities.

Mr. Henry Wilde has succeeded in representing with approximate accuracy the secular change at many points on the surface of the earth by placing two systems of currents within a globe, and imparting to the axis of one of them a motion of rotation about the polar axis of the earth. But he has had to supplement this comparatively simple arrangement by local features. He has coated the seas with thin sheet iron. The ratio between the two currents which serves to depict the secular change near the meridian of Greenwich fails in the West Indies. Thus this ingenious attempt to imitate the secular change by a simple rotation of the magnetic pole supports the view that local peculiarities play a powerful part in modifying the action of a simple first cause, if such exist. I need hardly say that I think the proper attitude of mind on this difficult subject is that of suspended judgment, but there is no doubt that recent investigation has, at all events, definitely raised the question how far secular change is either due to, or modified by, special magnetic features of different parts of the earth.

It is possible that light may be thrown upon this point by observations on a smaller scale. Assuming for the moment that the difference in the secular changes on opposite sides of the Atlantic is due to a difference of local causes, it is conceivable that similar causes, though less powerful and acting through smaller ranges, might produce similar though less obvious differences between places only a few miles apart. For testing this Greenwich and Kew are in many respects most favourably situated. Nowhere else are two first-class observatories so near together. Differences in the methods of publishing the results have made it somewhat difficult to compare them, but the late Mr. Whipple furnished me with figures for several years which made comparison easy. Without entering into details it may be sufficient to say that the declination needles at the two places do not from year to year run parallel courses. Between 1880–82 Kew outstripped its rival, between 1885 and 1889 it lost, so that the gain was rather more than compensated. The difference of the declination of the two places appears to increase and diminish through a range of five minutes of arc.

This evidence can be supplemented by other equally significant examples. No fact connected with terrestrial magnetism is more certain than that at present the rate of secular change of declination in this part of Europe increases as we go north. This is shown by a comparison of our survey with those of our predecessors fifty and thirty years ago, by M. Moureaux's results in France, and by Captain Creak's collation of previous observations. Yet, in spite of this, Stonyhurst, which is some 200 miles north of Greenwich and Kew, and should therefore outrun them, sometimes lags behind and then makes up for lost time by prodigious bounds. Between 1882 and 1886 the total secular change of declination at Stonyhurst was about 3'·5 less than that at Greenwich and Kew, whereas in the two years 1890–1892 it reached at Stonyhurst the enormous amount of 28', just doubling the corresponding alteration registered in the same time at Kew. If these fluctuations are caused by the instruments or methods of reduction, my argument in favour of frequent comparisons and uniform treatment would be much strengthened, but, apart from the inherent improbability of such large differences being due to the methods of observation,

[1] *Encyclopædia Britannica*, 9th edition. Art. "Meteorology—Terrestrial Magnetism."

the probability of their physical reality is increased by the work of the magnetic survey.

The large number of observations at our disposal has enabled us to calculate the secular change in a new way, by taking the means of observations made about five years apart at numerous though not identical stations scattered over districts about 150 miles square. The result thus obtained should be free from mere local variations, but as calculated for the south-east of England for the five years 1886-91 it differs by nearly 5 from the change actually observed at Kew.

We have also determined the secular change at twenty-five stations by double sets of observations made as nearly as possible on the same spot at intervals of several years. The results must be interpreted with caution. In districts such as Scotland, where strong local disturbances are frequent, a change of a few yards in the position of the observer might introduce errors far larger than the fluctuations of secular change. But when all such changes are eliminated, when all allowance is made for the possible inaccuracy of field observations, there are outstanding variations which can hardly be due to anything but a real difference in the rate of change of the magnetic elements.

A single example will suffice. St. Leonards and Tunbridge Wells are about thirty miles apart. Both are situated on the Hastings Sand formation, and on good non-magnetic observing ground. At them, as at the stations immediately around them —Lewes, Eastbourne, Appledore, Etchingham, Heathfield, and Maidstone—the local disturbing forces are very small. All these places lie within a district about forty miles square, at no point of which has the magnet been found to deviate by 5′ from the true magnetic meridian. No region could be more favourably situated for the determination of the secular change, yet according to our observations the alteration in the declination at St. Leonards in six years was practically equal to that at Tunbridge Wells in five. It is difficult to assign so great a variation to an accumulation of errors, and this is only one amongst several instances of the same kind which might be quoted.

We find, then, when we consider the earth as a whole, grave reason to question the old idea of a secular change caused by a magnetic pole or focus pursuing an orderly orbit around the geographical axis of the earth, or oscillating in some regular period in its neighbourhood. It would, of course, be absurd to admit the possibility of change in the tropics and to deny that possibility in the arctic circle, but the new facts lead us to look upon the earth not as magnetically inert, but as itself—at the equator as well as at the pole—producing or profoundly modifying the influences which give rise to secular change. And then, when we push our inquiry further, accumulating experience tells the same tale. The earth seems as it were alive with magnetic forces, be they due to electric currents or to variations in the state of magnetised matter. We need not now consider the sudden jerks which disturb the diurnal sweep of the magnet, which are simultaneous at places far apart, and probably originate in causes outside our globe. But the slower secular change, of which the small part that has been observed has taken centuries to accomplish, is apparently also interfered with by some slower agency the action of which is confined within narrow limits of space. Between Kew, Greenwich, and Stonyhurst, between St. Leonards and Tunbridge Wells, and I may add between Mablethorpe and Lincoln, Enniskillen and Sligo, Charleville and Bantry, the measured differences of secular variation are so large as to suggest that we are dealing not with an unruffled tide of change, which, unaltered by its passage over continent or ocean, sweeps slowly round the earth, but with a current fed by local springs or impeded by local obstacles, furrowed on the surface by billows and eddies, from which the magnetician, if he will but study them, may learn much as to the position and meaning of the deeps and the shallows below. But if this is the view which the facts I have quoted suggest, much remains to be done before it can be finally accepted; and in the first place—to come back to the point from which I started—we want, for some years at all events, a systematic and repeated comparison of the standard instruments in use at the different observatories. That they are not in accord is certain; whether the relations between them are constant or variable is doubtful. If constant, the suggestions I have outlined are probably correct; if variable, then the whole or part of the apparent fluctuations of secular change may be nothing more than the irregular shiftings of inconstant standards.

I cannot myself believe that this is the true explanation, but in any case it is important that the doubt should be set at rest, and that if the apparent fluctuations of secular change are not merely instrumental, the inquiry as to their cause should be undertaken in good earnest.

The question is interesting from another point of view. It is now fully established that even where the surface soil is non-magnetic, and even where geologists have every reason to believe that it lies upon non-magnetic strata of great thickness, there are clearly-defined lines and centres towards which the north-seeking pole of a magnet is attracted, or from which it is repelled. To the magnetic surveyor fluctuations in secular change would appear as variations in the positions of these lines, or as changes in the forces in play in their neighbourhood.

Greenwich and Kew are both under the influence of a widespread local disturbance which culminates near Reading. At both places the needle is deviated to the west of the normal magnetic meridian, and if the westerly declination diminishes sometimes faster and sometimes more slowly at one observatory than at the other, this must be, or, at all events, would in the first instance appear to be, due to local changes in the regional disturbing forces. The questions of the nature of the irregularities of secular change and of the causes of local disturbances are therefore intermingled; and information gained on these points may in turn be useful in solving the more difficult problem of world-wide secular variations.

Two causes of regional and local disturbances have been suggested, viz. earth currents, and the presence of visible or concealed magnetic rocks. The two theories are not mutually exclusive. Both causes of the observed effects may, and probably do, coexist. I have, however, elsewhere explained my reasons for believing that the presence of magnetic matter, magnetised by induction in the earth's field, is the principal cause of the existence of the magnetic ridge-lines and foci of attraction which for so many years we have been carefully tracing. I will only now mention what appears to me to be the final and conclusive argument, which, since it was first enunciated, has been strengthened by the results of our more recent work. We find that every great mass of basic rock, by which the needle is affected at considerable distances, attracts the north-seeking pole. Captain Creak some years ago showed that the same statement is true of those islands in the northern hemisphere which disturb the lines of equal declination, while islands in the southern hemisphere repel the north pole and attract the south. In other words, these disturbances are immediately explained if we suppose that they are due to magnetic matter magnetised by induction. The theory of earth currents would, on the other hand, require that round the masses of visible basalt, and round the island investigated by Captain Creak, currents, or eddies in currents, should circulate in directions which are always the same in the same hemisphere, and always opposed on opposite sides of the equator. For this supposition no satisfactory explanation is forthcoming, and, therefore, with all reserve and a full consciousness that in such matters hypothesis differs but little from speculation, it appears to me that the theory that induced magnetism is the main cause of the disturbance has the greater weight of evidence in its favour.

If this be granted, it is evident that the positions of the main lines and centres of attraction would be approximately constant, and, so far as it is possible to form an opinion, these conditions seem to be satisfied. There has certainly been no noticeable change in the chief loci of attraction in the five years which have elapsed between the epochs of our two surveys. Mr. Welsh's observations made in Scotland in 1857-8 fit in well with our own. Such evidence is not, however, inconsistent with minor changes, and it is certain that as the directions and magnitude of the inducing forces alter, the disturbing induced forces must alter also. But this change would be slow, and as the horizontal force is in these latitudes comparatively weak, the change in the disturbing forces would also be small, unless the vertical force altered greatly. It is at all events impossible to attribute to this cause oscillations which occupy at most eight or ten years. It is possible to suggest other changes in the state of the concealed magnetic matter—alterations of pressure, temperature, and the like—to which the oscillations of secular change might be due, but probably there will be a general consensus of opinion that if the slowly changing terms in the disturbance function are due to magnetic matter, the more rapid fluctuations of a few years' period are more likely to be connected with earth currents. It becomes, therefore, a matter of interest to disentangle the two constituents of local disturbances; and there is one question to which I think an answer might be obtained without a greater expenditure than the importance of the investigation warrants. Are the local variations in secular change waves which move from place to place, or are they stationary fluctuations, each of which is confined to a limited area beyond which it never travels? Thus, if the annual decrease in the declination is at one time more rapid at Greenwich than at Kew, and five years afterwards more rapid at Kew than at Greenwich, has the maximum of rapidity passed in the interval through all intervening places, or has there been a dividing line of no change which has separated two districts which have perhaps been the scenes of independent variations? The answer to this question is, I take it, outside the range of our knowledge now, but if the declination could be determined several times annually at each of a limited number of stations in the neighbourhood of London, to this inquiry, at all events, a definite answer would soon be furnished.

There are two other lines of investigation which I hope will be taken up sooner or later, for one of which it is doubtful whether the United Kingdom is the best site, while the other is of uncertain issue.

If, however, it be granted that the principal cause of local and regional magnetic disturbances is the magnetisation by the earth's field of magnetic matter concealed below its surface, the question as to the nature of this material still remains to be solved. Is it virgin iron or pure magnetite, or is it merely a magnetic rock of the same nature and properties as the basalts which are found in Skye and Mull? There is, of course, no *à priori* reason why all these different materials should not be active, some in one place and some in another.

As regards the United Kingdom I have, both in a paper on the Permeability of Magnetic Rocks and in the description of the recent survey, made calculations which tend to prove that, if we suppose that the temperature of the interior of the earth is, at a depth of twelve miles, such as to deprive matter of its magnetic properties, and if we further make the unfavourable assumption that down to that limit the susceptibility is constant, the forces which are observed on the surface are of the same order of magnitude as those which could be produced by large masses of ordinary basalt or gabbro. It would not, however, be wise to generalise this result, and to assume that in all places regional disturbances are due to basic rocks alone.

We know that local effects are produced by iron ore, for the Swedish miners seek for iron with the aid of the magnet, and in some other cases magnetic disturbances of considerable range are so intense as to suggest that material of very high magnetic permeability must be present.

If the concealed magnetic matter were iron, and if it were present in large quantity, it is evident that the results of experiments with the magnetometer and dip circle might be supplemented by observations made with the plumb-line or pendulum. In such a case the region of magnetic disturbance would also be a region of abnormal gravitational attraction. An account of a suggested connection between anomalies of these two kinds occurring in the same district has lately been published by Dr. Fritsche.[1]

Observations made about thirty years ago by a former director of the Astronomical Observatory in Moscow led to the conclusion that throughout two large districts to the north and south of that city the plumb-line is deviated in opposite directions. The deflections from the vertical are very considerable, and indicate a relative defect in the attraction exerted by the rocks in the neighbourhood of Moscow itself, and the suggestion has been made that there is either a huge cavity—a bubble in the earth crust—under the town, or that the matter beneath it is less dense than that which underlies the surface strata on either side at a distance of ten or twelve miles.

As long ago as 1853, Captain Meyen made magnetic observations in order to determine whether the same district is also the seat of any magnetic irregularity. His stations were hardly [illegible]tly numerous to lead to decisive results, but the magnetic [illegible] have recently been measured by Dr. Fritsche at thirty-one [illegible] within fifty miles of Moscow. The experiments were all made [illegible] seven days, so that no correction for secular change [illegible]. They indicate a locus of magnetic attraction running through Moscow itself. South of the town the disturbance again changes in direction so as to show either that repulsive forces are in play, or that there is another magnetic ridge line still further to the south. Dr. Fritsche thinks that these observations explain the gravitational anomalies without recourse to the somewhat forced hypothesis of a vast subterranean cave. He assumes that there is a concealed mass of iron, which approaches near to the surface at Moscow, and also along two loci to the south and north of the city. He attributes the magnetic irregularities to the attraction of the central iron hill, the deflections of the plumb-line to the flanking masses. It is perhaps not inconceivable that such results might follow in a special case, but without the support of calculation it certainly appears that the magnetic experiments point to the existence of the principal attracting mass under the town. This is in fact the arrangement shown in the figure with which Dr. Fritsche illustrates his hypothesis. If this is so, the theory would *prima facie* seem to require that the bob of a plumb-line should be attracted towards and not—as is actually the case—away from the centre of the magnetic disturbance. On the whole, then, though the coexistence of large magnetic and gravitational disturbances in the same place is suggestive, I do not think that they have as yet been proved to be different effects of the same hidden mass of magnetic matter.

In a few weeks an International Geodetic Conference will meet at Innsbruck, at which the Royal Society will be represented. It is, I believe, intended to extend the detailed investigation of the relations between the nature of the earth's crust and the gravitational and magnetic forces to which it gives rise. We may therefore hope that soecial attention will before long be given to localities where both may combine to give information as to facts outside the range of the ordinary methods of geology.

The second phenomenon on which more light is desirable, is the permanent magnetisation of magnetic rocks. It is known that fragments of these are strongly but irregularly magnetised, but that the effect of very large masses at a distance appears to be due to induced rather than to permanent magnetism. There are three questions to which I should like an answer. Are underground masses of magnetite ever permanently magnetised? Are large areas of surface masses, say a few hundred square yards in extent, ever permanently and approximately uniformly magnetised in the same sense? Is there any relation between the geological age and the direction of the permanent magnetism of magnetic rocks?

Inquiries such as these can only be taken up by individual workers, but I venture to think that the comparison of the observatory instruments and the fluctuations of secular change outside the observatories could best be investigated under the auspices of a great scientific society. The co-operation of the authorities of the observatories will no doubt be secured, but it is most important that the comparison should in all cases be made with one set of instruments, and by the same methods. Whether the British Association, which for so long managed a magnetic observatory, may think that it could usefully inaugurate the work, it would be improper for me in a presidential address to forecast. Who does it is of less importance than that it should be done, and I cannot but hope that the arguments and instances which I have to-day adduced may help to bring about not only the doing of the work, but the doing of it quickly.

[1] [illegible] Moskau und ihre Beziehungen [illegible] *Imp*[illegible] No. iv.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. H. B. DIXON, M.A., F.R.S., PRESIDENT OF THE SECTION.

"An Oxford School of Chemists."

IT has been said, and no doubt with truth, that few Presidents of Sections start writing an address without referring to that of their predecessor who held office on the last occasion when the Association met in the same city. By such reference each new President gains the advantage of many points of perspective and contrast; for in the interval a generation of workers has passed away, and the last new thing of the old meeting is the ancient instance of to-day. In the present case I turned to the Report of 1860 with a lively hope of drawing inspiration from it, for my predecessor at the last Oxford meeting was no less a master of experiment and expression than the late Prof. Brodie. Judge of my disappointment when I found that Brodie had written no address at all. Whether that great man, knowing there were better things to do here than listen to addresses, had the courage to make an innovation he thought desirable in itself, or whether, as others say, he was but obeying the etiquette of the Oxford professoriate—the fact remains the assembled chemists went away unaddressed, and the natural spring of inspiration for the address of 1894 is found dry at its source. Of course you will say, "Why do you not follow such a good example?" I wish I had the courage. As it is, I can but urge the vacuum of 1860 as some excuse for the emptiness of the address I now present—compelled to do so partly by the force of fashion and the demands of the assistant general secretary, and (shall I add?) partly by the gratification of holding forth, with a little brief authority, in my old academic home, endeared to me personally by so many happy memories, and hallowed in the minds of chemists by the traditions of such great achievements in the science we pursue.

I say *traditions* advisedly, for the chemical achievements spoken of were largely forgotten, or put on one side as guesses and half-truths. No chemist here will need reminding that I refer to *the first school of scientific chemistry*, the school founded two centuries and a half ago by Robert Boyle with his disciples Hooke and Mayow—a group whom I will venture to call "the Oxford school of chemists." And now that chemists are met together once more in Oxford it seemed to me not inappropriate for us to consider what this school of chemists accomplished, and wherein it failed, what led to the sudden growth and what to the decline of chemical investigation here, and what lessons for modern Oxford may be read in the history of that rise and fall.

The intellectual awakening which followed the re-discovery of the ancient world of literature gave rise to the scientific interrogation of nature. In Italy first, and then in France, England, and in Germany, the diffusion of classical learning broke down the ancient barriers of restraint, and developed a spirit of free inquiry. It was not so much that ignorance had to be dispelled, but that the right of search had to be established. Here and there during the middle ages some man of genius had arisen—learned beyond all his contemporaries, intrepid in the pursuit of truth—only to be crushed by a political and mental despotism. The name of Roger Bacon arises at once in our thoughts, who from his Oxford cell sent forth that great appeal for experimental science that nearly converted a Pope of Rome and won three centuries for intellectual freedom. But his labour bore no fruit. I know no better index to the dominant sentiment of the time than the following words from a papal rescript reproving the members of an Italian university for scientific presumption: "They must be content with the landmarks of science already fixed by their fathers, and have due fear of the curse pronounced against him who removeth his neighbour's landmark." Under such conditions no wonder philosophy was at a standstill. "The same knots were tied and untied; the same clouds were formed and dissipated."[1] The cramped philosophy of the middle ages had in alchemy a fitting colleague—with its mysticism, its sordid ideals, its trickery, and its arrogance. The revival of learning was thus an emancipation of the mind, and in the new freedom the sciences of mechanics, physics, and chemistry arose. The first necessity for progress was enlightenment, the second was experiment; in the year that Francis Bacon died Robert Boyle was born.

The common pursuit of experimental inquiry and the need for constant criticism and discussion among its followers led to the foundation of scientific societies. Such societies, which have greatly influenced the progress of knowledge, sprang up in Florence and Padua, in Paris and Oxford—wherever, among bodies of learned men, some were found in sympathy with natural philosophy. Among these associations the Philosophical Society of Oxford has played no unimportant part, and, however much Oxford may have undervalued its work, for one thing all chemists are grateful, and Oxford herself may feel proud—that here, under her influence, first grew up the idea that chemistry was no mere drudge of medicine, or genii of the alchemist, but a science to be studied purely for itself.

The origin of this Oxford Society has been well told by Dr. Wallis, one of its founders:—

"About the year 1645, while I lived in London (at a time when, by our civil wars, academic studies were much interrupted at both Universities), besides the conversation of eminent divines, I had the opportunity of being acquainted with divers worthy persons inquisitive into natural philosophy, and particularly of what hath been called experimental philosophy. We did by agreements meet weekly in London to treat and discourse of such affairs; of which number were Dr. John Wilkins, Dr. Jonathan Goddard, Dr. Ent, Dr. Merret, Mr. Samuel Foster, then Professor of Astronomy in Gresham College, and Mr. Theodore Haak, and many others.

"These meetings we held sometimes at Dr. Goddard's lodgings, on occasion of his keeping an operator at his house for grinding glasses for telescopes and microscopes; sometimes at a convenient place in Cheapside, and sometimes at Gresham College. Our business was (precluding matters of theology and State affairs) to discourse and consider of philosophical inquiries . . . . About the year 1648, some of our company being removed to Oxford (first Dr. Wilkins, then I, and soon after Dr Goddard), our company divided. Those in London continued to meet there as before, and those of us at Oxford, with Dr. Seth Ward (since Bishop of Salisbury), Dr. Ralph Bathurst, President of Trinity College, Dr. Petty, Dr. Willis (an eminent physician in Oxford), and divers others, continued such meetings in Oxford, and brought those studies into fashion there, meeting first at Dr. Petty's lodgings (in an apothecarie's house), because of the convenience of inspecting drugs, and, after his removal, at the lodgings of Dr. Wilkins, then Warden of Wadham College, and, after his removal, at the lodgings of the Honourable Mr. Robert Boyle, then resident for divers years in Oxford."

Robert Boyle, the youngest child of the great Earl of Cork, was born at Lismore in 1626. His mother died when he was a child. Always delicate, he was sent at twelve years of age with a tutor to the Continent; he remained abroad for six years. He studied chiefly at Geneva and at Florence, where he read the works of Galileo. Returning to England, in 1644, he busied himself with chemistry at Stalbridge, a manor in Dorsetshire left him by his father. On his visits to London he became one of the members of the "Invisible College," the germ of the Royal Society. "Vulcan has so bewitched me," he writes at the age of twenty-three, "as to make me fancy my laboratory a kind of elysium."

Drawn to Oxford in 1654, Boyle spent here the most active years of his life in experimental research. Of Boyle's scientific writings much has been said in extravagant praise and much in ridicule. Boerhaave wrote: "To him we owe the secrets of fire, air, water, animals, vegetables, and fossils." This phrase is not more grotesque than that of a recent writer, who says, "Boyle's name is identified with no great discovery.' Dr. Johnson has very justly remarked, in a number of the *Rambler*: "It is well known how much of our philosophy is derived from Boyle's discoveries, yet very few have read the details of his experiments. His name is indeed reverenced, but his works are neglected." It is, indeed, rather hard to read through one of Boyle's papers, even in the abridged form. Though clear, they are discursive. The writer cannot rid himself entirely of the essences and qualities of the alchemists; and it is only when we compare these records with the works of Van Helmont, his immediate predecessor, that we recognise the enormous advance that has been made by Boyle. I must pass over his physical work on the elasticity of the air. It must suffice to say that he established by most careful experiment the law which is known by his name—that the volume of a given mass of air varies inversely as the pressure upon it. He determined the density of the air, and pointed out that bodies altered in weight according to the varying buoyancy of the atmosphere. One of his most important chemical papers—certainly the one most frequently cited—is "The Sceptical Chemist," published anonymously in 1661. I will attempt the briefest account of it. The opening words of the dialogue strike the keynote of the whole:—

"Notwithstanding the subtle reasonings of the Peripatetics and the pretty experiments of the Chymists, I am so diffident as to think that, if neither can produce more cogent arguments than are usually given, a man may reasonably doubt as to the number of those material ingredients of mixed bodies which some call elements and others principles." He proceeds, through the mouth of one of the supposed disputants, to attack the doctrine of the three elements, the *tria prima* of the alchemists—sulphur, mercury, and salt. "There are some bodies," he says, "from which it has not yet been made to appear that any degree of fire can separate either salt, or

[1] Whewell, "Hist. of Ind. Sci."

sulphur, or mercury, much less all the three. Gold is the most obvious instance. It may be heated for months in a furnace without losing weight or altering in character, and yet one of its supposed constituents is volatile and another combustible. Neither can water or solvents separate any of the three principles from gold; the metal may be *added to*, and so brought into solution and into crystalline compounds, but the gold particles are present all the time; and the metal may be reduced to the same weight of yellow, ponderous, malleable substance it was before its mixture." He points out the confusion which earlier chemists had made between calcination in the open air and distillation in retorts; he shows that in compounds, *e.g.* copper nitrate, the particles retain their nature, although disguised, in the combination, for the nitric acid may be separated by heat, the copper by precipitation. But the sceptical chemist, though pouring ridicule on the *tria prima*, could not but admit the power of water to produce organic substances. He quotes Van Helmont's famous experiment of growing a shoot of willow in baked earth moistened with distilled water, and he repeats the experiment in various forms. Ignorant of the existence of carbonic acid in the air (discovered a century later by Black), he is driven to conclude that the plant is fashioned out of the pure water. But he rejects the doctrine—as old as Thales and as modern as Van Helmont—that water is the foundation of all things. M. de Rochas had published a remarkable experiment on water. By artificial heat, by graduations of coagulations and congelations, he had turned it into earth which produced animals, vegetables, and minerals. The minerals began to grow and increase, and were composed of much salt, little sulphur, and less mercury; the animals moved and ate, and were composed of much sulphur, little mercury, and less salt. "I have some suspicions," says Boyle, "concerning this strange relation; though as for the generation of living creatures, both vegetable and sensitive, it need not seem incredible, since we find that our common water, which is often impregnated with a variety of seeds, long kept in a quiet place, will putrefy, and then, too, produce moss and little worms according to the nature of the seeds that were lurking in it."

I will give two short quotations from the "Sceptical Chemist," which show the author at his best and his worst. In the first he is discussing the nature of chemical combination between elementary particles: "There are clusters wherein the particles stick not so close together, but they may meet with corpuscles of another denomination, disposed to be more closely united with some of them than they were among themselves; and in such case two corpuscles thus combining, losing that shape, size, or motion upon whose account they exhibited such a determinate quality, each of them really ceases to be a corpuscle of the same denomination as it was before; and from the coalition of these there may result a new body, as really one as either of the corpuscles before they were confounded. . . . If you dissolve minium in good spirit of vinegar and crystallise the solution, you shall not only have a saccharine salt exceedingly different from both its ingredients, but the union is so strict that the spirit of vinegar seems to be destroyed . . . for there is no sourness at all, but an admirable sweetness to be tasted in the concretion." In this passage we can distinctly see the germ of the modern theory of chemical affinity uniting atoms into chemical compounds. In the second quotation Boyle is arguing that fire is not only an analyser of mixtures, but compounds the ingredients of bodies after a new manner; mercury, for instance, may be turned into a liquid, from which the mercury cannot be reduced again, and consequently is more than a "disguise" of it. "Two friends of mine," he says, "both of them persons of unsuspected credit, have solemnly assured me that after many trials they made to reduce mercury into water, they once, by several cohobations, reduced a pound of quicksilver into almost a pound of water, and this without the addition of any substance, but only by urging the mercury with a fire skilfully managed. Hence it appears that by means of fire we may obtain from a mixed body what did not pre-exist therein." Boyle has sometimes been charged with credulity, and chemists who know how mercury has a way of disappearing without leaving even its weight of water behind will smile to hear that the persons of unsuspected credit responsible for this experiment were "the one a physician, the other a distinguished mathematician."

Boyle's writings contain the record of numerous important chemical observations, *e.g.* the synthesis of nitre, and the preparation of nitric acid by the distillation of nitre with oil of vitriol. He discovered several of the delicate tests we still use, *e.g.* solution of ammonia as a test for copper, silver nitrate as a test for chlorides, gallic acid as a test for iron. But I wish especially to refer to the work done by Boyle on the air and its relation to combustion. The air, according to him, was composed of three different kinds of particles: (1) exhalations from water and animals; (2) a very subtle emanation from the earth's magnetism, which produces the sensation of light; and (3) a fluid compressible and dilatable, having weight, and able to refract light. It is this third portion of air which plays an active part in many chemical operations. Like Van Helmont, Boyle recognised differences in gases, but did not distinguish them as being something different in kind from air. He prepared hydrogen by the action of hydrochloric and sulphuric acids on iron, but his chief concern was to show that the new gas was compressible and was dilatable by heat; in other words, that it was really *air*. His observations are worth quoting; they contain, I believe, the first undoubted description of hydrogen, and the first method devised for collecting and examining freshly prepared gases.

"Having provided a saline spirit . . . exceedingly sharp and piercing, we put into a vial a convenient quantity of filings of steel, purposely filed from a piece of good steel. This metalline powder being moistened with the menstruum was afterwards drenched with more, whereupon the mixture grew very hot, and belched up copious and stinking fumes. . . . Whencesoever this stinking smoak proceeded, so inflammable was it, that upon the approach of a lighted candle it would readily enough take fire, and burn with a blewish and somewhat greenish flame at the mouth of the viol; and that, though with little light, yet with more strength than one would easily suspect."[1]

And again: "We took a clear glass vial, capable of containing three ounces of water, with a long cylindrical neck; this we filled with oil of vitriol, and fair water, of each a like quantity, and casting in six small iron nails we stopped the mouth of the glass, and speedily inverting it, we put the neck of it into a wide-mouthed glass with more of the same liquor in it. . . . And soon after we perceived the bubbles, produced by the action of the menstruum upon the metal, ascending in swarms; by degrees they depressed the liquor till, at length, the substance contained in these bubbles possessed the whole cavity of the vial. And for three or four days and nights together the cavity of the glass was possessed by the air, since by its spring it was able for so long a time to hinder the liquor from regaining its former place. Just before we took the vial out of the other glass, upon the application of the warm hand to the convex part of the glass, the imprisoned substance readily dilated itself like air, and broke through the liquor in several succeeding bubbles."

The importance of this experiment will be evident when we consider that Van Helmont had declared that gases could be made artificially in many ways, but could not be caught and held in vessels.[2]

Armed with the air-pump which he had so greatly improved, Boyle in 1660 began many experiments on combustion, which he afterwards published under the title "New Experiments touching the Relation betwixt Flame and Air." In these researches he shows that sulphur will not burn when the air is removed. The sulphur was lowered on to a hot iron plate in a receiver made vacuous by the pump; it smoked, but did not ignite. On allowing a little air to enter "divers little flashes could be seen": these were extinguished on sucking out the air again. A candle flame and a hydrogen flame under a receiver were gradually extinguished when the air was pumped away. On the other hand, on dropping gunpowder on to a hot iron plate *in vacuo* there appeared "a broad blue flame like that of brimstone, which lasted so very long we could not but wonder at it"; and fulminating gold detonated *in vacuo* when heated by a burning glass, or when dropped on heated iron. Gunpowder also he found to burn under water. He is driven to the conclusion "that flame may exist without air." But it may be supposed that air is mechanically enclosed in the crystals of nitre—"in its very formation the corpuscles may intercept store of little aereal particles. . . . According to this surmise,

[1] "On the Difficulty of preserving Flame without Air," 1672.

[2] "Gas, vasis incoercible, foras in aerem prorumpit." (*Ortus Medicinæ*. The epithet "sylvestre" was applied by Van Helmont to all artificially prepared gases. He meant by it "untameable" and "non-condensible"—"quod in corpus cogi non potest visibile."

though our mixture burns under water, yet it does not burn without air, being supplied with enough to serve the turn by the numerous eruptions of the aereal particles of the dissipated nitre." However, he "removes this suspicion" by obtaining nitre crystallised *in vacuo*. He then suggests the possibility of the nitre supplying "vehemently agitated vapours" which are no true air, but being exceedingly rarefied by the fire "emulate air." Boyle never grasped the true function of air in combustion. From his later experiments on the calcination of metals he drew the same conclusion that we find in the "Sceptical Chemist," namely, that igneous particles combine with other corpuscles to form new bodies. And yet he saw there was a real connection between air and fire. In his tract on Artificial Phosphori, Boyle showed that a piece of phosphorus sealed up in a glass vessel gradually lost its light. "It seems," he wrote, "that the air included with the phosphorus either had some vital substance preyed upon thereby, or else was tamed by the fumes of the phosphorus and rendered at length unfit to continue the particular flame of our noctiluca."

The genius of Robert Hooke was in sharp contrast with that of Boyle. Quick, restless, imaginative, he sprang from discovery to discovery. With extraordinary acuteness and powers of invention, he lacked the steady purpose of Boyle, the calm judgment and completeness of Newton—his two great scientific contemporaries. It might be said of Hooke, as was said of a great poet, he touched nothing he did not strike fire from; and some would add that his touch had the same effect on persons as on things. We can hardly name a discovery of this age which Hooke had not in part anticipated and claimed as his own. Like a prospector in a newly discovered mining district, he hurried from spot to spot, pegging in his claims and promising to return to work out the ore. And what rich lodes he struck! The particular claim we are concerned with here is the discovery of the relation between air and flame. In 1665 Hooke published in the "Micrographia" a description of flame and the phenomena of combution which in my judgment has never been surpassed. How far he was indebted to Boyle will appear directly.

Born in 1635, Hooke spent five years at Westminster School, then under Dr. Busby, and proceeded to Christ Church in 1653. At school and college it is related of him that he devoted his time to designing flying machines. These mechanical inventions attracted the notice of Dr. Wilkins, Warden of Wadham, and a leading member of the Philosophical Society. This led to his introduction to Dr. Willis, to whom he became assistant in chemistry and natural philosophy. Willis recommended him to Boyle, whose assistant he became. His first work in Boyle's laboratory was the construction of the improved air-pump. In 1662 Boyle obtained for him the position of curator of experiments in the London Society, soon to be known as the Royal Society. Hooke was thus Boyle's assistant when those experiments on combustion I have described were being carried on. Among other experiments made by Boyle were some on the distillation of wood in retorts.

"Having sometimes distilled such woods as box, whilst our *caput mortuum* [*i.e.* the residue] remained in the retort it continued black like charcoal, though the retort were kept red hot in a vehement fire; but as soon as ever it was brought out of that vessel into the open air the burning coals would degenerate or fall asunder into pure white ashes."[1] Hooke saw the experiment and a new light flashed on him. "From the experiment of charring coals," he writes "(whereby we see that, notwithstanding the great heat, the solid parts of the wood remain, whilst they are preserved from the free access of the air, undissipated) we may learn that which has not been published or hinted, nay, not such much as thought of by any; and that in short is this:—

"That the air is the universal dissolvent of all sulphurous [*i.e.* combustible] bodies. . . .

"That this action of dissolution produces a very great heat, and that which we call fire.

"That this action is performed with so great a violence, and does so rapidly agitate the smallest parts of the combustible matter, that it produces in the diaphanous medium of the air the action, or pulse of *Light*.

"That this dissolution is made by a substance inherent and mixed with the air, that is like, if not the very same with, that which is mixed in saltpetre.

"That the dissolving parts of the air are but few . . . whereas saltpetre is a menstruum . . . that abounds more with these dissolvent particles.

"It seems reasonable to think that there is no such thing as an element of fire, . . . but that that shining transient body which we call flame is nothing else but a mixture of air and volatile parts of combustible bodies, which are acting upon one another whilst they ascend; which action . . . does further rarifie those parts that are acting or are very near them, whereby they, growing very much lighter than the heavy parts of that *menstruum* they are more remote, are thereby protruded and driven upwards."

Hooke quotes no other experiments in support of his theory of flame. He states that he has made many; he has, however, only time "to hint an hypothesis," which, if he is permitted opportunity, he will "prosecute, improve, and publish." Some years later he returned to his subject of flame in his tract called "Lampas," published in 1677. "The flame, as I formerly proved, being nothing but the parts of the oyl rarified and raised by heat into the form of a vapour or smoak, the free air that encompasseth this vapour keepeth it into a cylindrical form, and by its dissolving property preyeth upon those parts of it that are outwards, . . . producing the light which we observe; but those parts which rise from the wick which are in the middle are not turned to shining flame till they rise towards the top of the cone, where the free air can reach and so dissolve them. With the help of a piece of glass anyone will plainly perceive that all the middle of the cone of flame neither shines nor burns, but only the outward superficies thereof that is contiguous to the free and unsatiated air."

What is practically the same theory of flame was worked out experimentally by John Mayow, Fellow of All Souls: this was published a few years after the "Micrographia."

But Mayow went further, and distinctly showed the dual nature of the air. One constituent of air, the nitre air, is concerned in respiration and combustion; the other will neither support flame nor animal life. The ideas, the names, proposed by Hooke and Mayow are so exactly similar that it is impossible to imagine that the work was done independently. The two were working at the same time at Oxford, and Mayow, having been an undergraduate at Wadham under Dr. Wilkins, became the pupil of Willis. Yet Mayow nowhere mentions Hooke's name. A writer in the "Dictionary of National Biography"[1] has shrewdly observed that Hooke has brought no charge of plagiarism against Mayow, and even proposed him for the Royal Society four years after the publication of the "Five Tracts." Knowing what we do of Hooke's jealousy, it seems exceedingly unlikely that Mayow was merely working out Hooke's ideas. It seems to me probable that Hooke and Mayow worked together under Boyle between 1660 and 1662; that in Boyle's laboratory they saw and assisted in the experiments which led them jointly to their theory; that Hooke, busy with other work in London, published the hypothesis in 1665 without further verification: and that Mayow in Oxford systematically worked through the experiments on which he based his conclusions.

Let me briefly show what the experiments were on which Mayow relied. Combustible bodies will not burn in the vacuous receiver of Boyle's air-pump; they will burn *in vacuo* or under water when mixed with nitre. There is, therefore, something common to air and to nitre which causes combustion. The fiery particles in air and in nitre both form oil of vitriol by their union with sulphur; they both form iron vitriol by their union with pyrites. Rust of iron is produced both by the air and by acid of nitre; the acids of sugar and honey are formed, and wine is soured in the same way. The nitre-air (spiritus nitro-aereus), the supporter of combustion and the acid producer, is therefore the same chemical substance whether it exist in the gaseous form in air or is condensed in saltpetre.

Mayow heated a weighed quantity of antimony by means of a burning glass, and found it increased in weight during the calcination;[2] the calcined antimony, he adds, has the same properties as the body prepared by heating antimony with nitric acid; it is impossible to conceive, he says, whence the increase in weight arises except by the fixation of the particles of nitre-air during the heating.

The nitre-air does not make up the whole of the air, but only its more active and subtle part, for a candle under a glass will

[1] "The Sceptical Chemist."

[1] Mr. P. J. Hartog.

[2] This experiment seems to have been first described by Poppius, *Basilica Antimonii*, 1625.

cease to burn while there is still plenty of air left. The experiment by which Mayow shows this is so important that I will quote his words:—

"Let a lighted candle be so placed in water that the burning wick shall rise about six fingers' breadth above the water; then let a glass vessel of sufficient height be inverted over the candle. Care must be taken that the surface of the water within the glass shall be equal in height to that without, which may be done by including one leg of a bent syphon within the vessel while the other opens outside. The object of the syphon is that the air, enclosed by the vessel and compressed by its immersion into the water, may escape through the hollow syphon. When the air ceases to issue, the syphon is immediately withdrawn, so that no air can afterwards get into the glass. In a short time you will see the water gradually rising into the vessel while the candle still burns."

In other experiments he burnt camphor and sulphur supported on a shelf in the inverted vessel. The water rose, he says, because, owing to the disappearance of the fire-air, the air left could not resist the pressure of the atmosphere outside. When the combustibles were extinguished it was impossible to kindle them again by means of the sun's rays concentrated on them by a burning glass. The residual air was no more able to support combustion than the vacuum of Boyle's engine. Again, the respiration of animals in the closed space was shown to diminish the air, and to render it incapable of supporting combustion; the fire-air was as necessary for life as for flame. The larger portion of the air was something entirely different from fire-air, and incapable of supporting life or combustion. I believe this to be the first definite statement founded on experiment that the air is composed of two distinct gases.

I have given the fundamental facts in chemistry we owe to Mayow: the limits of his work are sufficiently obvious. He detected the existence of what we call oxygen gas in the air, and demonstrated some of its most remarkable properties. He did not isolate the gas, or show what became of it in combustion; he did not always distinguish between the gas itself and the heat produced by its action. But the advance he made was extraordinary—not so much in the conclusions he drew as in the experiments and arguments he founded them on. Compare him for a moment with another writer who had previously expressed similar views concerning the calcination of metals. Jean Rey, of Perigourd, a witty and shrewd physician, published in 1630 a series of essays attributing the increase in weight of metals on calcination to the fixation of the air. "When asked," he writes, "why tin and lead increase in weight on calcination, I reply and gloriously maintain that this increase comes from the air, which is thickened and made heavy and adhesive by the long and continued heat of the furnace. This air mingles with the calx and attaches itself to the smallest particles." The reply is good, but the reasons that gloriously maintain it are not altogether conclusive. I can only give two of them: (1) *The air has weight.*—This is shown by the increase in velocity of heavy bodies falling to the earth, because as the body approaches the earth it subtends a wider angle from the centre of the earth, and receives more shocks from the particles of air. Again, although the air appears to weigh nothing on the balance, this is because we weigh it in the air; it loses its weight, just as water weighs nothing in water. Fire has weight too, and should we ever find ourselves in a region where fire is the predominant element, we shall be able to prove the statement in the same way. (2) *Fire can thicken and make air heavy.*—Stand a cannon upright and put a red-hot ball into it. You must admit that the air in the gun is so small in quantity that it will be heated to the same temperature as the ball. Nevertheless you can hold your hand in the mouth of the gun at first, but in a short time you cannot do so. Not that the air has got hotter, it is cooling all the time; it is because the air is thickened. Now if you drop a piece of wool into the mouth, it will not descend, and if you push it in, it will come up again, proving the air is heavier. Lastly, the air is seen to tremble over the mouth of the gun, and objects seen through it are blurred. This is due to the thickening, it cannot be due to a motion of the air; "for I see," he says, "a lady's beauty quite distinctly through the air she flutters with her fan."

From what has been stated it will be clear that the Oxford school of Chemistry was a *school of research*. Boyle gave no instruction in the ordinary sense; and, indeed, had no official connection with the University. But that he thought instruction in chemistry should be given in the University is obvious from the fact that he brought over a chemist from Strasburg, and set him up as a lecturer with rooms next his own and the use of his laboratory. Of these lectures we find a quaint account in Anthony Wood's diary:—

"An. Dom. 1663.

"Began a course of chemistry under the noted chemist and rosicrucian, Peter Sthael, of Strasburg, brought to Oxon. by the hon. Mr. Rob. Boyle, an. 1659. He took to him scholars in the house of John Cross next on the w. side to University Colle The club consisted of 10 at least, whereof Francis Turner of New Coll. was one, Ben Woodroff of Ch. Ch. another, and John Lock of the same house, afterwards a noted writer. This John Lock was a man of turbulent spirit, clamorous and never contented. The club wrote and took notes from the mouth of their master, who sat at the upper end of the table, but the said J. Lock scorned to do it; so that while every man besides were writing, he would be prating and troublesome. After the beginning of the year 1663 Mr. Sthael removed his elaboratory to a draper's house, called John Bowell, afterwards mayor of the city, situate in the parish of All Saints. He built his elaboratory in an old hall in the back, for the house itself had been an ancient hostle; therein A. W. and his fellows were instructed. The chemical club concluded, A. W. paid Mr. Sthael 30 shill: having paid 30 shill: beforehand. A. W. got some knowledge and experience, but his mind still hung after antiquities and musick."

In spite of Boyle's private position, his blameless life, his devoutness, and his charity, his work aroused bitter animosity in Oxford. He was attacked in the University pulpit, in public orations, in private squibs; his theories were described as destructive of religion, his experiments as undermining the University. But what chiefly drew the indignation of his opponents was that he, a gentleman by birth and fortune, should concern himself with low mechanical arts. Against these attacks Boyle replied with irresistible logic. His vindication of the nobility of scientific work constitutes one of his greatest claims on our gratitude.

Boyle left Oxford in 1668. Mayow died in 1679. In 1683 Anthony Wood informs us that "the Oxford elaboratory was quite finished"; but the impulse given to the study of Chemistry in Oxford gradually died out. I do not know the history of the Chair of Chemistry in Oxford (if there was one) in the eighteenth century. Richard Frewin, of Christ Church, is described as Professor of Chemistry in 1708. He does not seem to have taken himself too seriously in this capacity. Uffenbach, who visited Oxford in 1710, says he found the stoves in fair condition, but everything else in the laboratory in dirt and disorder. Frewin himself was elected Camden Professor of Ancient History in 1727. He seems to have thrown himself into his new work with greater ardour; for Hearne relates that, on his election, he at once bought one hundred pounds' worth of books in chronology and history to fit himself for his duties. For a companion picture to this we may glance at the appointment in 1764 of Richard Watson (afterwards Bishop of Llandaff) to the Chair of Chemistry at Cambridge, which had been founded in 1702. Dr. Watson, we are told, knew nothing at all of chemistry: had never read a syllable nor seen a single experiment on the subject. On his election he sent to Paris for an "operator," and set to work in his laboratory. In fourteen months he began to lecture to a large audience.

But Watson at Cambridge was succeeded by Wollaston. We had to wait till Brodie for a successor to Boyle.

II.

We have seen what a vigorous effort Chemistry made to plant itself in Oxford in the seventeenth century. If the soil had been prepared the roots must have struck deep. But the University paid little heed, and after a few years of prodigal growth the plant withered and died out. It would seem that the positions are reversed at the present day. The University spends large sums for supervision and appliances; the young plants are brought here and nurtured at great expense, but the fair blossoms produce little fruit. Even our best friends admit that the results are somewhat disappointing. If these are the facts—and I speak as one who shares the responsibility for the present condition of chemistry here—it is the duty of those concerned to speak out; and I can conceive no more fitting opportunity than the present for pointing out some of the causes that appear to hinder our growth. Let no one think I wish to disparage the University. I should be the last person to do so. I owe to my old college the opportunity, the help, and the example which made me a chemist, and gave me an interest in life. I only wish to see more general the advantages it was my luck to meet with in Christ Church.

Chemistry in modern Oxford is accorded a place side by side with older studies. No one can complain that scholarships are not offered broadcast, that money has not been freely given for laboratories; and yet I think the student does not feel around him the atmosphere in which an experimental science should be cultivated. We see Chemistry endowed and extended, we do not see it respected by the bulk of students and of learned men. In my undergraduate days a rhyme was current here (I think it was coined in Cambridge—the Parnassus of parodies) expressing views which were undoubtedly held concerning the claims of chemistry as a subject for a degree. One verse ran—it was from the Lamentation of a would-be Bachelor—

> "I thought to pass some time before, but here, alas, I am,
> Having managed to be plucked in every classical exam.
> I cannot get up Plato, so my reverend tutor thinks
> I had better take up Chemistry, which is commonly called 'Stinks.'"

I do not quarrel with the versifier (except as a poet), I do not even quarrel with the reverend tutor, whose opinion of us is obviously small, because I do not think myself that Chemistry as it is taught is a very good subject for a degree. Still less is it a subject which we should allow to monopolise the schoolboys' time. While holding strongly that the elements of Physics and Chemistry form a necessary part of a liberal education, I believe we have made two mistakes with regard to the teaching of science. We have by our science scholarships encouraged too early specialisation at school; we have overburdened our undergraduates here with a multitude of facts they cannot retain. A boy specialises for two years at school; he learns a prodigious array of facts from the latest text-book, and also acquires some skill in the art of quickly reproducing what he has learnt. He wins a science scholarship. We then tell him he must go back to, or begin, the study of the classical languages we look on as essential for our degrees. By a certain time he must reach a certain (rather low) standard, or his scholarship lapses. He learns that it is advisable to get assistance from those who have made a special study of preparing candidates for pass examinations. He crams; or he goes to a crammer and is crammed. Let us suppose, as is usually the case, that the obstacle is Greek. I will not deny that the standard of Greek demanded may imply some important discipline at school, and some real culture of the mind, provided the instruction given is on wholesome lines and forms part of a liberal course. Got up in a hurry as it too often is, solely with the object of passing, it means time and effort wasted and worse than wasted. It is of no value in itself, for it is forgotten in less time than it took to acquire; and it gives the student the first pernicious taste of that superficiality and false knowledge it should be our special aim to remove. Is it not desirable that scholarships should be the reward of progress and ability *in the general subjects of school education* among which the elements of science should have a place? The brightest and most persevering boys would come to the University, and there make choice of the special course they wished to pursue.

My second complaint is that we teach too many facts. They are not all important. After three or four years' steady accumulation our men go into the schools walking dictionaries of chemistry. Parents not unnaturally think that their sons, after four years of college training, should be fit to take responsible places wherever chemists are in demand. But manufacturers, as a rule, do not care for University graduates. I cannot blame them. We cannot guarantee that the men we send out with honours in Chemistry can attack a new problem, can work out new processes, can prepare new dyes. German manufacturers, on the other hand, *prefer* a University graduate, for they have in *their* degree a guarantee that the student has successfully attacked some unknown problem, and added to the store of knowledge.

The influence of science on the nation's industry has been recognised and insisted on by those who can make their voices heard. The country has at length awakened to the fact that something is wanting, and cries out for Technical Instruction. It is not afraid of spending money: indeed, many well-meaning bodies are spending—and in some cases I fear, wasting—money with a prodigal hand. And what, after all, is the great need? Speaking for the subject I know best, I say unhesitatingly that we want scientific chemists who can and will make discoveries; we want men trained, not only in what has been done, but taught how to set about winning new knowledge. The Universities, I urge, should teach the art of research. This is what is wanted, and this, as all experience shows, is what the Universities can do better than anyone else. And no exorbitant amount of time need be demanded for this purpose. If the student has learnt the elements of science at school, three years at most should suffice for the preliminary degree course. The graduate, armed with the necessary manipulative skill, would then start research work under proper guidance as the second and more valuable portion of his University training. And here the new research degree (by whatever name it may be called) may give us most valuable help. I hope that serious work will be demanded for it, and that the research course will become the recognised avenue to science fellowships and lectureships in the University. Two years would show what the man had in him. In that time either he would have proved himself no chemist, or he would have made some useful advance in our knowledge, and would have secured a testimonial of fitness such as no examination could confer. Five years in all—the minimum time now laid down for a medical qualification—would surely be not too much to ask for the chemist's training.

No extra expense need be incurred to carry out this plan. Some of the college scholarships at present offered on entrance might be reserved for research studentships on graduation. These studentships should be the reward of the successful undergraduate career. On this point, which I have urged for many years, I am glad to find myself in entire agreement with the President of the Chemical Society. At Owens College our most successful endowment in chemistry has been the Dalton Scholarship, awarded for a research done in the College laboratories. In the Victoria University we have lately founded scholarships for the encouragement of research, which are awarded on the results of the final examination in the several Honours Schools. The winners are entitled to hold their scholarships at any university at home or abroad where they can continue their special studies.

I plead, then, for greater encouragement of chemical research in Oxford. Make it part of the normal course of training for everyone who wishes to be a chemist in fact as well as in name. Consider, not only the country's need, but the value of research itself as a mental training, as stimulating and strengthening the activities, as creating that sense of devotion and discipleship which becomes the tradition of every great school of learning.

Lastly, let us own that we ourselves—the teachers here—have been perhaps too critical, too much afraid of making mistakes, forgetting that the witty American's remark—that he who never makes mistakes never makes anything—has a far wider application in science than in politics. Only by practice and drill can we learn to collect our strength and swing it with precision into acts. Without that training, no matter how much faculty of seeing a man has "the step from knowing to doing" is rarely taken. There is nothing, I believe, in Oxford antagonistic to our cause. The genius of the place has not declared against scientific research; and if it be a true saying that men here imbibe a liberal education from the very air breathed by Locke and Berkeley, surely we also may draw scientific inspiration from this air, not only breathed, but first explained by Boyle and Hooke and Mayow.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY L. FLETCHER, M.A., F.R.S., F.G.S., PRESIDENT OF THE SECTION.

WITH an anxious desire to conform to the traditions of the past, I have sought in the Reports of the Association for guidance in my present difficulty; and have remarked that it is customary for a president, on first taking the chair, to express a deep sense of unworthiness for the position to which he has been called. My first duty, then, seemed a simple and obvious one; till I further remarked, to my dismay, that the more distinguished the president the more humble have been the terms in which such expression has been made. Hence I feel that it may appear to you presumptuous on my part if I myself make any apology at all, and it would doubtless imply a claim to the highest distinction if I were to make that humble apology which would be most appropriate to the circumstances of the case.

Instead, however, of dispensing with the apology altogether—that might be too radical an innovation to be introduced this year—I propose, with your sanction, to make a lesser change, and merely to defer the apology from the first to the last day of our session. I may reasonably hope to be able, at that later stage, to make clear to you, by simple reference to your own experience during the meeting, that any apology I may feel it to be then my duty to make is of no merely formal character, but one which is worthy of your serious consideration.

I would ask that in the meantime your continuous sympathy be extended to one who now finds himself in a position he would have been the last to seek, and whose ordinary duties in life involve speechless communion with inanimate nature rather than oral address to an assembly of fellow-workers.

This matter of apologetic precedent being thus disposed of to our common satisfaction, I should have preferred to have brought the delay of the normal business of the Section to an immediate end by calling upon the author of the first paper to now address you. Such, indeed, was the ordinary course of procedure in the earlier, and perhaps presidentially happier, years of the Association; but the occasion of taking the chair having been once seized upon, in absence of mind, by a mathematical president for the delivery of an address, it has come about that each president now feels it his bounden duty, not merely to give an address, but to make the address at least as long and at least as elaborate as any which has preceded it.

We shall all agree that a presidential address, if there is to be any at all, should be elaborately short and elaborately simple; it should deal, not with technical details such as are only intelligible, even to the president himself, after much study, but with general principles such as can be immediately grasped by every member of an audience; an opening address which is so long that it can be only partly read, and is written to be studied afterwards in the Reports of the Association, may more appropriately be issued as an ordinary memoir. I make this remark to safeguard the interests of future audiences, for the example of technicality which I am now about to set is one which I cannot recommend my successors to follow.

As for subject, an account of the progress of scientific work is always interesting and instructive, and immediately suggests itself as the natural basis of a presidential address. But seeing that, so lately as in February last, the geologists have had the advantage of an address from the retiring president of their Society, Mr. Hudleston, which has been virtually exhaustive in its survey and criticism of the British geological work of the last seven years, the time has scarcely yet arrived when a continuation of that review by the president of this Section can be of service to the members of the Association.

For this and other still more weighty reasons which I need not directly mention, I feel myself debarred from undertaking any review of recent geological progress, and shall therefore ask you to allow me to confine myself, in the remarks it is my duty to make, to a science which, though it is not purely geological and in the Reports of the Association has long been associated with another science, chemistry, is yet very closely related to the science of our own Section, Geology.

I trust that the members of the Section of Chemistry and Mineralogy are now so closely engaged in another place that they will fail to discover, or at any rate to resent, the technical trespass on their own domain: as for yourselves, you will perhaps be more ready to pardon the temporary excursion from the domain of pure geology if I remind you that the fathers of the Geological Society defined their sole object to be "the investigation of the mineral structure of the earth"; and I may add, if further defence be desired, that in the first half of this century the relationship of mineralogy and geology was so intimate that it was possible for a Section of the British Museum to be officially designated "the Department of Mineralogy, including Geology."

I was the more impelled to choose this subject for our consideration to-day when I reflected that pure mineralogy has been hitherto almost completely out of sight, and therefore probably out of mind, at the meetings of the Association. It is true that at the first meeting, held sixty-three years ago, Dr. Whewell, then the Professor of Mineralogy at Cambridge, was invited to draw up a report on the state of knowledge of the science, and that his report was submitted and printed in the following year. But in the course of the sixty-three years during which the Association has flourished, it has chanced that a mineralogist has on only one occasion, that of 1862, been seated in a presidential chair; and since at that time presidential addresses had not yet come to be regarded as necessary to the existence of the Sections, Prof. Miller refrained from inflicting a mineralogical dissertation on an audience which, he had reason to presume, would consist entirely, or almost entirely, of chemists. Perhaps you might be tempted to think that the want of prominence of the mineralogists at our previous meetings has been due to a becoming sense of modesty resulting from the study of that science: this would be a mistake. The fact is that a mineralogical memoir, dealing largely with numerical quantities and involving great variety of experiment and technicality, may be read and studied, but should never be heard; like the mathematician, the mineralogist despairs of making clear to an audience, especially a mixed one, the bearing of any researches which have been made in his subject. But now that sixty-two years have elapsed since the issue of Prof. Whewell's Report, the time has perhaps at length arrived when it is advisable, notwithstanding the difficulties surrounding an oral treatment of mineralogy, to attempt to give to the Association a faint idea of the present position of the study of the subject. And if most of my hearers find that the remarks are too technical to be in any great part intelligible, let them console themselves with the reflection that, if the future at all resembles the past, only Shalum and Hilpa can have to endure again that particular kind of *mauvais quart d'heure* which is to precede the geological feast of to-day.

The Systems of Crystallisation.—At the time of the publication of Prof. Whewell's report it had already been established by the researches of Romé de l'Isle, Haüy, Mohs, and Weiss that the position of any single face of any crystal can be exactly defined by means of two sets of quantities: firstly, three lines or axes, of which the lengths and mutual inclinations are characteristic of the substance itself; secondly, three whole numbers or indices, rarely rising higher in magnitude than the number 6: further an empirical arrangement of crystals into systems had been based by Mohs and Weiss on the relative lengths and inclinations of the axes. And a long series of observations of the optical characters of crystals had revealed to Brewster the fact that the boundaries of the classes of optically isotropic, uniaxal and biaxal crystals form part of the boundaries of the empirical systems. But whereas only three optical classes of crystals had been recognised, it was certain that there were at least four geometrical systems, and it was a matter of controversy as to whether the independence of two others should not be regarded as geometrically established.

The first important discovery following the issue of Whewell's Report was one which proved that the two doubted systems are natural ones. It was found by Herschel and Neumann that the biaxal crystals are not optically similar, as had hitherto been supposed, but are of three kinds. In crystals of one kind—for example, barytes—the two lines bisecting the angle of the optic axes internally and externally, and a third line perpendicular to both, are constant in direction in the crystal whatever the colour of the light; in a second kind—for instance, selenite—only one of these lines is constant when the colour varies; in a third kind—for instance, borax—none of the three lines has any constancy of direction. And these three kinds of biaxal crystal correspond exactly in their facial development to the three systems of crystallisation of which the independence had already been asserted by some crystallographers on geometrical grounds. From this time the arrangement of crystals into the six systems has been regarded as a natural one; and the optical method based on the figures seen in plates when examined in convergent polarised light has been in constant use, and is an invaluable aid in the determination of the system of crystallisation.

Crystallographic Notation.—For a simple method of expressing the relative positions of crystal faces by a symbol, crystallographers are infinitely indebted to the late Prof. Miller, of Cambridge. The symbols introduced by Mohs, Weiss, Lévy, Naumann, and the modification of the latter suggested by Dana, though interesting, are not to be compared for legibility, pronounceability, or utility in calculation, with the simple symbol which is associated with the name of Prof. Miller. Though the symbol was not invented by him, he was the one who, so to say, gave it life. He discovered and made known its many advantages; and in his treatise published in 1839—a treatise which is a masterpiece of mathematical terseness and simple elegance—he gave the methods of crystallographic calculation which render the advantages of the symbol particularly manifest. It may be here remarked that in that treatise the rationality of the anharmonic ratios of any four tautozonal planes of a crystal was first made known, and the property was largely used in the simplification of the methods of calculation: the fact that the fraction was of the knd which had been already termed an anharmonic ratio, however, had escaped the atteation of the author.

But the change of a method of notation, like a change in the system of weights and measures, involves such serious practical difficulties that many years passed away before the Millerian symbol received abroad the consideration which it deserved. Now, at last, no continental text-book of mineralogy fails to introduce the Millerian indices, even if the symbols of Lévy or of Naumann are given in addition; and it is evident that within a few more years the mineralogist will be completely relieved from the tiresome necessity of translating each crystalline symbol into another form to make it intelligible to him, and the student will be able to make a more advantageous use of the time which has been hitherto devoted to acquiring a mastery over a second and unnecessary form of crystallographic notation. For this result credit is largely due to Prof. Groth, of Munich, whose adoption of the Millerian symbol in the *Zeitschrift für Krystallographie* has done much to bring home its advantages to the foreign worker. It is to be hoped that Prof. Groth will earn the further gratitude of students by encouraging the adoption of the true Millerian symbol in the still outstanding case of the Rhombohedral System.

Rationality of Indices and the Law of Zones.—It may here be pointed out that, although the importance of zones for the simplification of crystallographic calculation had been recognised by Weiss, it was only later that Neumann proved that the fact that all possible crystal faces can be derived by means of the intersection of zones is a necessary consequence of the rationality of the indices; that, indeed, the law of zones is mathematically identical with the law of rationality. To the same able physicist and mathematician we owe the development of the method of stereographic projection now in common use by crystallographers for the representation of the poles of crystal faces.

Symmetry.—We have said that the recognition of six systems of crystallisation was a result of consideration of the lengths and mutual inclinations of certain lines called axes. Now, it had long ago been remarked that any one face of a crystal is accompanied by certain others similarly related to the geometrically similar parts of what may be regarded as a fundamental figure: such a group of concurrent faces is called a simple form. It came to be recognised, too, that all the faces of such a form can be geometrically derived from any one of them by repetition, according to certain laws of symmetry, and that the same laws of symmetry are binding for every simple form or combination of forms exhibited by crystals of the same substance. Hence it came to be perceived, though very slowly, that the essential differences of the systems of crystallisation are not mere differences of lengths and mutual inclinations of lines of reference, but are really differences of symmetry. Ever since his appointment to the professorship of Mineralogy in this University, now thirty-eight years ago, Mr. Maskelyne has been persistent in directing attention to the importance of symmetry, and such importance now receives universal recognition.

Thirty-two Types of Symmetry in Crystals.—But in each system of crystallisation it becomes necessary to recognise both completely and partially symmetrical types. In the latter, the symmetry is in abeyance relative to various planes or lines which in other crystals of the same system are active as planes or axes of symmetry. But this abeyance of symmetry is itself found to be subject to a law, for all planes or axes of symmetry which are geometrically similar are either simultaneously active or simultaneously in abeyance. By means of this law relating to partial symmetry, it has been inferred that altogether thirty-two types of symmetry are possible in the six crystalline systems.

The possible existence of these thirty-two types of symmetry of crystals is thus an induction from observation: the question naturally arises as to why only these thirty-two exist, or are inferred by analogy to be possible. Axes of symmetry are observed, round which faces of crystals are symmetrically repeated by twos or threes or fours or sixes; why is it that in crystals no axis of symmetry is ever met with round which the faces are symmetrically repeated by fives or sevens? A few words as to how this most important problem has been attacked and solved may be of interest.

We know that the characters of a crystal relative to any line in it vary with the direction of the line, but are the same for all lines parallel to each other. Such a property will result, if we imagine with Bravais that in a crystal elementary particles are arranged at equal distances from each other along every line, and are similarly arranged in all those lines which are parallel to each other; the distances separating particles being, however, in general different for lines which are inclined to each other. Such an arrangement of particles is termed parallelepipedal: space may be imagined to be completely filled with equal and similarly disposed parallelepipeds, and an elementary particle to be placed at every corner or quoin of each. Further, each particle is regarded, not as being spherical, but as having different characters on its different side; and the particles must be similarly orientated—that is, have similarly sides in similar positions.

Now, it will be seen on an examination of a model or figure that with such an arrangement any plane containing three particles will contain an infinite number, all arranged at the corners of parallelograms. Further, any such plane will clearly have whole numbers for the indices which fix its position, for along any line the distance between two particles is by hypothesis a whole multiple of the common distance between any two adjacent ones in the same line. Thus the first great crystallographic law—the law of the rationality of the indices—is an immediate consequence.

In the next place, it was found that the possible modes of symmetry of arrangement of the particles of such a system depend on the form of the paralleliped, and that any possible arrangement of the particles must present a symmetry which is identical with one or other of the six completely symmetrical types already referred to. Aod calculation shows that any other mode of grouping—a repetition by fives or sevens, for example—round an axis of symmetry, would involve the presence of planes having irrational indices; and this according to the first law is impossible.

The abeyance of symmetry, however, met with in the partially symmetrical types required the aid of an auxiliary hypothesis—namely, that the abeyance of symmetry belongs to the particle itself, and not to the arrangement of the particles.

But the parallelepipedal arrangement imagined by Bravais is unnecessarily special. Our actual observations of physical characters relate not to single lines of particles, but to groups of parallel lines of particles: the identity of character observed in parallel directions is thus not necessarily due to actual identity of each line with its neighbour, but may be due to statistical equality, an equality of averages. If, for example, a plane were divided into regular hexagons, and a particle were placed at each corner of each of these figures, the physical properties of the system of particles would be the same along all lines parallel to each other as far as experiment could decide, and yet the arrangement of the particles in the plane, though possibly crystalline, is not that of a Bravais system. In any straight line passing along the sides of a series of the hexagons, the particles will not be equidistant from each other: they are in equidistant pairs, and the two nearest particles of adjacent pairs are twice as far from each other as the particles of the same pair.

Sohncke accordingly suggested a more general definition than that of Bravais for the regularity of the arrangement, a definition which had been proposed some years before by Wiener—namely, that the grouping relative to any one particle is identical with that relative to any other. This definition admits of the possibility of the hexagonal arrangement just mentioned; further, it allows of the orientation of the particles themselves being different in adjacent lines. Following a mathematical process which had been already employed by Jordan, Sohncke deduced all the possible modes of grouping consistent with the new definition, and for a time was under the impression that the types of symmetry found by him to be mathematically possible are exactly identical with those already referred to; and this without introducing the auxiliary hypothesis relative to partial symmetry of the elementary particles of merosymmetrical crystals, except in cases of hemimorphism. It was, however, pointed out by Wulff, who has himself made valuable contributions to the subject, that though no unknown crystallographic type belongs to such a regular arrangement, one type of symmetry, that presented by dioptase, is missing; and it seems that, in this case at least, the merosymmetry can only be accounted for by the merosymmetry of the particle, or something equivalent to it, if the definition of regularity suggested by Sohncke is to be accepted. It was recognised by Sohncke that each of his point-systems can be regarded as a composite Bravais system, one of the latter being repeated in various positions corresponding with the symmetry of the parallelepiped itself.

More recently, Schonflies has made a more general hypothesis still—namely, that in each substance, whether its crystals be completely or partially symmetrical in facial development, the particles are not of a single kind, but of two kinds, related to each other in form in much the same way as a right-hand glove and a left-hand glove. With this hypothesis he finds that all the thirty-two known types are accounted for without any specialisation of the characters of the particle, and that no other type of symmetry is mathematically possible.

It now only remained to discover that Prof. Hessel had already arrived at the thirty-two types of crystallographic symmetry by mathematical reasoning more than sixty years ago; his work, being far in advance of his time, appears to have attracted no attention, and the memoir remained unnoticed till more than half a century after its publication.

Starting from Sohncke's definition of a regular point-system, and proceeding, though independently, by a method which closely resembles that of the regular partitioning of space by Schonflies, Mr. William Barlow has given in a paper just issued a general definition applicable to all homogeneous structures whatever, and has shown that every such homogeneous structure falls into one or other of thirty-two types of symmetry, coinciding exactly with the thirty-two types of crystal-symmetry. He points out that each of those homogeneous structures which possess planes of symmetry or centres of symmetry does so by reason of its having an additional property beyond mere homogeneity, namely, that if we disregard mere orientation, it is identical with its own image in a mirror. Mr. Barlow further discovers that every one of the Sohnckian point-systems can be geometrically constructed by finite repetition of some one of a certain ten of them.

Lord Kelvin, who, with characteristic versatility, has lately enlightened us with his researches on Molecular Tactics, has quite recently attacked another problem of the same group, and has sought to discover the most general form of cell which shall be such that each cell encloses a single point of a Bravais system, while all the cells resemble the parallelepipeds, of which we have already spoken, in being equal, similar, similarly orientated, and in completely filling up space. He finds that in the general case the cell can have at most fourteen walls, which may be themselves either plane or curved, and may meet in edges either plane or curved. Having regard, however, to the limited time at our disposal, we may hesitate before following Lord Kelvin into his curious and many-walled cells.

The deduction of the thirty-two types of symmetry by mathematical reasoning was also made independently by both Gadolin and Viktor von Lang thirty years ago from the law of rationality of indices; while Fedorow points out that the method of deduction recorded in the recent German treatise of Schonflies is remarkably similar to the one independently published by himself in Russia. Both Curie and Minnigerode have also lately given comparatively brief solutions of the problem.

Nor must I omit to mention to you the elaborate memoir dealing with the symmetry of parallelepipedal point-systems which was written by the late Prof. Henry Stephen Smith, whose too early death this University has so much reason to deplore. To the outer world he was perhaps best known as one of the most perfect mathematicians of the age, but those who had the good fortune to find themselves among his pupils will always treasure up in their memory rather the kindly courtesy, the warm sympathy of the man, than the genius, however transcendent, of the mathematician.

To sum up this part of the subject—it is now established that a definition of the regularity of a point system can be so framed that thirty-two, and only thirty-two, types of symmetry are mathematically possible in a regular system, and that these are identical with the types of symmetry that have been actually observed in crystals, or are inferred by analogy to be crystallographically possible.

It remains for subsequent investigators to determine what the points of the system really correspond to in the crystal; according to Schonflies, the physicist and the chemist can be allowed in each crystal absolute control within a definite elementary region of space, and the crystallographer is only entitled to demand that the features of this region are repeated throughout space according to one or other of the thirty-two types of symmetry already referred to; or, what appears to be the same thing, the crystallographer requires mere homegeneity of structure.

Simplicity of Indices.—We have seen that the planes containing points of a regular point-system have rational indices. But there still remains unaccounted for the remarkable fact that the indices of the natural limiting faces, and also of the cleavage-planes of a crystal are not merely whole numbers, but are in general extremely simple whole numbers. Bravais and his followers have sought to account for this by the hypothesis that both the natural limiting planes and the cleavage-planes are those planes of a point-system which are most densely sprinkled with points of the system. Curie and Liveing, independently of each other, have been led to the same result from considerations relative to capillary constants. Sohncke, however, pointing out that there are many cases—for instance, calcite—where an excellent cleavage-plane is rarely a limiting plane, suggests that his generalised point-system is more satisfactory than a Bravais system in that not only the density of the sprinkling must be had regard to, but also the tangential cohesion of the particles in the plane, and that in his system these may be independent of each other; while Wulff remarks that Sohncke's arrangement is identical with that of Bravais for the anorthic system, where the same objection holds, and he denies the legitimacy of the reasoning by which the hypothesis of a relation between the density of the sprinkling of points on a plane and the likelihood of the natural occurrence of the plane as a limiting face is supported.

Complexity of Indices.—Doubtless, however, crystal faces are observed of which the symbols involve indices far exceeding 6 in magnitude—so complex, in fact, that one is tempted to doubt the rigidity of the experimental proof that indices are necessarily rational. Often, though the numbers are high, their ratios differ by only small amounts from simple ones. A most patient and detailed study of such faces was made for danburite by the late Dr. Max Schuster of Vienna, and the results were brought by him some years ago to the notice of this Section. From careful examination of similar faces in the case of quartz, Molengraaf has been led to conclude that it is extremely probable that such faces are of secondary origin and have been the result of etching; they would in such case correspond, not to original limiting planes, but to directions in which the crystal yields most readily to solvent or decomposing influences.

Optical Characters.—Passing from the purely geometrical characters of crystals to the optical, we may in the first place remark that the relationship between crystalline form and circular polarisation discovered by Herschel in the case of quartz, has been generalised since the issue of Whewell's Report. We now know that many crystallised substances belonging to different systems give circular polarisation, and that all of them are merosymmetrical in facial development or structure; further, they belong to types of symmetry which have a common feature, though this is only a necessary, not a sufficient, condition.

The importance of the discovery of the dispersions of the mean lines has already been referred to.

We may recall attention to the fact noticed by Reusch that when cleavage-plates of biaxal mica are crossed in pairs and the pairs are piled one upon another in similar positions, the optical figure yielded by the combination approaches nearer and nearer to that of a uniaxal crystal the thinner the plates and the more numerous the pairs: in the same way, by means of triplets of plates, each plate being turned through one-third of a complete revolution from the position of the preceding one, it is found possible to closely imitate the optical figure of a right-handed or a left-handed circularly polarising crystal.

And it has been observed that repeated combinations of differently orientated parts actually occur in crystals. Large crystals of potassium ferrocyanide, for example, are really composite, and the different parts are differently orientated: on the one hand, a thick slice may give an optical figure which is uniaxal; on the other hand, a thin slice shows two optic axes inclined to each other at a considerable angle.

It has been suggested that the circular polarisation of quartz and other crystals is due to a spiral molecular arrangement orresponding to that of the mica-triplets as arranged by Reusch. ;uch a spiral arrangement is shown by the points of the corre-ponding Sohnckian system.

Optical Anomalies.—As already mentioned, we owe to 3rewster the establishment of the relation between the optical ·ehaviour of crystals and the systems of crystallisation. But in he course of his long research Brewster met with numerous ·uzzling exceptions, and to the investigation of the origin f their peculiar optical behaviour he devoted much study; ıbsequent workers have concurred in expressing their admira-on of the accuracy of his observations and descriptions, more specially when regard is had to the extreme simplicity of the pparatus available in those early days.

It was recognised by Brewster that some of these optical nomalies are due to a condition of strain, of the crystal as in ıe case of the diamond. But in other minerals, as analcime nd apophyllite, the hypothesis of strain was not entertained by im: he regarded the crystals as being truly composite and not imple; and, recognising optically different kinds of apophyllite, ent so far as to give to one of them the specific name of tesse-te by reason of its distinctive characters. Biot, on the other and, sought to account for this kind of optical behaviour in nother way, by the hypothesis of lamellar polarisation: a rystal of alum, for example; he held to be built up of thin ıminæ arranged parallel to the octahedral planes, and imagined ıat light which had traversed such a crystal is polarised by its assage through the aggregation of laminæ in the same way as y passage through a pile of glass plates. But in the latter case ıere is a frequent passage of the light from air to glass and lass to air, whereas in the case of alum there is no evidence of ıe existence of atmospheric intervals. Frankenheim sought to vercome this difficulty by the further hypothesis that the ıccessive layers of a composite posassium- and ammonium-lum are of different chemical composition, but such a differ-ıce of material would be insufficient for the desired object by ·ason of the nearness to each other of the refractive indices of lums of different composition. Still it is a remarkable fact that either a pure potassium-alum nor a pure ammonium-alum ıows any depolarisation-effects at all; these belong only to ıe alums of mixed composition, and yet there is no visible ifference in the physical structure of the crystals of simple and omposite material.

An epoch was made in the history of the so-called optical nomalies by the publication in 1876 of an elaborate memoir by rof. Ernest Mallard of Paris, whose death last month eprived Mineralogy of its greatest philosopher. To make the osition more clear, we may take as a definite illustration the ıineral boracite. In development of faces and magnitude of ngles the crystals of this mineral are, as far as measurement ith the goniometer can decide, precisely cubic in their sym-ıetry. But an apparently simple crystal of boracite, when xamined in polarised light, behaves exactly like a regularly omposite body. If the crystal be a rhombic dodecahedron in xternal development, all the twelve pyramids which can be ırmed by drawing lines from the centre to the angular points re found to be exactly similar to each other in everything but rientation; and, further, each of them has the optical haracters of a biaxal crystal, the optic bisectrix of each indi-idual pyramid being perpendicular to the corresponding base, nd thus having a different direction for each of the six pairs of arallel faces of the dodecahedron. Hence Mallard inferred ıat boracite belongs really, not to the cubic, but to the ortho-ıombic system, and that its crystallographic elements are so early those of a cubic crystal that the molecular structure is in able equilibrium, not only when different molecules have their milar lines parallel, but also when only approximately similar nes have the same orientation: further, the cubic symmetry of ıe external form was regarded by him as a consequence of the pproximation of the crystallographic elements to those of a ıbic crystal and of the variety of orientation of the constituent ıoleculcs. Variety of orientation of constituent molecules is, ı fact, already recognised in the case of ordinary interpenetrant vins. The variation of optical character in different crystals f the same substance or different parts of the same crystal was ıen explained as being due to the variation in the number of ıolecules belonging to each mode of orientation.

According to another view, it was contended that a crystal f boracite is really cubic and simple, but that, like unannealed lass, it is in a state of strain related to the external form. It as replied that the optical characters of such unannealed glass are changed with the change of strain which follows the fracture of the specimen, while those of boracite are unaltered when the crystal is broken. To this it was rejoined that a once compressed gum retains its depolarising character unchanged on fracture of the specimen, and that the same permanence may very well be a character of some strained crystallised bodies.

The controversy, however, passed to a fresh stage when it was discovered that boracite becomes optically isotropic when sufficiently heated, and resumes an optically composite character on cooling. Mallard showed that the temperature at which the change takes place is a definite one, 265° C., and that a definite amount of heat is absorbed or given out during the change of condition.

It is now agreed that boracite is really dimorphous; that above 265° it is cubic in symmetry, below 265° orthorhombic: the only remaining point of controversy as regards boracite seems to be whether the external form owes its cubic symmetry to the crystallisation having taken place at a temperature higher than 265°, and therefore when the structure itself was truly cubic—or at a temperature below 265°, in which case the cubic character of the form would be ascribed to the fact that the orthorhombic constituent particles are so nearly cubic in their dimensions that at any temperature they may by variety of orientation combine to form a structure having practically cubic symmetry, and naturally limiting itself by faces corresponding to such a symmetry.

In exactly the same way leucite and tridymite become re-spectively optically isotropic and uniaxal when sufficiently heated, and the optical characters then correspond exactly to the symmetry of the external form.

Three years ago Dr. Brauns prepared a most useful summary of the ninety-four memoirs which had up to that time been con-tributed relative to the much-discussed subject of the optical anomalies of crystals, and added many new experimental results which had been obtained by himself. He concludes that the original view of Mallard—namely, that an optically anomalous structure consists merely of differently orientated particles of the same kind and of symmetry approximating to a higher type—is only applicable to a very limited number of crystals, such as those of prehnite; that dimorphism is the true cause in others, boracite being an example; that in the remaining minerals the cause is strain, which in some of them is due to foreign enclosures, as in the case of the diamond, and in others is due to a molecular action between isomorphous substances, as in the mixed alums and the garnets.

Planes of Gliding.—One of the most startling of crystallo-graphic discoveries was one made by Reusch, who found that if a crystal of calcite is compressed in a certain way each particle springs into a new but definite position, exactly as if the crystal had undergone a simple shear and the particles at the same time had each described a semi-somersault: a simpler method of producing the same result was discovered afterwards by Baumhauer. If only part of the calcite crystal is sheared, the two parts of the structure itself are related to each other in the same way as the two parts of a twin growth; but in general the external form is different from that of a twin, since after the shearing of the material few of the faces retain their former crystallographic signification. The property has since been shown by Bauer, Liebisch, and more especially Mugge, to be a very general one; and doubtless the so-called twin lamellæ met with in rock-constituents have in many cases resulted from pressure during earth-movements long subsequent to the epoch of formation of the crystals. Similar lamellæ have been pro-duced artifically in anhydrite and some kinds of felspar by ex-posure of the crystals to a high temperature.

Piezo-electricity.—The most remarkable addition to our knowledge of the relation of minerals and electricity has been the recent discovery of the electrification produced by strain (piezo-electricity). It has been shown by J. and P. Curie that if a quartz-plate, with faces cut parallel to the axis and silvered to make them conductive, be strained in a certain direction, the two faces either become oppositely electrified or show no signs of electrification at all, according as the faces of the plate are cut to be perpendicular to the prism-faces, or to pass through the prism edges. Lord Kelvin says that this result is explicable by electric eolotropy of the molecule and by nothing else, a character which he had suggested for the molecule thirty-four years ago: experiments confirmatory of this hypothesis of the permanent electrification of the molecule were made some time ago by Riecke.

Pyro-electricity.—The development of opposite electricities at different parts of a crystal during changing temperature (pyro-electricity) has long been known in the case of tourmaline. We owe to Hankel a long series of investigations of this kind relative to boracite, topaz, and various other minerals, but it seems to be now established that most of the electrifications observed by means of his method are really piezo-electric, and are due to strains caused by inequality of temperature in different parts of the cooling crystal. A model has been lately made by Lord Kelvin which gives a perfect mechanical representation of the elasticity, the piezo-electricity, and also the pyro-electricity of a crystal.

Electrical Methods.—A delightfully simple method of investigating the difference of electrical condition of the parts of a cooling crystal and of making the distribution of electricity visible to the eye has been invented by Kundt. Mixed particles of red minium and (yellow) sulphur are oppositely electrified by their passage through the meshes of a small sieve; falling on the cooling crystal, each particle adheres to the oppositely electrified region, and the electrical condition of the latter is thus immediately indicated by the colour of the adherent powder. Mr. Miers remarks that this method is practically useful as a means of discrimination even when the crystals are extremely minute.

Other Physical Characters.—Of other physical characters much studied since the issue of Whewell's Report, I may recall to you more especially the dilatation of crystals on change of temperature, in which the observations of Mitscherlich have been extended by Fizeau and Beckenkamp; the forms of the isothermal surfaces of crystals, as determined by Sénarmont, and afterwards by Röntgen; the magnetic induction treated of by Faraday, Lord Kelvin, Plucker, and Tyndall; the hardness of crystals for different directions lying in the same faces, by Grailich, Pekárek, and Exner; the elasticity of crystals, investigated by Neumann, Lord Kelvin, Voigt, Baumgarten, and Koch; the distortion of crystals in an electro-magnetic field, by Kundt, Röntgen, and MM. Curie.

Chemical Relations.—In the short time I can reasonably ask you to allow me it is clearly impossible to enter upon any discussion of the increase of our knowledge of the chemical relations of minerals, and to treat of the much-investigated subjects isomorphism, polymorphism, and morphotropy, nor can I attempt to give you any idea of the advance which has been made towards a natural classification: nor must I mention the experiments which have been made relative to the growth of crystals, the etching of their faces, or their directions of easiest solution.

As regards systematic mineralogy an immense amount of progress has been made. The condition of affairs in 1832 was described by Whewell as follows:—"We have very few minerals of which the chemical constitution is not liable to some dispute; scarcely a single species of which the rules and limits are known, or in which two different analyses taken at random might not lead to different formulæ; and no system of classification which has obtained general acceptation or is maintained, even by its proposer, to be free from gross anomalies." An idea of the extent of the improvement will be best obtained from a comparison of the first edition of Dana's Treatise, published in 1837, and that treasury of information, the sixth edition, which appeared in 1892. The names of Miller and Descloizeaux are to be honourably mentioned in connection with this detailed work on species. In the interval of time under consideration the number of well-established species has been more than doubled, and the rate at which new species are discovered shows as yet no sign of diminution. In particular, I may remind you of the work which has been done in the correlation of the members of large groups, like the felspars, amphiboles, pyroxenes, scapolites, micas, tourmalines, and garnets. A paper just published by Penfield relative to topaz furnishes an excellent illustration of the important results which are still to be arrived at from a careful study of a common mineral. It has long been known that the mutual inclination of the optic axes of topaz is very different in different specimens, and it has been suspected that the variation might depend on the percentage of fluorine. Prof. Penfield has carefully determined, not only the fluorine, but also the water yielded in the course of analysis of specimens from different localities, and finds that the analytical results are best explained by the hypothesis of an isomorphous replacement of fluorine by hydroxyl; further, he discovers that the magnitude of the angle between the optic axes is a function of the amount of that replacement.

The successes achieved in the artificial formation of minerals, the advances made in the methods of discrimination of minerals by the blowpipe and micro-chemical reactions, the increase in our knowledge of the modes of alteration of minerals, of their association, of their modes of occurrence, must all be left undiscussed.

Instruments.—I may add a word relative to the instrumental appliances which have been placed at the service of the mineralogist since the issue of Whewell's Report. As regards goniometers, the provision of two mechanical circular movements in perpendicular planes for the easier adjustment of a crystal-edge parallel to the axis of the instrument, first suggested by Viktor von Lang when assistant at the British Museum, has proved a great convenience and is now in general use. The employment of a collimator with interchangeable signals, of a telescope with interchangeable eyepieces, and the provision of lenses and diaphragms for obtaining images from faces so small as to be invisible to the unassisted eye, would seem to have brought the reflective goniometer, the invention of our distinguished countryman Dr. Wollaston, to a degree of perfection where further improvement is scarcely to be looked for; though two crystallographers, Fedorow and Goldschmidt, have recently constructed instruments with an additional telescope and entirely different arrangements. It may be worthy of remark that, though reflective goniometers are generally made for use with very small specimens, one was constructed for the British Museum some years ago by which it is possible to measure the angles of a valuable crystal without removal of the specimen from a matrix of several pounds' weight.

The polariscope for use with convergent light, the stauroscope, the employment of polarised light with the microscope, the adaptation of the microscope for the observation of the interference-figures yielded by extremely minute crystals, the spectroscope in the investigation of selective absorption, have all proved of great service in the advancement of our knowledge of the characters of minerals.

Worthy of special mention is that recent addition to our resources, the total reflectometer, an instrument by which it is possible to determine with wonderful accuracy the refractive index or indices from observation of the reflected light. The process was long ago suggested by Wollaston: but it is only within the last few years that forms of instrument have been devised by Kohlrausch, Soret, Liebisch, Pulfrich, and Abbe, which make the method as precise in its results as that which depends on refraction by a prism. In its more refined forms the total reflectometer has been used to test the accuracy of the form of Fresnel's wave-surface: in the convenient, though less precise, form devised by Bertrand, the instrument is useful in the discrimination of the species of minerals.

For the measurement of the optic axal angle, when the angle is so large that the rays corresponding to the optic axes are totally reflected at the surface of the plate and do not emerge into air from the crystal, Prof. W. G. Adams made the valuable suggestion that the crystal-plate should be interposed between two hemispheres of glass; several instruments on this principle have been constructed abroad, and have only been imperfectly satisfactory, but one lately made in this country for the British Museum, under the superintendence of my excellent colleague Mr. Miers, proves to be most efficient for the intended purpose. Mr. Tutton's apparatus for supplying monochromatic light of any desired wave-length is a noteworthy addition to the instrumental resources of the mineralogist. The meldometer of Joly for the more accurate determination of the fusing point of minerals should also be recalled to you.

In this slight sketch it has been possible to make only the barest mention of some of the more important results which have been arrived at since the issue of Whewell's Report. You will doubtless think that it must have been possible in the year 1832 to look forward enthusiastically to the progress which was about to be made. But though Professor Whewell was himself confident that valuable discoveries would reward the mineralogical worker, he was sadly depressed, and, I think I may venture to say, with good reason, by the neglect of mineralogical study in this country. His own words are: "This decided check in the progress of the science has, I think, without question, damped the interest with which Mineralogy, as a branch of Natural Philosophy, has been looked upon in Eng land. Indeed, this feeling appears to have gone so far that all the general questions of the science excite with us scarcely any interest whatever. But a more forward and hopeful spirit appears to have prevailed for some time in other countries, especially Sweden, Germany, and more recently France." Those are the words of despair. I may add that in the same year he resigned his professorship of Mineralogy, and directed his vast energy to the advancement of other subjects.

Now, I think, that a country like our own, which aims at taking and maintaining a high place in the scale of civilisation, ought in some way or other to secure that in every important branch of learning there is a group of men in the country who will make it the main purpose of their lives to render themselves familiar with all that has been and is being discovered in the subject, will do whatever is possible to fill up the gaps in the science, and, last but not least, will make the more important results accessible to other workers for whom so complete and original a survey is impracticable.

No one will doubt that Mineralogy should be such an important branch of learning. Minerals existed before man was thrust upon the scene; they will possibly continue to exist long after he himself has passed away; at least as persistent as himself, they will have an interest for every age.

The continental nations have not only long recognised the importance of mineralogical study, but have acted accordingly. The difference between action and inaction will be most clearly grasped if we compare the position of Mineralogy in Germany with that in this country.

In Freiberg, the centre of a mining district in Saxony, an institute was opened in the year 1766 for the scientific training of those students whose interest was in minerals, and the lectures on Mineralogy given there by Prof. Werner became a prominent feature; of the many pupils of this remarkable man, Von Buch Breithaupt, Haidinger, Humboldt, Mohs, Naumann, and Weiss may be especially mentioned as having afterwards distinguished themselves by their scientific work. Of other Germans, who have likewise gone to their rest after much labour given to the advancement of Mineralogy and Crystallography, we may especially recall Beer, Bischof, Blum, Credner, Hessel, Klaproth, Kobell, Lasaulx, Mitscherlich, Neumann, Pfaff, Plattner, Plücker, Quenstedt, Vom Rath, Reusch, Gustav Rose, Heinrich Rose, Sadebeck, Scheerer, Sartorius von Waltershausen, Websky, and Wöhler. Of the many Germans who are now contributing to our knowledge of minerals it is an invidious task to make a selection, but we may mention Arzruni, Bauer, Beckenkamp, Bücking, Cathrein, Cohen, Goldschmidt, Groth, Haushofer, Hintze, Hirschwald, Klein, Klockmann, Knop, Laspeyres, Lehmann, Liebisch, Lüdecke, Mügge, Osann, Rosenbusch, Sandberger, Streng, Voigt, Weisbach, and Zirkel: most of them are University Professors of Mineralogy; all of them hold important positions as teachers of the subject. Further, the laboratories and instruments available for the teaching of practical work are in many cases, notably at Strassburg, Munich, Göttingen, and Berlin, of an elaborate character.

So much for Germany; let us now look at home. In the Universities of England, Wales, Scotland, and Ireland there is a grand total of—two Professorships of Mineralogy, one of them at Cambridge, the other, and younger one, at Oxford. Further, the stipends are nearly as low as they can be made; in the former case, according to the University Calendar, the stipend paid from the University Chest to the present holder of the office amounts to 300*l*. a year; in the more ancient but less extravagant University of Oxford, the Calendar states that the present professor receives, subject to previous deduction of income-tax, the annual sum of 100*l*., and the necessary instruments and many of the specimens have presumably been provided from his private resources; in case of residence he is to be allowed another 150*l*. a year for the luxuries which University life involves. And these are the only teaching appointments in his own subject that a successful investigator of minerals can look forward to being a candidate for! The result is that all those students who intend to earn their own living, all those who feel anxious to undertake professorial work, conclude that, however much they may be interested in the investigation of the characters of minerals, they will do well to follow the example of Prof. Whewell and turn to other branches of science in which there is a more hopeful prospect of their studies meeting with practical recognition.

It cannot be expected that advanced Mineralogy will ever be able to command the attention of more than a limited number of students, seeing that its successful pursuit requires a preliminary knowledge of at least three other sciences—mathematics, physics, and chemistry—sciences which must be assigned a fundamental importance in any scheme of education; if geology can be added, so much the better. Only few students can find time in their undergraduate days to acquire a competent knowledge of the preliminary sciences and to proceed afterwards to the study of Mineralogy. But the comparatively flourishing condition of the science in Germany, France, and other countries indicates that this is not a sufficient reason for refraining from giving proper facilities and encouragement to those who wish to enter upon its study. Some years ago the University of Cambridge took a step in the right direction, and introduced Mineralogy into their examinational system in such a way that the students of Physics, Chemistry, and Geology could give time to the acquisition of a knowledge of Crystallography and Mineralogy, and obtain credit for that knowledge in the examination for a degree.

It is clear that if in the future there is to be an honourable rivalry between this and other countries in the advancement of the knowledge of minerals, each of our Universities should be enabled in some way or other to found Professorships of Mineralogy, and be prevailed upon to follow the example of Cambridge in encouraging the students of Physics, Chemistry, and Geology to acquire a knowledge of Crystallography and Mineralogy before their education is regarded as complete. Even where a student has no intention of devoting himself to advanced mineralogical study, an elementary knowledge of Crystallography and Mineralogy will be extremely useful in giving him a better grasp of his own special subject.

And if, perchance, any of you are anxious to reduce the amount of those unmentionable duties of which we have heard so much of late, and feel that you can best do this by the endowment of Professorships of Mineralogy in our Universities, I would advise you not to do what has been so long practicable at this Association, couple Mineralogy with any other science—that would be an unwise economy. Each of the sciences is now so vast in its extent that no professor can be thoroughly master of what has been done, and is now being done, by other workers, in more than one of them. I remember that in my younger days it was held by some at Oxford that the Professor of Mineralogy, a so-called subordinate subject, should continue to be paid on a lower scale than his brother professors, and that he should obtain a living wage by adding a college tutorship or a lectureship in some other subject to his professorial duties. It is not by the prospect of such appointments that you can expect the most capable men to be attracted to the study of minerals. The practical effect of such an arrangement would only be that a college lecturer would give formal teaching in Mineralogy while devoting his real energy to another subject in which the pupils are more numerous.

It only remains to thank you for the way in which you have listened to a technical address relative to a science for the study of which very few facilities have been offered to you in our own country. Not often does the mineralogist present himself before an audience; he sees only too clearly that

> The applause of listening senates to command,
> To read his history in a nation's eyes,
> His lot forbids;

but I shall not have broken the long silence in vain if I have made clear to you that, though the Science of Mineralogy is itself making great progress, we have hitherto given too little encouragement to its study in our own Universities, and lag far behind both Germany and France in the recognition of its importance.

NOTES.

WE notice with much regret that Dr. C. R. Alder Wright died on July 25, at the early age of forty-nine. He was elected a Fellow of the Royal Society in 1881.

DR. M. FILHOL has been appointed to the chair of Comparative Anatomy in the Paris Muséum d'Histoire Naturelle, in succession to the late Prof. Pouchet.

ACCORDING to a telegram from Prjevalsk (formerly Karakol), a monument to the Russian traveller Prjevalsky has been unveiled there. The monument is built very picturesquely on the slope of the mountains, facing Lake Issyk-kul.

IT is reported that Prof. Brugsch, the eminent Egyptologist, is seriously ill.

MR. CHARLES E. CASSAL, Public Analyst for Kensington and St. George's, Hanover Square, has been elected honorary president (of Section VII. Food) of the forthcoming International Congress of Hygiene and Demography at Budapest.

NEWS of the Wellman Arctic expedition has been received which fortunately confirms the hope, which we expressed when the report of the disaster was received, that the exploring party of the expedition had escaped the initial danger. The *Malygen*, a Norwegian fishing vessel, arrived at Tromsö from Spitzbergen, on August 2, with the captain and three of the crew of the *Ragnvald Jarl* on board. They report that Mr. Wellman landed on May 24, at Walden Island (80° 37′ N.), in the north of Spitzbergen, with 13 men, all in good health, 40 dogs, and provisions for 110 days. Four days later the *Ragnvald Jarl* was crushed in the ice and sank, only part of the stores and equipment being saved. A message was despatched to Mr. Wellman, who was overtaken at Marten's Island, and immediately returned with several members of his party, and after helping to build a house on Walden Island for the shipwrecked crew, set out finally on May 31 for his northern journey. He was heard from on June 17, when Mr. Winship left the advanced party, who were waiting six miles east of Platen Island for open water to form, as the ice was impassable. All were well at that time. This news shows that Mr. Wellman found the conditions of ice-travel harder than he had expected, and since he had spent so much of the best time of the year in travelling so short a distance, there seems little hope that he could have made a great journey northward before the general southward movement of the ice set in, and compelled his retreat to Danes Island. Baron Nordenskjold telegraphs to the Royal Geographical Society, strongly urging the importance of sending out a supply of provisions, and arranging for the return of the expedition to Europe, should it succeed in regaining Spitzbergen.

THE great Constantine medal of the Russian Geographical Society has been awarded this year to Prof. A. N. Veselovsky, for his thirty-five years' work in the domain of both Russian and West European ancient literature and folk-lore; and the Count Lutke medal to W. E. Fuss, for his many years' investigations of chronometers. It is known that since the splendid researches of Struve into the influence of temperature upon the errors of chronometers, these errors can easily be eliminated; but that changes of moisture still continued to remain a considerable cause of errors, the more so as its action was found to be different on different instruments. In the course of his researches, Fuss made the important discovery that the rate of some chronometers is not modified at all by that cause, and he was able to determine a means of rendering the instruments quite insensible to the influence of moisture. Consequently, all devices which are in use in the navies of Western Europe for isolating the chronometers from the surrounding moisture on board ship, have been abandoned in Russia; and the chronometer determinations are nevertheless quite free from this source of error, as may be seen from the many researches of Fuss, printed in the "Hydrographical Memoirs," published at St. Petersburg. The great gold medals of the different sections of the Geographical Society have been awarded, by the section of Ethnography to M. Karskiy, for researches among the Byelo-russians; in Statistics, to a collective work of twenty-two explorers, on the economic conditions of the peasants in the governments of Irkutsk and Yeniseisk; and to Prof. Fortunatoff, for various works, of which his inquiry into the productivity of rye crops in European Russia is the most remarkable. The great silver medal bearing Prjevalsky's name has been awarded to K. N. Rossikoff, for his explorations of the glaciers and physical geography of Caucasus. Small gold medals have been awarded to B. I. Sreznewski, for meteorological work; D. Z. Trofimenko, for cartographic work in Mezen; and to P. S. Popoff, for translations of Chinese manuscripts relative to Mongolia. Several silver and bronze medals have been distributed for various works of less importance.

WE have received from the Imperial Russian Geographical Society a pamphlet by Admiral S. Makaroff, setting forth the desirability of an international agreement with regard to the publication of the materials contained in the meteorological log-books of ships in all parts of the world. Admiral Makaroff has paid some attention to this subject, and as the author of a volume containing the results of observations made during a voyage of exploration round the world, in the Russian frigate *Vitiaz*, in 1886–89, his opinion carries considerable weight. He proposes that original observations should be published by each country in a tabular form, or at least for a period of two years, viz. from January 1, 1882, to January 1, 1884, thus embracing the time during which observations were made by the international Polar expeditions. In the report of a committee appointed to consider certain questions relating to the Meteorological Department of the Board of Trade, and presented to Parliament in 1866, of which Mr. Francis Galton was a member, it was recommended that the results of marine observations should be published on one uniform plan, in the form of tables, for months and seasons. The main difference between these two proposals is that Admiral Makaroff asks for original observations, pointing out that mean data give no exact idea of the daily changes which occur in the condition of the atmosphere. At a conference on maritime meteorology, held in London in 1874, it was also recommended to publish deductions in the form of tables, in addition to charts. Thus while general opinion favours a tabular, as one form of publication of marine meteorological data, experience of over forty years, since the Maritime Conference held at Brussels, shows that each country is disposed to publish its observations in the form suited to its own requirements, Russia, only, having published a small number of meteorological logs *in extenso*; so that the prospect of any international agreement binding all countries to adopt any special form of publication, however desirable it may be, seems very remote.

THE Midland Union of Natural History and Scientific Societies held their seventeenth annual meeting at Ellesmere, Shropshire, on Friday and Saturday last. The Council met at the Town Hall on Friday afternoon, under the presidency of Mr. W. H. Wilkinson, and eleven delegates from the various societies were present. It was decided that the papers competing for the Darwin medal should be published within the area of the Union, in place of the *Midland Naturalist*, now defunct. The annual meeting was subsequently held in the Museum, when Mr. Brownlow R. C. Tower was elected president for the ensuing year, Mr. Egbert de Hamel was re-elected treasurer, and Prof. Hillhouse (Mason College, Birmingham) and Mr. T. V. Hodgson (of Harborne) were elected secretaries.

PROF. W. C. MACKENZIE, of the Tewfikieh College of Agriculture, Ghizeh, sends us some further particulars with regard to the nitrate-bearing clays of Egypt, described in these columns in May last (vol. l. p. 61). It appears that Messrs. Floyer and Sickenberger have sent in a preliminary report, in which they state that the supply seems to be almost inexhaustible. They consider it to be a "foliated marl, greenish and sometimes reddish, with veins of white gypsum, and incrustations or small crystals of chloride of sodium, and some sulphate of sodium. Its taste is salty and slightly bitter, from the latter

Its primary stratum has a depth of from 50 metres (Floyer and Seckenberger) to 100 metres (Zittel), and is horizontally bedded between the Lower Londinian, a hard white limestone of the Lower Eocene, and the Suessonian, a yellowish or greyish limestone between the Lower Eocene and the Upper Cretaceous formations." Prof. Mackenzie says that the substance is hard and stony in the deeper regions, and disintegrated near the surface. The compositions of the samples obtained, however, do not give any further information as to the possibility of extracting the nitrate with any hope of commercial success. Fifteen samples were sent to Prof. Mackenzie, and they contained quantities of nitrate varying from 1 per cent. to 17·5 per cent. The average of all would be equal to about 5 per cent. but whether this represents the composition of the mass, is open to question. We understand that a lot of forty tons has been taken to Cairo for extraction, and this will give a better idea as to the possibility of success than can be obtained from the analyses of small samples taken at random from the surface.

WE recently referred to the important studies of M. Marcel Bertrand on the geological structure of the Western Alps. A full account of them, with maps and sections, has now been published in the *Bull. Soc. Géol. France.* The author also describes the lustrous schists of that area, and concludes that they are a "flysch" facies of Triassic age.

IN a somewhat crude paper, entitled "Migration and the Food Quest, a Study in the Peopling of America," contributed to the *American Anthropologist* for July, Mr. Otis Tufton Mason, starting with the simple generalisation that the desire to appease hunger and thirst in the easiest way determines migration, seeks evidence for the primitive peopling of America from the islands of the Indian Ocean. The theory in its main features is probably sound enough, but there are so few facts bearing on the application of the theory to the peopling of America, that the specific question is not much advanced.

DR. F. PLEHN, the German Government medical officer in the Cameroons, has made a special study of the beliefs and customs of the Dualla negroes with respect to illness and death, and he has a paper on the subject in the last number of Danckelmann's *Mittheilungen aus den Deutschen Schutzgebieten.* He finds that, contrary to the custom of most primitive tribes, the magician and medical man have separate functions amongst the Dualla. The magician lives in the bush, only coming to the villages when his services are required, and his duties are practically confined to the discovery of thieves and of people who have used magic in order to produce illness or death. The doctor may be a man or a woman, and the office is usually hereditary, although sometimes a student is initiated on payment of a handsome fee. They have some knowledge of the use of plant products as medicine, but are practically ignorant of surgery.

IN the form of a lecture delivered at the Marine Biological Laboratory of Wood's Holl, Massachusetts, Prof. J. M. Macfarlane describes some very interesting observations on the irrito-contractility of plants. He maintains that, in the animal as in the vegetable kingdom, we have to do with a true contractile tissue. In the higher plants this tissue is made up of cells, each consisting of an irrito-contractile protoplasmic sac enclosing a quantity of sap, each cell being joined to neighbouring cells by protoplasmic processes which pass through minute pores in the common cellulose membrane. Irrito-contractility may be started by stimuli of a mechanical, chemical, thermal, luminous, or electrical nature. The seat of this contractility is unquestionably the vacuolated protoplasm, and not the cell-wall, as held by some observers. The degree of contraction of an organ is proportional to the relative molecular activity of the protoplasm, and to the strength or continuity of the stimulus. Prof. Macfarlane has already shown that in the leaves of *Dionæa* contractility can only be excited by two successive stimuli separated by an interval of time; and he now illustrates his conclusions by the phenomena presented by the closure of the leaves in a number of different plants.

THE Report of the Director of the Aquarium of the U.S. Fish Commission at the Chicago Exhibition (*Bull. U.S. Fish Com.* for 1893, pp. 143-190) is well worthy of perusal by those who are concerned in the management of large aquaria, or who take any general interest in such affairs. It is the record of an ambitious enterprise, fraught with many inherent difficulties; and the frank statement which Prof. S. A. Forbes has given, both of the failures and the successes which attended the efforts of his staff, should be of considerable service in other and future undertakings of a similar kind. The marine aquaria had a capacity of 40,000 galls., and, although the necessary supply of sea-water and marine animals had to be obtained at a distance of nearly a thousand miles, this part of the exhibition gave the greatest satisfaction. The fresh-water aquaria, paradoxically enough, were much more difficult to maintain in good condition, owing to the ravages wrought among the fishes by that well-known fungous pest *Saprolegnia,* the germs of which were found to be abundant in the water supply from Lake Michigan. The precipitation of nocuous matter from the water by the ingenious use of an alum tank, followed by careful filtration, was the principal means by which the disease was kept in check; but the least derangement of the filtering apparatus was immediately followed by a fresh outbreak of the plague. Another equally troublesome pest made its appearance during the hot weather in the form of an Infusorian parasite (*Ichthyophthirius* of Fouquet), which attacked and inflamed the skins of the less hardy fishes, and led to a great mortality. "Young cat-fish died like sheep with the murrain." Special observations on these two unbidden guests are given as appendices to the Director's Report. It may be mentioned, in passing, that Prof. Forbes speaks strongly in favour of the employment of shallow open pools or basins, freely exposed to sun and air, instead of the traditional deep narrow tanks with sides of glass.

A RECENT number of the *British Medical Journal* says "that a large collection of indigenous medicinal plants and drugs, fibres, and cereals has already been made in the Imperial Institute from India and the East. A great many of the Indian drugs have enjoyed a reputation in tropical diseases for the last 2000 years. They are, however, employed in the crude state, generally in combination with metallic and mineral compounds, and do not therefore indicate their individual value as medicines. They have, with a few exceptions, undergone no chemical analysis or pharmacological experimentation, and such researches have not yet been taken up either by Government or by private individuals in India, neither are there facilities or expert knowledge easily procurable for such researches. To submit them to experts in London for proper investigation would be very costly under the circumstances. The establishment of a chemical and pharmacological laboratory in connection with the Imperial Institute, under a committee of experts, would be a valuable addition. There are few institutions of the kind where any original researches can be made in London; it will therefore be a very desirable and useful institution for the promotion of science. It may in addition be expected to help towards the discovery of important medicines and products of great dietetic and commercial value. The benefits which would accrue from the institution would be greatly appreciated both by English and Indian contributors to the funds of the Imperial Institute; and it would tend to bring together scientific men from all classes and races of men in the British Empire." It is remarked with regret that though such a project as this has been contemplated by the authorities in charge of the Institute, little more progress has been made in the matter. We cordially agree with our contemporary in thinking the matter important enough to engage the attention of the committee of the Institute, and would urge that the necessary steps for its consideration be taken at the earliest possible date.

DR. J. W. VAN BEBBER, of the Deutsche Seewarte, has examined the daily synoptic weather charts for the North Atlantic Ocean and adjacent continents, issued in connection with the Danish Meteorological Institute, for four years ending November 1887, and has published some useful results obtained from them in the *Annalen der Hydrographie* for June. The tables show the frequency of the occurrence of barometric depressions in the North Atlantic for areas of 10° of longitude and 5° of latitude, and charts give further information graphically. These low pressure areas exhibit an increase of frequency from high northern to middle latitudes, and then a decrease towards low latitudes, so that below the 30th parallel the minima occur very rarely. In the meridianal direction, the barometric minima are most frequent on the eastern coast of North America, and originate less frequently over the ocean. The mean height of the barometer in the areas of low pressure exhibits several peculiarities in different seasons. In spring, the depth of the barometric minima over the whole area is relatively small; to the south of Iceland the barometer frequently falls considerably below twenty-nine inches. In summer the mean height of the barometer, especially on the ocean, is higher than in spring, the lowest readings being generally between Iceland and Greenland, while in autumn and winter the readings over the ocean are considerably lower than in the other seasons. The lowest readings are again found to the south of Iceland, where the mean minima in winter fall below 28·5 inches. With regard to barometric maxima, or areas of high pressure, their movement is mostly towards east and south-east. The regularity of their paths is shown by the charts to be much greater than is usually supposed. The behaviour of stationary maxima is very interesting; there is in all seasons a great frequency of stationary maxima over the ocean between 20° and 40° W. long. and 25° and 40° N. lat. There is also another maximum of frequency in spring and summer between Greenland and Spitzbergen. These stationary maxima exert an important influence over the weather of the British Islands, and the discussion of synoptic charts, such as now undertaken by Dr. van Bebber, is one of the most likely means of improving our knowledge of weather phenomena.

AN account of the performance of the new continuous-record seismometrograph of the Collegio Romano, during 1893 and 1894, was communicated to the Accademia dei Lincei at a recent meeting by Dr. G. Agamennone. The registration was mechanical, and not, as in some modern instruments, photographic. The pendulum for the two horizontal components was 6m. long, and carried a bob weighing 75 kgr. Records were obtained at Rome of the three earthquakes of Zante in 1893, and also of the shocks felt in Samothrace, Aleppo, Servia, and Nikolaiev. On November 5, 1893, the instruments, both at the Collegio Romano and the Rocca di Papa Observatory, registered the violent earthquake proceeding from Turkestan and Northern India. But the most interesting record, reproduced in the author's paper, is that of the Japanese earthquake of March 22, 1894. The disturbances registered at Rome lasted nearly an hour, and showed three main series of shocks, with intervals of comparative quiet between. Towards the close of the earthquake the individual wave-lines became distinctly visible, each wave taking about seventeen seconds to pass. Taking the velocity of propagation of these earth tremors as 2500 metres per second, this would give some 40 km. for the wave-length of this disturbance. These slow undulations began to appear at 11h. 58m., whereas from the beginning of the earthquake at 11h. 37m. 20s. till then the period had been much shorter, and the individual traces overlapped. What is of special importance in this record is the enormous distance—nearly one earth-quadrant—across which the disturbance was propagated.

AT the last meeting of the Société Helvétique des Sciences Naturelles at Lausanne, M. Raoul Pictet gave some particulars concerning cold-burns experienced by himself and his assistants during his investigations of the lowest temperatures attainable. He distinguishes two degrees of burns. In the case of the first, the skin is reddened, and turns blue on the following day. The area of the spot is nearly doubled during the following days, and it is not generally healed till about five or six weeks afterwards. It is accompanied by a very painful itching on the affected spot and the surrounding tissues. When the burning is more serious, produced by a longer contact with the cold body, or by contact rendered perfect by alcohol, ether, or liquid air, a burn of the second degree is experienced. The skin is rapidly detached, and all the parts reached by the cold behave like foreign bodies. A long and stubborn suppuration sets in, which does not seem to accelerate the reconstitution of the tissues. The wounds are always malignant, and scar very slowly and in a manner altogether different from burns produced by fire. When on one occasion M. Pictet had suffered a severe burn on the hand, due to a drop of liquid air, he seriously scorched the same hand accidentally. The scorched portion was healed in ten or twelve days, whereas six months afterwards the wound produced by the cold burn was still open. In order to try the effect of radiation in dry cold air, M. Pictet held his bare arm up to the elbow in a refrigerating vessel maintained at − 105° without touching the metallic walls. He felt over the whole skin and throughout the muscles a sensation which had a distinct character, and could not be described by words. The sensation is not disagreeable at first, but gradually becomes decidedly so, and appears to have its seat in the central bone or the periosteum. After three or four minutes the skin is rather blue, and the pain becomes intense and more deep-seated. On withdrawing the arm from the refrigerator at the end of ten minutes a strong reaction is experienced, accompanied by superficial inflammation of the skin. This reaction resembles that which takes place after handling snow for some time with bare arms, except that it is more intense.

WHETHER electromagnetic waves are capable of producing mechanical effects on the conductors forming resonators, is a question which has been investigated by different observers, the results obtained being entirely discordant. The current number of *Wiedemann's Annalen* contains a paper, by Herr Lebedew, on the subject, in which he describes a new form of apparatus which he has employed, and with which he finds that these waves can exert mechanical effects on suspended resonators. The electric waves were set up by means of a Lecher wire system twenty-eight metres long; the waves in this system, which damp out with such great rapidity, being used to induce others in a suitably placed vibrator. The magnetic vibrator consists of a piece of zinc, 20 cm. by 65 cm., bent double, so that the distance between the opposite ends, which form the plates of a condenser, could be adjusted, and thus the wave-length of the vibrations produced be varied between 320 cm. and 380 cm. The magnetic resonator consists of a coil of four turns of fine silver wire, with its axis horizontal, and having terminals connected to two electr meter needles, the relative position of which could be adjusted, and thus the "pitch" of the resonator altered. The resonator for showing the effect of the electric component consisted of a coil of fine silver wire with its axis vertical, the two ends being connected to two cylindrical quadrants. In each case the wires, &c., were fixed to a light glass rod, and the whole was suspended by a fine quartz fibre. The author finds that both types of instrument behave in the same manner, and that the effect increases as the pitch of the resonator approaches unison with the vibrator, suddenly changing sign when this point is passed. Thus, when the resonators were tuned higher than the vibrators, they were attracted, while when they were turned lower, they were repelled. The effects of slow changes of potential and electrostatic charges produced thereby did not affect the instruments, since the author found that when the knobs of the induction coil were so far separated that no spark passed, and therefore no electrical oscillations were set up, the resonators were unaffected.

An interesting contribution to the subject of electrical oscillations and electrical resonance is made in a paper by Mr. John Trowbridge in the current number of the *Philosophical Magazine*. Being desirous of investigating the conditions under which the formulæ given by Kelvin, Stefan, and others for the time of oscillation hold, and considering that method first employed by Spottiswoode of exciting a Ruhmkorff coil, by means of an alternating current dynamo, was a much more powerful method of exciting oscillations than the ordinary method of charging Leyden jars by means of an electrical machine, or working an induction coil by a primary battery, the author has designed a form of apparatus in which he employs an alternator capable of giving a current of from 15 to 25 ampères with a potential difference of 120 volts, together with a suitable transformer to obtain the necessary difference of potential. He, in general, employs one primary circuit between two entirely separate and disconnected secondary circuits, so arranged that the images of the sparks in the three spark-gaps, after reflection in a rotating mirror, could be formed side by side on the same photographic plate. The most striking results obtained by the author are that a unidirectional spark (non-oscillatory) always excites an oscillatory discharge in a secondary circuit if the self-induction, capacity and resistance of this circuit permit an oscillatory movement. In every case the first effect of the exciting unidirectional primary spark is to make the secondary circuit act as if there were no capacity in its circuit, a thread-like spark resulting, which is exactly like that produced when all the capacity in the secondary circuit is removed. After a short interval of time the electricity rushes into the condensers, and begins to oscillate, the strength of the oscillations rising, after one or two vibrations, to a maximum, and then decreasing; the rate of oscillation finally assuming a steady state, and being expressed by the formula $t = 2\pi\sqrt{LC}$. If a unidirectional primary spark excites oscillations in neighbouring circuits which are slightly out of tune, the phenomenon of electrical beats or interferences can be produced in these circuits, and is very clearly shown on the photographs of the sparks. If the primary spark ceases to be unidirectional, and becomes oscillatory, these oscillations will tend to compel those of the secondary to follow them, and if they are not sufficiently powerful to do this they beat with the secondary oscillations. When all capacity is removed from the secondary circuits they oscillate in tune with the primary circuit. The author has been led to suspect that there is a change in the period of electrical oscillations when an iron wire is substituted for a copper one of the same geometrical form, and is at present engaged in investigating this point.

The forty-first report of the Department of Science and Art, and the Directory (revised to June 1894), have been issued.

Messrs. Dulau and Co., have issued a catalogue of works they have for sale, on astronomy, terrestrial magnetism, and meteorology.

We have received from the publishers (Messrs. Bliss, Sands, and Foster) the latest volume of their very pretty series, entitled "The Country Month by Month." The number treats of "The Plant-World in August," and "Wild Life" in the pleasant month upon which we have just entered. The series should be a favourite one with lovers of nature, the style of writing in it being bright and chatty, and the general get-up very tasteful.

A report, just received from Mr. Joseph Baxendell, showing the results of observations made in connection with the meteorological department of the Corporation of Southport during 1893, does credit to municipal meteorology. The report includes tables showing the results of routine observations, and also various notes relating to the instruments used and methods employed.

Mr. J. D. Potter has sent us "Twelve Charts of the Tidal Streams of the North Sea and its Coasts," which he has recently published for Mr. F. Howard Collins. The two thousand arrows which are to be found upon the charts represent the direction of the tidal streams of the North Sea and its surrounding coasts at all hours of the tide upon any day of the year. The time of high water at Dover supplies the key. The charts are reduced from the one published by order of the Lords Commissioners of the Admiralty, and numbered 2339.

The first number of *Contributions from the Zoological Laboratory of the University of Pennsylvania* has been received. It contains three articles, as follows, and is illustrated by four plates:—"The Correlations of the Volumes and Surfaces of Organisms," by Dr. J. A. Ryder; "The Growth of *Euglena viridis* when constrained principally to two Dimensions of Space," by Dr. J. A. Ryder; "Descriptions of three new Polychæta from the New Jersey Coast," by J. P. Moore. The new serial is issued through the Pennsylvania Press, Philadelphia.

Yet another magazine professing to be devoted to science has appeared—*The New Science Review: a Miscellany of Modern Thought and Discovery*. The latest arrival, which will be published quarterly, hails from America, but has an office in Henrietta Street, Covent Garden. Some of the articles in the first number seem to us scarcely to fall under the head of science, but this lapse into other realms may be due to the fact that the magazine aims at originality. Among the articles somewhat more closely allied to science than those we have hinted at, may be mentioned—"The Mystery of the Ice-age and its Solution," by Major-General Drayson; "The Problem of the Pole," by C. Morris; and "Nikola Tesla and his Works," by Lieut. F. J. Patten; while Prof. A. Heilpin contributes "Current Scientific Discussion."

Both physical and natural science are fairly represented in the current number of *Science Progress*. Dr. D. H. Scott surveys recent work on the morphology of tissues in the higher plants; St. George Mivart makes some critical remarks on the theories of epigenesis and evolution; and Prof. E. Waymouth Reid describes electromotive phenomena in glands. The arrangement of the molecules in a crystal, forms the subject of an interesting article by Mr. H. A. Miers; and a useful paper on atomic weights is contributed by Mr. Alexander Scott. In the July number of the journal the titles of chemical papers which appeared in May were enumerated. A similar list for June is given in the current issue, and an editorial note informs us that the list will be continued in each number.

THE First Biennial Report, for the years 1892 and 1893, of the Maryland State Weather Service, which was organised on May 1, 1891, has been published. As in other States, the observers are voluntary, and the Weather Bureau supplies instruments, &c. The present report is intended to give a general view of the climate, so far as conclusions can be drawn from data yet obtainable; it also contains a general summary of the physical features of Maryland, and of the different types of soil, each of which is specially adapted to the cultivation of certain classes of plants. The Director of the service, W. B. Clark, points out that the climate is generally what is known as continental, but is greatly modified in the eastern part of the State by the ocean. The average mean temperature of January is 32°·8, and of July 75°·8, a mean range of 43°, but the differences in certain localities are very considerable. Rainfall is fairly equally distributed throughout the year, the maximum occurring in the spring; the mean annual fall is 42·4 inches. Snow never fails completely, even with warmest winters.

THE *Reports of the Director of the Michigan Mining School* for 1890–1892 have just been distributed, and tell of much good work having been accomplished at this popular institution during the years under review. In the report for 1891–92 mention is made of a number of changes which were to come into effect in 1893, one being the lengthening of the course from three to four years, and the raising the age for admittance into the regular course to twenty years, unless the intending student shall have completed a regular course in some good high school or academy. The need of some kind of endowment is pointed out, the school being at present entirely dependent upon legislative aid. The report also calls attention to the necessity for the erection of an additional building on grounds belonging to the school. This building would be used for machine shops, testing and electrical laboratories, the mining engineering laboratories, &c. A metallurgical laboratory is much needed, but cannot at present be proceeded with for want of funds. The work in each department has developed so much that an increased expenditure all round is deemed necessary.

DIAZOMETHANE, $H_2C\begin{smallmatrix}N\\ \\ N\end{smallmatrix}$, has been isolated by Prof. von Pechmann, of Munich, and a preliminary communication concerning it is contributed to the current *Berichte*. This interesting substance is a yellow gas at the ordinary temperature, which condenses when cooled to a yellow liquid. It appears to be odourless, but is extremely poisonous, so much so that Dr. Pechmann finds it very difficult to work with in the gaseous state, owing to its violent action upon the respiratory organs. The principal properties of the substance have therefore been studied with its solution in ether. It is obtained by the action of alkalies under special conditions upon any of the nitrosamines of the type NR . Ac . NO, where R represents an alkyl radical such as methyl, ethyl or benzyl, and Ac stands for acetyl, benzyl, or the radicals $CONH_2$ and $COOC_2H_5$. The yield of the gas is at least fifty per cent. of the theoretical when nitrosomethylbenzamide or nitrosomethylurethane are employed. The reaction appears to be a very simple one, represented by the following equation:—

$$CH_3N\begin{smallmatrix}\diagup NO\\ \diagdown Ac\end{smallmatrix} + NaOH = CH_2N_2 + H_2O + AcONa.$$

The new substance behaves in a characteristic manner towards dilute acids. The yellow solution in ether is instantly decolourised upon the addition of the acid at the ordinary temperature, nitrogen being evolved. Water acts in a similar manner and almost as vigorously as when acidified. It is much more stable, however, towards alcohol. Iodine decomposes diazomethane with formation of methylene iodide CH_2I_2 and evolution of nitrogen. The reaction may be carried out volumetrically if the iodine is likewise employed dissolved in ether, the completion being indicated by a sudden decolourisation of the liquid; the nitrogen can readily be measured by means of the nitrometer, over mercury. Diazomethane reacts with silver nitrate and Fehling's solution in a similar manner to the diazoacetic ether described by Curtius. Mercuric oxide is reduced in the cold. Cork is bleached and eventually destroyed by the gas, so that the ethereal solution cannot be preserved in vessels closed with cork stoppers. The best proof of its composition and constitution is considered by Prof. Pechmann to be afforded by its reaction with the methyl ether of fumaric acid. The yellow ethereal solution of diazomethane is instantly decolourised upon admixture with the fumaric methyl ether; the substance produced is a direct addition product which has been obtained in crystals, and which upon boiling with dilute hydrochloric acid evolves carbon dioxide and yields crystals of hydrazine hydrochloride. Moreover, the silver salt of this compound is stable, and has been analysed. In concluding his preliminary notice, Prof. Pechmann states that he has likewise isolated diazoethane in a similar manner, employing, of course, an ethyl instead of a methyl nitrosamine. Further particulars of these compounds will doubtless be awaited with considerable interest.

THE additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Mrs. Keirnander; a Blotched Genet (*Genetta tigrina*) from Lamoo, East Africa, presented by Miss M. Clode; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Miss Sullivan; a Four-horned Sheep (*Ovis aries*, var.) presented by Mr. Frank C. Strick; a Blackcap (*Sylvia atricapilla*) British, presented by Captain John Richardson; a Smooth Snake (*Coronella lævis*) British, presented by Mr. John Gray; a Common Viper (*Vipera berus*) from Scotland, presented by Mr. J. Anderson; a Red and Blue Macaw (*Ara macao*) from South America, deposited.

OUR ASTRONOMICAL COLUMN.

THE MAGNESIUM SPECTRUM AS A CRITERION OF STELLAR TEMPERATURE.—The variations undergone by the spectrum of magnesium when the element is subjected to different temperatures were studied some years ago, and their use in estimating the comparative temperatures of celestial bodies have been pointed out. Prof. J. E. Keeler contributes a note on the matter to the *Astronomische Nachrichten*, No. 3245, his remarks referring especially to some observations recently published by Prof. Scheiner on the behaviour, under different temperatures, of the lines at λ 4482 and λ 4352. The former line is strong and broad in the spectrum of magnesium, when luminosity is produced by means of the electric spark with Leyden jar in the circuit, but it does not appear in the arc spectrum; on the other hand, the line at λ 4352 is strong in the arc spectrum, but faint in the spark spectrum. Similar differences of relative intensity are found to exist in stellar spectra, and Prof. Scheiner is not alone in thinking that they afford a means of estimating the approximate temperatures of the absorptive atmospheres of celestial bodies exhibiting them. In connection with this subject, Prof. Keeler comments upon the absence of the magnesium triplet *b* from the spectrum of Rigel, while the line at λ 4482 is conspicuous. He suggests that the star is at too high a temperature for the production of the *b* group, and uses the relative strength of the group in different spectra as a criterion of stellar temperature. It is pointed out that Kayser and Runge have shown that the group is characteristic of a molecular structure which cannot exist at a very high temperature, whereas the lines at λ 4482 and λ 4352 do not represent the same molecular state. These considerations lead to the conclusion that the aspect of the *b* lines in stellar spectra may be used as an index to the temperature in the same way as the two lines selected by Prof. Scheiner. And since the *b* group is absent from the spectra of Rigel and certain other stars, it is thought that these bodies must be at a temperature higher than that of the most powerful electric spark, for, were they at this temperature, laboratory observations indicate that the group should be well visible in their spectra.

THE AUGUST SWARM OF METEORS.—Many have already begun to observe, during the past few evenings, some of the forerunners of the August swarm of meteors which at this time are visible in very considerable numbers. Although, at its best, this swarm does not offer such beautiful displays as those which occur when the earth meets with the densest part of the November swarm, yet, on account of their uniform distribution and moderate density along their orbit, the shower is always fairly bright and distinct. Unlike the November meteors, the Perseids always herald their approach a few days beforehand by an increasing number of outliers as the maximum approaches; on the 10th this is reached, and from that time a decrease in their number rapidly diminishes. Another peculiarity of this swarm is that the average intensity year by year does not exhibit such wide variations as those shown by the Leonids, which attain a maximum every $33\frac{1}{4}$ years. By plotting the paths of the observed meteors on a globe or star chart, the radiant point so found should be approximately 45° R.A. and 57° Declination for the 10th. Close observation every evening will reveal a daily movement of the radiant point eastward among the stars, as shown in the following ephemeris, taken from Mr. Denning's table in the "Companion to the Observatory." The dates before the 10th are given for the sake of those who have commenced their observations early, and would like to compare their observed radiant points with those calculated :—

Date.	Radiant. α.	δ.	Date.	Radiant. α.	δ.
	°	°		°	°
July 19	19	+51	Aug. 2	36	+55
,, 21	22	52	,, 4	38	56
,, 23	25	52	,, 6	40	56
,, 25	27	53	,, 8	42	57
,, 27	30	54	,, 10	45	57
,, 29	32	54	,, 12	47	57
,, 31	34	55	,, 14	50	58
			,, 16	53	58

The comet with which these Perseids are supposed to be connected, is that which appeared in 1862, and was discovered by Mr. Swift, of Rochester, New York, on July 15. The orbit, after a calculation made by the late Dr. Oppolzer, of Vienna, was found to be elliptic, and the periodic time 120 years. Schiaparelli it was, however, that drew attention to the similarity between the meteoritic and cometary orbits. The next appearance of the comet does not take place before another half-century.

INSTITUTION OF MECHANICAL ENGINEERS.

THE annual summer meeting of the Institution of Mechanical Engineers was held last week in Manchester, under the presidency of Prof. A. B. W. Kennedy, the President of the Institution. The meeting commenced on Tuesday, the 31st ult., and concluded on the Friday following. There were but two sittings for the reading and discussion of papers. The following is a list of the papers on the agenda :—

(1) "Description of the New Electric Lighting Works, Manchester," by Dr. John Hopkinson, F.R.S.

(2) "Electric Welding," by Benjamin Alfred Dobson.

(3) "Description of Twin Screw-Propellers with Adjustable Immersion, fitted on Canal Boats," by Henry Barcroft, of Newry.

(4) "Description of the Manchester Main Drainage Works," by Wm. Thomas Olive, Resident Engineer.

(5) "The Manufacture of Standard Screws for Machine-made Watches," by Charles J. Hewitt, of Prescot.

(6) "Drilling Machines for Cylindrical Boiler Shells," by Samuel Dixon, of Manchester.

The last two papers were adjourned until the next meeting in London. Dr. Hopkinson's paper was a short one, the scope of which is sufficiently indicated by the title. Outlined particulars were given of the new installation at Manchester. There were, however, no special features which require notice in the present instance. The discussion which followed chiefly turned on the use of jockey pulleys. It is interesting to notice, however, the progress that has been made in electric lighting since the author read his first paper on the subject before the Institution, now fifteen years ago. Since that time this department of practical science has undergone an extraordinary development. The only electric lights then were arc lights, the first incandescent lights in a practical form being made about a year later. To-day there are millions of incandescent lights in use. The machine the author used for experimenting upon in 1879 was at that time considered a fairly large one and highly economical; it required six horse-power to drive it. Now many machines have been working for a considerable time, requiring over 1000 horse-power to drive them. The commercial efficiency of the machine then was about 50 per cent., but now machines are produced having commercial efficiencies of 94 per cent.

Mr. Dobson's paper on electric welding was one of practical interest, although the system of welding by electricity is one that is now well known. The author, has, however, adopted this method of joining metal for some time in the extensive works of his firm at Bolton. Practical every-day working for nearly three years of the process of welding by electric force enabled him to give certain indications and appreciations of the method considered as a practical workshop operation. During the period mentioned his firm has had two machines in operation, worked from the same generating dynamo, and engaged upon different classes of work. The one is specially arranged for joining bar iron and steel, and the other, which is a smaller machine, is used for work of a more delicate nature, such as brazing and piecing clean-finished work, where the fire-heat would have destroyed the quality of the work on the adjacent material. Great difficulties were experienced at first in regard to the requisite mechanical power, it being found that this power had been much understated. The author, having about 35 indicated horse-power to spare on a certain engine, and understanding that 30 horse-power would be the utmost required to piece a 2-inch round bar, determined to drive the dynamo from that engine. This practical test showed that instead of 30 horse-power as much as 80 horse-power seemed to be wanted for the larger sizes. A portable engine capable of working up to 100 indicated horse-power with 80 lbs. pressure was supplied and placed at a distance of about 45 yards from the welding machine. Even with this engine it was found that when piecing the larger diameters—as yet nothing over $2\frac{1}{4}$ inches has been pieced—if the work was to be done in reasonable time, the speed of the engine was greatly checked. A Thomson-Houston welding dynamo was used by the author's firm. Its speed is 1000 revolutions per minute, and it gives at full load a current of 200 ampères at 300 volts with 100 alternations per second. Transformers are used. The author gave full particulars of the work done and tests made. The question of cost had not been alluded to in detail by the author, who admitted, however, that the payment of royalty, the cost of horse-power, and the depreciation, which on electrical apparatus is heavy, together brought the cost considerably over the net cost of the ordinary smith's hearth work; the payment in wages, &c., being considerably less. The loss in weight of iron is about one-twentieth. On straightforward welds the total cost is between ten and fifteen per cent. more than the ordinary smith's work; but in the case of delicate work and difficult operations, the cost is about one-third of that of the smith's work. The real advantage of the apparatus, as at present arranged, is not so much an economy as a method of securing an absolutely reliable result, and occasionally saving considerable expenditure by its adaptability.

In the discussion which followed the reading of this paper, no important points were brought forward.

Mr. Barcroft in his paper described an arrangement by which steam power could be applied to ordinary canal boats. Although doubtless the application was suitable for the position it had to fill, the machinery possessed neither scientific nor engineering interest, except of a very limited order.

Mr. Olive's paper on the Manchester Main Drainage Works was a useful description of an ordinary installation of this nature. The Manchester works have but recently been put up, and are indeed hardly yet in full working order.

ON THE NEWTONIAN CONSTANT OF GRAVITATION.[1]

II.

I HAVE already stated that two measurements, viz. the horizontal distances between the axes of the wires which support the lead balls, and of the fibres which support the gold balls,

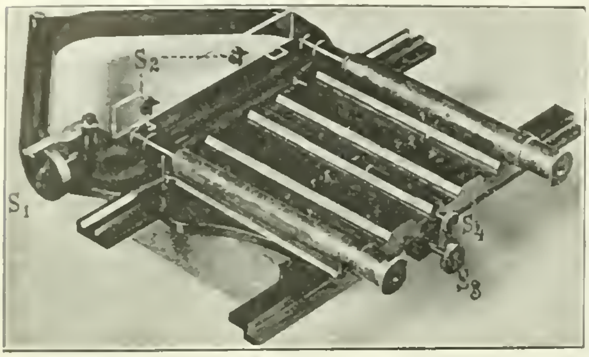


Fig. 4.

must be made with the highest degree of accuracy attainable, for on these the result directly depends. In order to accomplish this, I had to design a special instrument, an optical compass, which is illustrated in Fig. 4. This is an arrangement pair of traversing slides, each carrying a microscope in one or other of three grooves. The two traversing slides are drawn together by a spring, and can be separated by a screw cone, forming a very delicate fine adjustment. This is operated by the screw-head S_4; S_3 is a focussing screw giving a fine adjustment to the focussing slide. S_2 S_2 are two parallelising screws, the purpose of which is to bring the microscopically-divided glass scale into focus at each end simultaneously. S_1 is a micrometer screw-head, which is employed to push the scale bodily to the right by measured amounts. The two microscopes are focussed upon, say, the right sides of the wires, the focussing slide is then withdrawn, leaving them relatively unchanged, and the microscopic scale is then put in its place. The distance from wire to wire is thus transferred directly to the scale, and the fractional part of any one division of 1/100 inch is all that has to be referred to and measured by the screw. Every slide in this apparatus is geometrically arranged, so that the movements are all perfectly free, unconstrained, and without shake. In measuring the distance between the fibres, which must be done while they are freely suspended, so that a force of a millionth of the weight of a grain will give them a considerable motion, means have to be provided to exclude draught, which yet must not interfere with the apparent distances of the fibres. No microscope cover-glass is any use for this purpose. It is sure to be prismatic, and when inserted between the microscope and an object, it will certainly cause it to shift its apparent position. A piece of clear mica is perfect in this respect, no movement, even with a high power, being visible. I mention this, as it well illustrates the sort of trap that is ever set for the experimentalist. If I had not been aware of this, and had used, as would be natural, a window

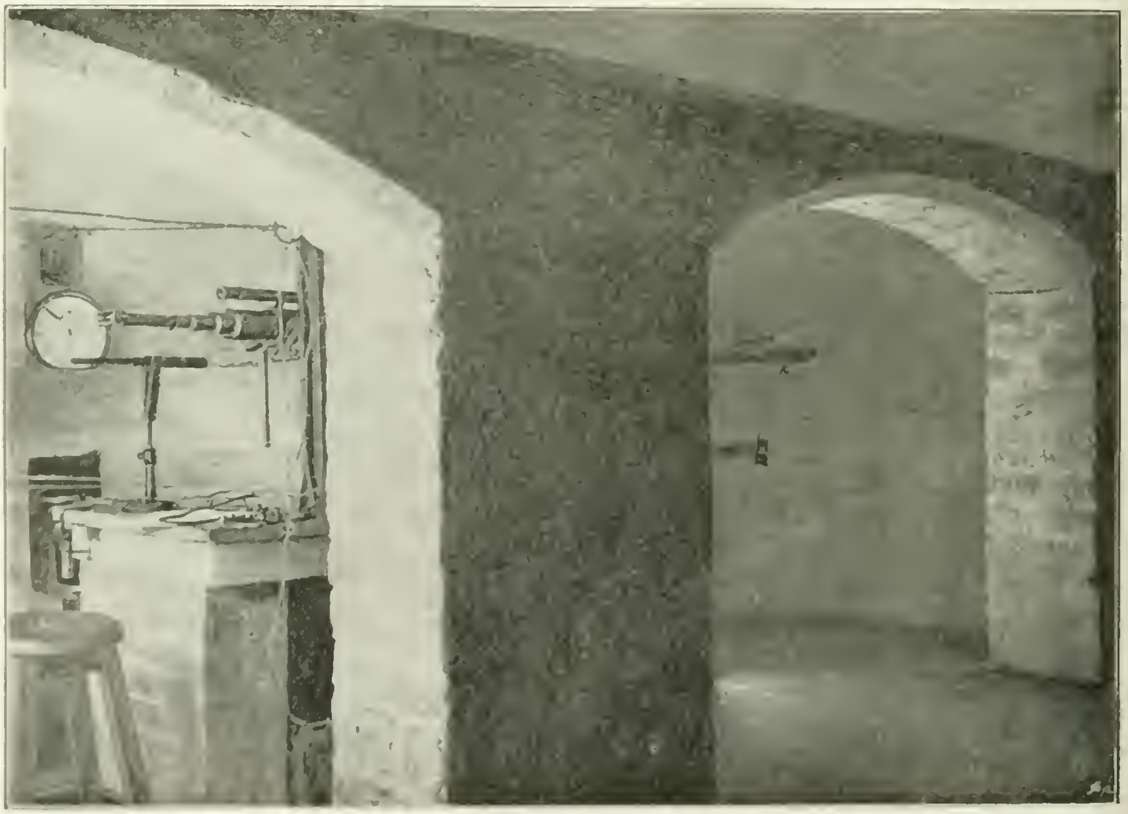


Fig. 5.

which rests upon the lid of the apparatus on the circular V-groove seen in Fig. 1, so that it can rotate without shake. Upon the lower framing rests the focussing slide, and on this a of microscope cover-glass, then each fibre would have appeared as definitely in its place as before, but the place would have been wrong, perhaps by 1/1000 inch, and thus a consistent error affecting all the experiments alike would have been introduced,

[1] Continued from p. 3?4.

and no multiplication of observations or taking of means would have eliminated it. It is on this account that it is so important in experimental work to vary the conditions in every way, so as to discover unsuspected consistent errors.

The microscope scale was made by Zeiss, and is a most perfect example of scale construction. In order to test the accuracy and find the errors of the scale, I took advantage of my visit to Cardiff, for the meeting of the British Association, to compare it with a series of Whitworth standard bars on Prof. Viriamu Jones's very perfect Whitworth measuring machine. For this class of work sunshine or dust give great trouble, but I was fortunate in having splendid weather for my purpose, as visitors will probably remember. It rained without ceasing during the two days that I was making these measurements.

Having now very imperfectly described the apparatus and the place in which I have carried out my experiments, I will next show a series of photographs, which I took by magnesium

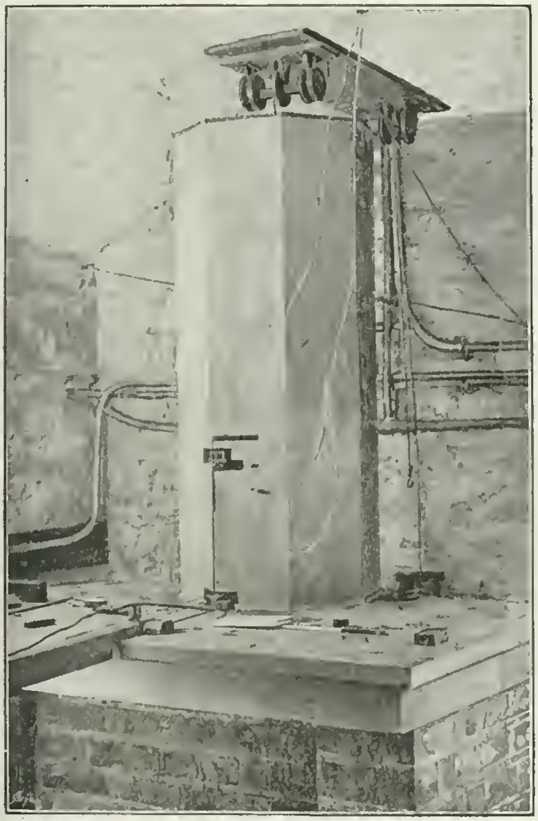


FIG. 6.

light, to give a better idea of the appearance of the apparatus and its surroundings. Fig. 5 is a view of the vault showing the clock, the eye end of the big telescope, and the little telescope. In the distant corner is seen the felt screen with a long slit, through which the scale and telescope can be seen from the mirror of the instrument. This, of course, is on the table behind the screen. Fig. 6 is a view of the corner itself, with the screen drawn back. The octagon protecting house, which surrounds the apparatus, is seen in position. Here again a slit is cut large enough to allow the scale and telescope to be seen from the mirror. Fig. 7 is a view of the instrument with the two halves of the octagon house separated. Here a further system of screens consisting of concentric brass tubes may be seen, but the lower one, which surrounds the window, has been removed and placed upon the table. The driving gear is also seen in this photograph, and a tube coming from the screw under the instrument which holds the central tube, which tube is also seen in Fig. 1. This tube enables me to control the motion of the mirror from the telescope without approaching the corner in which the apparatus is set up. This is done as follows: the back window at the level of the mirror is made of metal, with a hole in it in which is screwed a metal tube lightly filled with cotton wool. This is not central, but opposite one end of the mirror. The tube on the table does not fit the screw, but is merely bent up and enters it loosely. By gently drawing air from the end of the tube at the telescope a very feeble draught is produced in the apparatus, for nearly all the required air is supplied by leakage round the pipe near the screw, very little entering through the window pipe, in consequence of the resistance offered by the cotton wool. In this way, if the mirror is

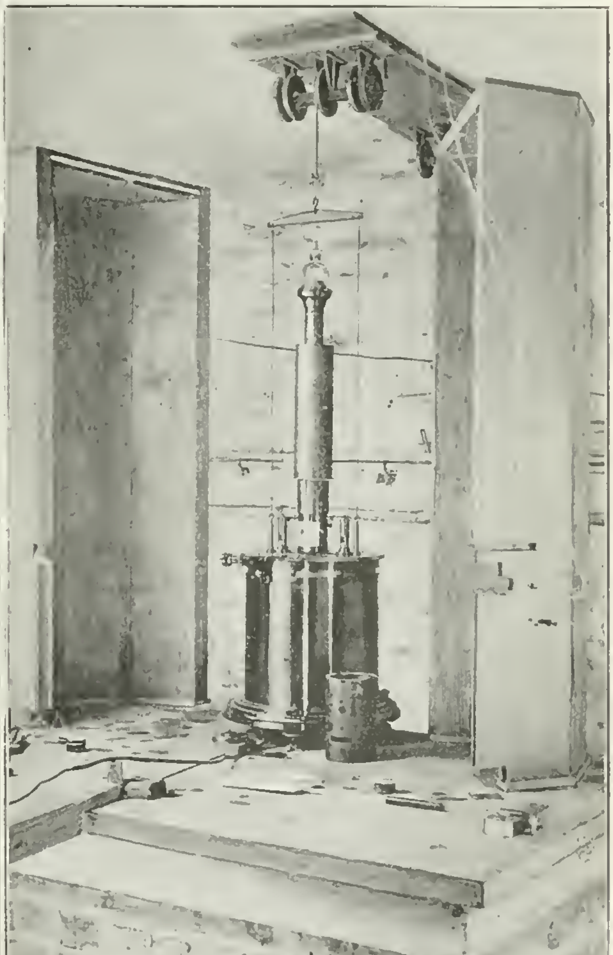


FIG. 7.

moving it may be gently brought to rest without impact, or it may be given a swing of any desired amplitude. So perfectly does this work, that the mirror may be steadied very quickly so as to move through less than a scale division, an amount which corresponds to six or seven seconds of arc, or to a force of less than one thousand millionth of the weight of a grain.

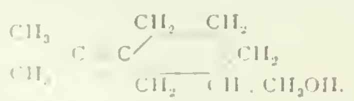
The operations for any complete experiment are fourteen in number. I do not intend to go through these seriatim, as time will not allow me to do so. It is sufficient now to say that the first eight are necessary to get the instrument and scale relatively fixed and adjusted, the vertical measures made, and generally all ready for operation 9, in which the optical compass is employed. This is a most important one, for not only are the horizontal measures made, on which so much depends, but in addition the plane of the wires and fibres are made identical, the corresponding scale reading is found, and any eccentricities are measured and may be corrected.

(*To be continued.*)

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, July 30.—M. Lœwy in the chair.—Conditions necessary for the production and the perception of murmurings in tubes through which air-currents pass, by M. A. Chauveau.—On certain of the later geological and climatic phases in Barbary, by M. A. Pomel. The quaternary period was marked in Barbary by (1) a rainy phase with formation of alluvial deposits, followed by (2) a dry period characterised by the formation of travertinous crusts, and (3) the partial submergence and reappearance of the coast districts with the production of a narrow band of marine beds and a moderately humid climate, which has since deteriorated to the present condition of excessive dryness.—Report on M. Bigourdan's memoir "On the micrometric measurement of small angular celestial distances, and on a method of perfecting this kind of measurement," by MM. Lœwy, Tisserand, and Wolf. The method used by the author for the measurement of micrometric angular distances consists in the use of glass points in place of the micrometer threads, so that the image is never blotted out by superposition. It allows of much easier work, and is at least as accurate as any method previously employed.—On the theory of differential quadratic formulæ, by M. Wladimir de Tannenberg.—On the integration of certain systems of equations with derived partials of the first order involving several unknown functions, by M. Riquier.—On the absorption of light in isotropic and crystallised media, by M. G. Moreau.—A contribution to the study of the structure of steel, by M. F. Osmond. With moderately hard steel, containing 0·45 per cent. of carbon and 0·35 per cent. of manganese, the structure was found to vary gradually in samples all originally heated to 825° C. and quenched in water at 15° C. after cooling to 720°, 690°, 670°, 650°, and 640° respectively. Hardening from 640 left the structure almost the same as slow cooling. With hard steel, containing 1·24 per cent. carbon, the variation is more rapid; the temperature of maximum hardening lies very near to that of no hardening. The structure, as studied by polished surfaces, in steel of moderate hardness gives information concerning (1) the maximum temperature of heating, (2) the temperature from which it has been hardened, and (3) the rate of cooling.—A refractometer with a chamber capable of being heated, and its application to measurements with fatty substances, by M. Fery.—On the constitution of rhodinol from essence of Pelargonium, by MM. Ph. Barbier and L. Bouveault. Rhodinol is demonstrated to be a primary alcohol, $C_{10}H_{18}O$, containing one ethylenic grouping; it is a cyclic compound, and its rotatory power and that of its derivatives prove the presence of an asymmetric carbon atom. The consideration of the foregoing, together with the ease with which on oxidation it yields acetone and α-methyladipic acid, leads to the provisional formula:



—Action of thionyl chloride on some inorganic acids and organic compounds, by M. Ch. Moureu. With mineral acids $SOCl_2$ gives the corresponding chlorhydrins; with aldoximes it yields nitriles by dehydration; with oxalic and formic acids it behaves just like sulphuric acid. In each case equal volumes of hydrogen chloride and sulphur dioxide are liberated.—On the stability of aqueous solutions of mercuric chloride, by M. E. Burcker.—The oxidation of beer worts, by M. P. Petit.—The mechanism of the influence of toxic substances acting by means of secondary causes in the production of infection, by MM. Charrin and Duclert. The conclusion is drawn that poisons aid infection by an antiphagocytary action allowing the more rapid multiplication of the disease microbe without increasing the virulence of its virus.—On some new laws of pupillary contraction, by M. Ch. Henry.—Is the use of the Auer burner capable of causing partial poisoning? By M. N. Grehant. The author quotes experimental results from which he draws the conclusion that the Auer burner in use does not cause poisoning by the trace of carbon monoxide produced.—On the transformation of "Paguriens" into anomourous crabs of the sub-family of the Lithodinæ, by M. E. L. Bouvier.—On the venomous gland of the "Myriapodes Chilopodes," by M. O. Duboscq.—Branchiæ in *Physa lamellata*, by M. Paul Pelsener.—On the Hongkong plague, by M. Yersin. A specific bacillus is found in great numbers in the bubon, but not in the blood.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—The Country Month by Month, August: Owen and Boulger (Bliss).—Les Machines Thérmiques: Dr. A. Witz (Paris, Gauthier-Villars).—Object-Lessons in Elementary Science: V. T. Murche, 3 Vols. (Macmillan).—Fur and Feather Series—The Grouse: Macpherson, Stuart-Wortley, and Saintsbury (Longmans).—41st Report of the Department of Science and Art (Eyre and Spottiswoode).—Directory, with Regulations for Establishing and Conducting Science and Art Schools and Classes (Eyre and Spottiswoode).—The Wild Garden: W. Robinson, 4th edition (Murray).—A Treatise on the Measurement of Electrical Resistance: W. A. Price (Oxford, Clarendon Press).—The Animal as a Machine and a Prime Motor: R. H. Thurston (K. Paul).—The Collected Mathematical Papers of Henry John Stephen Smith, edited by Dr. J. W. L. Glaisher, 2 Vols. (Oxford, Clarendon Press).—Progress in Flying Machines: O. Chanute (S. Low).

Pamphlets.—Report on the Gohna Landslip, Garhwal: T. H. Holland.—Romanes Lecture, 1894—The Effect of External Influences upon Development: Dr. A. Weismann (Frowde).—Sketch and Check-List of the Flora of Kaffraria: T. R. Sim (Cape Town, "Argus").

Serials.—Bulletin of the New York Mathematical Society, Vol. 3, No. 10 (New York, Macmillan).—Geological Magazine, August (K. Paul).—Journal of the Chemical Society, July and August (Gurney and Jackson).—Geologische und Geographische Experimente: E. Reyer, 3 and 4 Heft (Leipzig, Engelmann).—Science Progress, August (Scientific Press, Ltd.).—Scribner's Magazine, August (S. Low).—Fortnightly Review, August (Chapman).—Medical Magazine, August (Southwood).—Natural History of Plants: Kerner and Oliver, part 4 (Blackie).—Himmel und Erde, August (Berlin).—Seismological Journal of Japan, Vol. 3, 1894 (Yokohama).—Journal of the Anthropological Institute, August (K. Paul).—Societa Reale di Napoli, Atti della Reale Accademia delle Scienze Fisiche e Matematiche Serie Seconda, Vol. 6 (Napoli).—Rendiconto dell'Accademia delle Scienze Fisiche e Matematiche, Serie 2a, Vol. 8 (Napoli)

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THURSDAY, AUGUST 16, 1894.

THE BRITISH ASSOCIATION.

OXFORD, AUGUST 15.

THE meeting which is now ending is in many ways a memorable one. To those who are engaged chiefly in the serious work of the Sections it will be memorable because of the unusual fulness of the sectional meetings and the exceptionally high standard of the communications which have been brought before them. To the popular mind the great feature of the meeting is the Presidential address. Apart from the accessory advantages derived from the eminence of the speaker, his position as Chancellor of the University, his command of the English language, his oratorical powers, and the unusual splendour of the University ceremonial, the address must be considered as one of the most remarkable that has been given from the Presidential chair for many years past. Its effects are likely to be considerable, because, unlike the majority of scientific addresses, it was thoroughly comprehended by the whole audience, and was written in such clear, vigorous, and easy English that there is no educated person who cannot understand every word of it. Whether the effect will be for good or for evil, time will show. Lord Salisbury passed in review the weaknesses of all branches of science, but his exposure of the incompleteness of the ethereal and atomic theories are not likely to prejudice the general belief in them. These are impersonal questions which the average layman is content to leave in the hands of specialists. It is otherwise with Evolution, which came in for a large share of criticism, much of which, it must be said, was criticism of a somewhat unfair kind. Evolution and the Darwinian hypothesis have been accepted of late by the people in a somewhat reluctant and hesitating fashion; there has been no great champion of the opposite view, and the "lay" mind has been overwhelmed with masses of technical argument until it has relapsed into sullen acquiescence. For the first time for some years past a voice has spoken from a seat of authority, and has raised the hope that the bondage under which unwilling minds were lying may be broken, that the doctrine of Evolution may be overthrown, and that of design resuscitated in place of it. One has only to read the articles which have appeared in all the leading newspapers to understand how real this hope is, and how gladly a large number of educated people would undo the labours which were begun by Treviranus and Lamarck, carried on to success by Charles Darwin and by Wallace, and elaborated by Huxley, Haeckel, Weismann, and many others. The biologist knows well the answer to most of Lord Salisbury's criticisms, and can show that most of them have often been raised before, and have been completely answered. They were partly answered by Prof. Huxley in the admirable speech in which he seconded the vote of thanks, and it is to be hoped that he has not said his last word in response to the challenge thrown down. A perusal of the newspaper articles of last week betrays a weakness in the armour of scientific debate, a weakness from which Prof. Huxley alone, or almost alone, is exempt. Since the "Origin of Species" was first published, much has been spoken and written on the subject, and an enormous mass of evidence has been accumulated, much of which is of the nature of verification, and carries, or should carry, as much weight in support of the theory of descent with modification as did the discovery of new elements in support of the theory of Mendeléef. But the subject is a large and intricate one, and the writings of many of the staunchest adherents of Evolution have failed to influence those who are not professed biologists because they have been couched in such technical, and, at times, in such uncouth language that they could not possibly be understood except by those who have had a long training in the special subject. Lord Salisbury has taught us that a skilled debater and a master of epigram may, by a sudden and brilliant attack, make a breach of some considerable extent in what we have come to consider as an almost impregnable stronghold. That the breach will be rapidly repaired, there can be no doubt, and in repairing it biologists will feel the advantage of having to improve the range and penetration of their weapons of offence and defence. It is not enough that a scientific truth should be the possession of a privileged few; those who value the truth should try to spread it and make it common intellectual property, and this can only be done when they realise that simplicity of language, a correct style, and a good arrangement are essential to its propagation. It is unnecessary to remind readers of NATURE that the questions in dispute among biologists are not as to whether evolution has taken place, but as to the manner in which it has taken place; that the selection of favourable variations is not denied, but that the operations of natural selection are still imperfectly understood, and that arguments drawn from artificial selection, if they are applicable at all, are applicable only to a very limited extent. Nobody supposes that the methods of artificial selection, the mating of the favourably varying bridegroom with the favourably varying bride, find their exact parallel in nature. The argument from artificial selection was originally brought in to prove that under certain conditions species were capable of transformation, and the different conditions under which transformation may be effected, and the extent of transformation under known conditions, are now the most promising subjects of biological study. This fact was very well exemplified in the discussion which followed Prof. D'Arcy Thompson's paper "On some Difficulties of Darwinism," on Monday last. It might appear that the debating of such a question in Section D was proof of the truth of Lord Salisbury's contention, that there is a reaction against Darwinism; but it is to be observed that none of the eminent authorities who took part in the debate doubted the fact of progressive modification; the question at issue was whether the direct effect of external conditions is or is not a factor of importance in causing and perpetuating variations. The sum and substance of Lord Salisbury's address was that science is not infallible, and still far from having attained an exact knowledge even of fundamental problems. This science knows very well, and the proceedings of Sections show how very much is still to be learnt.

It is impossible to review the work of each Section in detail, but it may be said that never in recent years has so much matter of novel or remarkable character been communicated in every department of Science. Section A has been particularly active. When it has not been occupied in holding joint discussions with Section G, on Flight and on Integrators, or with Section I, on the Theory of Vision, it has divided itself into three departments—two for Physics, and one for pure Mathematics—and in each the number and the quality of the communications have been of the highest order, one of the most remarkable being that of Prof. G. Quincke, on the formation of soap-bubbles by the contact of alkaline oleates with water.

But, so far as the scientific importance of the communications made to the present meeting is concerned, it is conceded on all hands that a verbal and really an informal announcement made by Lord Rayleigh to Section B, on Monday, on behalf of himself and Prof. Ramsay, takes the first place. It is known that Lord Rayleigh has been for many years engaged upon the determination of the densities of various gases. We have learnt that he found in the case of nitrogen different densities amounting to about one half per cent. according as the gas was obtained from chemical compounds and the so-called nitrogen of the atmosphere. This and other points have recently occupied the attention of both Lord Rayleigh and Prof. Ramsay, and they have succeeded in isolating from this so-called atmospheric nitrogen, and by two distinct processes, a second inert ingredient denser than true nitrogen. The first method employed was that used by Cavendish in his demonstration of the composition of nitric acid. Air mixed with oxygen is submitted to electric sparks in presence of alkali until no further contraction takes place. The excess of oxygen is then absorbed by pyrogallol. That the residual gas is not nitrogen is inferred from the manner of preparation, and from the appearance of its spectrum. A second method giving much larger quantities of the new gas depends upon the removal of nitrogen from deoxygenated air by passing it over heated magnesium. When this process was allowed to continue, the density gradually rose to 14·88, 16·1, and finally to 19·09. At this stage the absorption appeared to have reached its limit, indicating that the new gas amounts to about 1 per cent. of the nitrogen of the atmosphere. When the gas thus prepared was sparked with oxygen there was little or no contraction. Lord Rayleigh and Prof. Ramsay have already found that no liquefaction occurs when the gas is compressed at atmospheric temperatures.

Sir Henry Roscoe said that the communication was one of the greatest possible interest and importance, and the Section as well as the distinguished authors were greatly to be congratulated on the announcement of the discovery of what would in all probability turn out to be a new elementary body existing in the atmosphere. The discovery appeared to him to be of special significance, as being one brought about by the application of exact quantitative experiment to the elucidation of the problem of the chemical constitution of our planet.

There were many other communications of a most interesting nature, including a discussion on the action of moisture in promoting chemical changes, a problem which has occupied the attention of several Oxford chemists of late years. Mr. Miers read a paper of great interest to crystallographers in Section C, and Mr. Culverwell's criticism of Croll's views on the Ice Age excited much interest.

It was thought by many that the division of Section D into two very distinct departments of Zoology and Botany, and into a third and completely separate department of Physiology, might weaken the proceedings of each; but the fear has proved to be entirely groundless, for there has been almost a superfluity of interesting material, and the attendance in each Section or department has been as good as was usually the case in the undivided Section. One is glad to note, however, that the division is permissive, and that the three subjects may reunite under the common denomination of Biology in any meetings at which such a galaxy of talent as has been brought together on this occasion is not to be expected. Section E (Geography) has had one of the most successful years in its experience, and has been attended daily by large audiences, which were very well accommodated in the great North Writing School. Economic Science has been hardly less successful, and G and H have at various times been densely crowded, the accommodation in the Anatomical Department having proved sometimes to be altogether inadequate for the large audiences which assembled to hear Mr. Arthur Evans, Prof. Macalister, M. Emile Cartailhac, and Dr. Louis Robinson.

A further feature of the Oxford meeting may be mentioned. Several of the colleges dispensed a magnificent hospitality, and the reunions of foreign and English men of science in Magdalen and Merton will long be remembered by those who were fortunate enough to take a part in them. New College was not behindhand, since it entertained the Sectional Secretaries during their stay in Oxford; whilst Brasenose, Merton, Corpus Christi, Lincoln, Jesus, and Balliol vied with one another in hospitable efforts. Pembroke College was prepared to have done as much, but its intentions were frustrated by a sad event which happened just before the meeting. During the month of August Oxford is usually depleted (most of the University residents are away on their holidays), but for this occasion many returned and showed that the old traditions of University hospitality have not been forgotten since the Universities Acts came into force. The sixty-fourth meeting has altogether been a magnificent one, and well worthy of the town in which it was held.

The following is a synopsis of grants appropriated to scientific purposes by the General Committee:—

	£
Electrical Standards	25
Photographs of Meteorological Phenomena	10
Earth Tremors	75
Abstracts of Physical Papers	100
Reduction of Magnetic Observations made at Falmouth Observatory	50
Comparison of Magnetic Standards	25
Calculation of certain Integrals	15
Meteorological Observations on Ben Nevis	50
Uniformity of Size of Pages of Transactions, &c.	5
Wave-length Tables of the Spectra of the Elements	10
Action of Light upon Dyed Colours	5
Formation of Haloids from Pure Materials	20
Isomeric Naphthalene Derivatives	30
Electrolytic Quantitative Analysis	40
Erratic Blocks	10
Palæozoic Phyllopoda	5
Photographs of Geological Interest (renewed)	10
Shell-bearing Deposits at Clava, &c.	10
Eurypterids of the Pentland Hills	3
New Sections of Stonesfield Slate	50
Exploration of Calf Hole Cave	10
Investigation of a Coral Reef by Boring and Sounding	10
Nature and Probable Age of High-level Flint-drifts	10
Examination of the Locality where the Cetiosaurus in the Oxford Museum was found	20
Table at the Zoological Station, Naples	100
Table at the Biological Laboratory, Plymouth (renewed)	20
Zoology, Botany, and Geology of the Irish Sea (partly renewed)	40
Zoology and Botany of the West India Islands	50
Index of Genera and Species of Animals	50
Climatology of Tropical Africa	5
Exploration of Hadramout	50
Calibration and Comparison of Measuring Instruments	50
Anthropometric Measurements in Schools	5
Lake Village at Glastonbury	30
Exploration of a Kitchen-midden at Hastings	10
Ethnographical Survey	30
Physiological Applications of the Phonograph	25
Corresponding Societies	30
Mathematical Tables (unexpended balance)	
	£1093

SECTION D.

BIOLOGY.

Opening Address by Prof. I. Bayley Balfour, M.A., M.D., F.R.S., President of the Section.

The prospect of visiting Oxford to-day has, I am sure, been to all of us a pleasant one, and we who are specially interested in biology have looked forward to our meeting at this time with the distinguished members of the Oxford Biological School. But as we gather here there will, I think, be present to the minds of all of us a thought of one member of that school, whom we had hoped to meet, who is recently gone from it in the prime of his intellectual life. By the death of George John Romanes biological science is bereft of one of its foremost expositors, Oxford is deprived too soon of one whose mental power was yet in its zenith, and each one of us who knew him cannot but feel a deep sense of personal loss; and we shall in our meeting here sadly miss the man brimming with a geniality which robbed differences of their difficulty and charmed away bitterness from those controversies in which he revelled. This is not the occasion upon which to dwell on his character, his merits, or his work. We must all, I think, have appreciated the graceful accuracy with which these were sketched in the pages of Nature by one of his colleagues; but under the shadow, as we are here, of his recent death, I believe I give utterance to feelings every one of you would wish expressed in paying this passing tribute to his memory from the chair of the Section of the Association devoted to the subject of his life-work.

I cannot open the business of the Section without referring to the fact that its organisation appears to be variable, like the objects of its study. It has changed its constitution more than any other Section of the Association, under influences partly from within in the strength of its elements, partly from without in the local circumstances of its meetings. At its origin it was the Section of botany, zoology, anatomy, and physiology; in the following year anatomy and physiology became a new Section, E, only after some years to merge again in the original one. Then a partition was tried—a physiology department and an anthropology department were formed within Section D; but the Montreal meeting saw anthropology as Section H of the Association, and physiology again an integral portion of Section D. This year, as you are aware, physiology—I must be careful to say animal physiology—has again become a definite Section—I. Whether or no the habit thus acquired through the environment of Oxford will be so permanent as to be transmitted and appear at future meetings of the Association is a problem upon which I refrain from speculating; my reason for mentioning this matter at all is to point out that, as in previous devolutions of subjects from Section D, animal physiology is the only physiology which is concerned. It was part of the original proposal that plant physiology should form a portion of the province of Section I. To this the botanical members of Section D are unable to assent. We all readily admit that the development within recent years of our knowledge of plant-life is entirely in the direction of bringing to light fundamental similarities between the vital processes in plants and in animals. To no one do we owe more in this sphere of investigation than to two of the distinguished botanists from Germany whom we are glad to welcome at this meeting—Profs. Pfeffer and Strasburger. And we fully reciprocate the desire for mutual comment and criticism implied in the suggestion of combination. But allowing these as grounds for the conjoint treatment of the physiology of plants and animals in one section, what we botanists feel is that we are a compact body of workers in a science the boundaries of which it is at present not difficult to define, and that to divorce physiology from morphology and other branches of botany would tend to loosen our cohesion, would be to go against the current of our progress, and would take all the vitality from our discussions. To have papers on plant physiology dealt with in Section I, whilst those on other botanical subjects were dealt with in Section D, would be not merely an extremely inconvenient arrangement, from causes inherent in the subjects themselves, but would strike at that fraternity and spirit of camaraderie amongst those treading the same path of science, the promotion of which is the chief, if not the only, function the British Association now fulfils. At the outset, therefore, of our meetings, I wish to make it known that papers and discussions on all botanical subjects will take place in Section D.

And now I pass to the special topic upon which I am to address you. In selecting it I have followed the lead of those of my predecessors in this chair who have used the opportunity to discuss a practical subject. Forestry, about which I purpose to speak, is a branch of applied science to which, in this country, but little attention has been given by any class of the community. By scientific men it has been practically ignored. Yet it is a division of Rural Economy which ought to be the basis of a large national industry.

There are no intrinsic circumstances in the country to prevent our growing trees as a profitable crop for timber as well as our neighbours. On the contrary, Great Britain is specially well adapted for tree-growing. We have woodlands of fine trees, grown after traditional rule-of-thumb methods, abundant in many districts. The beauty of an English landscape lies in its trees and its pastures. Nowhere in the world, probably, are to be found finer specimens of tree-growth. As arboriculturists we are unrivalled. But the growing of trees for effect and in plantations is a very different matter from their cultivation on scientific principles, for the purpose of yielding profitable crops. This is sylviculture. The guiding lines of the two methods of culture are by no means the same—nay, they may be opposed; and it is the sylvicultural aspect of the science of forestry which has hitherto been neglected in this country. The recognition of this is no new thing. But within recent years it has attracted considerable public attention, as the importance of wood cultivation in our national life has been more realised; and although various proposals have been put forward, and some little effort made for the purpose of remedying the admittedly unsatisfactory state of forestry practice, there has been so far no great result. I attribute this in great measure to the apathy of scientific men, especially botanists, and I am convinced that until they devote attention to forestry the great issues involved in it will not be rightly appreciated in the country.

It is not the first time the subject has been before this Section. I find that in 1885, at the Aberdeen meeting, a committee was appointed by it to consider "whether the condition of our forests and woodlands might not be improved by the establishment of a forest-school." The good intention of the promoters was not fulfilled, however. The committee did not meet.

In the first instance, let me briefly refer to the national economic features of forests as they affect us.

There are two aspects from which forests are of importance to a country—firstly, as a source of timber and fuel; secondly, on account of their hygienic and climatic influences.

With regard to the latter, it is a popular notion that trees exercise considerable influence upon atmospheric conditions, but it is only within recent years, and as the result of long experimental research in Switzerland, France, Austria, Germany, and other areas where forestry is practised at a high level of excellence, and also in the United States, that any sufficient data have been forthcoming to form a basis of scientific conclusion upon so important a matter. Although many points are still far from clear, the evidence goes to show that the direct influence of tree-growth upon climate is no mere superstition. Stated in the most general terms, it is proved that forests improve the soil drainage, and thereby modify miasmatic conditions; whilst, like all green plants, trees exercise, through the process of carbon-assimilation, a purifying effect upon the air, the existence of the increased quantity of ozone often claimed for the vicinity of forests is not yet established; by opposing obstacles to air currents, forests prevent the dissemination of dust particles with their contingent germs; they reduce the extremes of temperature of the air; they increase the relative humidity of the air and the precipitation in rainfall, and they protect and control the waterflow from the soil.

To us these effects do not appeal with the same force that they do in continental areas. Our insular and geographical position renders us in a measure independent of them. The data for these continental results, it must be remembered, are derived from large forest areas such as do not exist here. For this country I know of no experimental evidence on the subject. As, however, the effects of forest influence are felt mainly in local modifications of climatic conditions, we are not justified in regarding the conclusions that have been reached as inapplicable to Britain. No little interest attaches, therefore, to a statement based upon these continental observations to which Dr. Nisbet has recently done well to call attention—that, "where the rainfall is over forty inches it is undesirable to increase the forest area." The significance of this dictum, if it be established, to Britain, dependent so largely upon her agriculture, is evident. Wet years, unfavourable to farm crops, are, under existing conditions, more numerous than favourable dry ones, and any extensive tree-planting in agricultural areas might therefore prove disastrous. But I may here emphasise the point that, whilst for the growing of specimen trees we may agree with Evelyn when he says, "If I were to make choice of the place or the tree, it should be such as grows in the best cow-pasture, or upland meadow, where the mould is rich and sweet," yet the harvest which scientific sylviculture reaps comes from land unsuited to agriculture, which would otherwise lie barren and waste, and therefore schemes for the afforestation of such areas in non-agricultural districts need not be prejudiced by the prospect of an increased local rainfall. At the same time we must not fail to learn the obvious lesson that afforestation is not, as some suppose, a simple matter of employment of labour, but that it involves the consideration of weighty scientific problems.

Forests, as a source of fuel, have not the direct importance to this country, rich as it is in coal-supply, that they have in States less favoured, but their economic importance to us as a source of timber needs no comment. There are no means available through which to estimate the annual output of timber from our plantations, but indirectly we can gauge the insufficiency of our woodlands to supply the timber necessities of the country by reference to the returns showing the amount and value of forest produce annually imported. This has been steadily increasing until in 1893 its value exceeded eighteen million pounds. Of course a considerable proportion of the materials thus imported could not in any circumstances be produced in Britain. But, after allowing a liberal discount for these, there remains a large bill which we pay for produce, no small portion of which could be furnished at home. No one would suggest that in the limited and densely populated area of Great Britain timber-trees of kinds suiting our climate could be grown sufficient to supply all our demands; that would be impossible. But few would venture to deny that we could do very much better for ourselves than we do, and that our labour payments abroad might be materially reduced. It is admitted that well-grown home timber is, of its kind, equal to, if not superior in quality to, that which is imported; it is surely, then, legitimate to expect that a large supply of well-grown timber would enable us to hold the market to a much larger extent than is presently the case, and that we might be very much less dependent than we are upon the surplus timber of other nations.

The importance of this to the country is increased by the consideration of the continued appreciation of timber. There is abundant evidence forthcoming to indicate that the present rate of timber consumption of the world is in excess of the present reproduction in the forests of the great timber supplying countries, and with the persistence of existing conditions we would appear to be within measurable distance of timber famine. Experience, too, teaches that we may expect not a diminution but rather an increase in consumption. No doubt as civilisation advances the discoveries of science will, as they have done in the past, enable us to substitute in many ways for the naturally produced wood other substances prepared by manufacture; but this saving in some directions has been, and will probably continue to be, counterbalanced by greater utilisation in others—witness, for example, the enormous development within recent years of the wood-pulp industry abroad, and consider the prospect opened up by the manufacture of wood silk which is now being begun in Britain.

That the possibility of forest exhaustion is no chimera should be evident to anyone conversant with current timber literature. Taking North Europe, for instance:—In Norway, "raw timber is yearly becoming more expensive and more difficult to obtain." To Sweden, "pitch pine long beams are taken from America, suitable ones of sufficient size and quality being unobtainable now in Sweden." In Scandinavia, the virgin forests, "excepting such as are specially reserved by the Government in the districts where mills are situated, are almost exhausted." In Russia, the Riga "supply of oak is exhausted." These sentences, culled within the past few weeks from trade journals, show that this is a more pertinent question than some would suppose. In Sweden, which, it is remarkable, is actually importing logs from America, the situation is regarded as so serious that proposals are on foot for the imposition of a tax upon exported timber for the purpose of raising a fund for replanting denuded areas. But it is not only in North European countries that there are signs of the giving out of timber forests. As they fail the demand upon Canadian and American stocks increases, and when we look at these Canada "shows signs of beginning to find it hard to continue her voluminous exports to Europe, and at the same time send sufficient supplies to the United States." But the most striking evidence is that furnished by the chief of the United States department of forestry, in his official report for the year 1892, in which he says: "While there are still enormous quantities of virgin timber standing, the supply is not inexhaustible. Even were we to assume on every acre a stand of 10,000 feet B.M. of saw timber—a most extravagant average—we would, with our present consumption, have hardly one hundred years of supply in sight, the time it takes to grow a tree to a satisfactory log size. Certain kinds of supplies are beginning to give out. Even the white pine resources, which a few years ago seemed so great that to attempt an accurate estimate of them was deemed too difficult an undertaking, have, since then, become reduced to such small proportions that the end of the whole supply in both Canada and the United States is now plainly in view."

It must be owned that there are those who do not regard the suggestion of forest exhaustion as a serious one. They argue that the prophecy is no new one, and yet we are none the worse off than we have been; that failing supply from one source it has always been possible to tap another, and so it will probably continue; and then the period when exhaustion is likely to take place is so far off, there is ample time for the growth of new forests to replace those being cut. No doubt there is time. But this is just the kernel of the whole forestry question. With proper conservancy of forest areas, the application of scientific principles to the recuperation of areas recklessly denuded, and the afforestation of barren and waste lands, timber sufficient to meet a greater demand than is now made could be produced. This is the aim of scientific forestry, and it is to secure this that those who have given attention to the subject are working, conceiving it to be a duty of this generation to hand down to its successors a heritage no less valuable than that which it received.

With an acreage of wooded land amounting to only 4 per cent. of their total area, Great Britain and Ireland possess a smaller proportion so covered than any other European country. Denmark comes near with only about 5 per cent., in France the percentage rises to 15, in Norway and Germany to 25, in Austria-Hungary to 30, whilst in Sweden the amount is over 40 per cent. The United States is estimated to have about 25 per cent. These figures do not, however, give a fair basis of comparison of the amount of timber area in Great Britain with other countries, inasmuch as in the continental lands the bulk of the woodlands is true forest, whilst a large part of the area included in the British return is merely pleasure ground, and another large portion is only plantation; of real forest the area is extremely limited. It is not surprising, then, that we are not able to furnish ourselves with an adequate supply of timber. But although there is so little land under wood, there are thousands of acres unsuited for any other crop, and these for reasons I have already indicated, it is desirable to have planted. How to have this accomplished, and how to secure that woodlands already existing shall be tended so as to produce a maximum result, giving a profitable return, are the problems we wish to see solved.

It will conduce to appreciation of the question if I briefly discuss the causes which have been active in developing the present condition of woodlands in Britain, and in bringing about the disparity between it and other countries in respect of woodland area.

State ownership of continental forests will probably occur to most people as the reason for the difference in area just pointed out. This is true with, however, some qualification. In consequence of the circumstances of their situation continental States have been compelled to recognise the national economic importance of forests. This they have done, not so much by the creation of State ownership in vast forests as by the organisation of a State department of forestry and a State system of forestry education. It is altogether a mistake to suppose, as is often the case, that the whole or even a large part of the forests on the continent belong to the respective States. The amount of State-owned forest is surprisingly small. Fernow gives it in Germany as about 33 per cent. of the whole forest area; in Scandinavia 15 to 20 per cent., in France some 10 per cent., in Switzerland 4 per cent., whilst in Italy it is not 2 per cent. The bulk of the forest is in the hands of private owners or corporate bodies, subject, though apparently not always, to some control or limitation by the State. But the example of the States in the management of their own woods, their readiness to give advice through their officials, and the education which is carefully provided for those concerned in forestry work, have resulted in those privately-owned forests being as well managed as those of the State. It is important to make clear this distinction, because it shows that a State system of conservancy and supervision of forestry is quite compatible with large private ownership in forests, and that efficient sylviculture upon a large scale is not inseparable from State ownership.

But someone may say, "We, too, have State forests!" Yes, but it is almost absurd to mention them in the same sentence with those of the continent for any part they play at present in connection with forestry in Britain. The nine thousand acres at Windsor are mainly covered with specimen trees. Of the twenty-five thousand acres in the Forest of Dean, a portion is supposed to be cultivated for a profitable crop, but appears to result in an annual deficit. The New Forest, with its sixty-three thousand acres of soil-area, affords us one of the most interesting object-lessons, showing the triumph of sentiment over common-sense, that the country affords. Its history is well enough known, and I need only remind you that Parliament has decreed the major part of it to persist as a barren waste, whilst in the remainder, which is covered with trees, the practice of forestry is prohibited, so that slowly the whole is going to wreck and ruin. This illustrates the value to us of State forests! In the days of the "wooden walls" the dockyards obtained valuable timber from them, but now their large area is, one may say, of no State service whatever as forest, if one excepts a small portion of Windsor Forest recently attached for instruction purposes to Coopers Hill College. There can be no question that if the State had set an example of scientific forestry in even a portion of these areas, the practice of sylviculture now throughout the country would have been very different.

I need not dwell on the fact that the conditions of land tenure in the country have exercised an important influence upon the extent of wood-planting in the country; and they must always do so. "The oak scorns to grow except on free land" is a saw that sums up pithily the relationship between land-laws and woodlands in England. Copyholders could hardly be expected to plant much timber when the lord of the manor claimed the crop; and I believe it is possible in some counties to trace the boundaries of copyholds by the entire absence of trees on one side of a line and the luxuriant growth on the opposite side. The intricacies of entail and the fact that life-renters had themselves to bear the expense of planting, except where necessary for shelter, without prospect of seeing a return for the outlay, must have operated prejudicially to an increase in woodlands. Happily since 1882 in England, and by an Act of last year for Scotland, the last-mentioned restriction upon tree-planting is removed.

Nor shall I pause over the question of game, which has been at once the origin and the destruction of forests in Britain. Not that it is an unimportant element. But the instinctive love of sport in the British race is proof against all argument of utility, and the needs of sport will always be a barrier, as they have been in the past, to the planting of large areas well adapted for timber-growing. It cannot well be otherwise. Landowners can hardly be expected to forego large and immediate game-rents for what appear the long-delayed, even though possibly greater, profits of timber cultivation. In this case the inevitable must be accepted. Nevertheless, there are large areas, the game-rent of which is infinitesimal for their acreage, which might be planted.

The most potent factors in bringing about the present condition of our woodlands are probably to be looked for in the nature of the crop itself and in the want of appreciation of its character manifested by landowners; in a word, in a want of knowledge of the principles of scientific forestry. Forestry is handicapped as compared with agriculture by the fact that the crop cannot be reaped within the year. The owner who plants and incurs the initial expense of stock, fencing, and perhaps draining, may after some years secure intermediate return from thinnings, but it will rarely happen that he reaps the final yield at maturity of the crop he has sown; it will fall to his successor. It is this planting for posterity that makes demands upon the landowner to which he is unequal. Hence it comes about that woodlands, beyond what may be requisite in the way of cover plantation and for shelter, are often regarded as expensive luxuries, and, in the time of high agricultural values, landowners have even grubbed out trees to make way for annual crops yielding an immediate return. But scientific tree-growing for profit does not consist in the covering of soil-area indiscriminately with trees, without definite system and relation of its part one to the other. Just as the farmer has to plan his rotations on a definite system with reference to his total acreage, so in properly managed timber-growing must areas be arranged in such a way that some part of the forest will be yielding annually its final return of mature crop, and cleared areas will by a natural process of regeneration replenish themselves without recourse to the expensive operation of planting being necessary. Scientifically worked a forest area of suitable land, of which there is such abundance in Britain, should be capable of yielding an annual net revenue as regular as that obtainable by any other form of soil cultivation.

It is nevertheless frequently urged as a reason for not growing timber that wood will not pay in Britain. A landowner will tell you he has acres of land which do not return him more than half-a-crown, and if it would pay better he would be glad to put them under timber, but he does not believe it would; and he will point to rates on woodlands which must be paid although no crop is being reaped. He will demonstrate that there is no market for home timber, which seldom fetches its value, and that there is a prejudice against it which increases the difficulty of any attempt to compete with the foreigner.

There is some reason in the latter part of this contention. The wood-grower in Britain has I think just cause for complaint when he finds his produce not only handicapped by preferential transport rates to foreign timber, as has been the case in the past, but that it is also disparaged by exclusion from, or admission only under conditions to, competition with foreign timber by the terms of building specifications. It is said to be the common practice of architects and others to bar home timber in this way, and the Government itself has not been guiltless in the matter. The Post Office form of tender a couple of years ago for telegraph poles entirely cut out native produce from competition, and the conditions of contract framed by the Board of Agriculture under the Land Improvements Act were until recently almost prohibitive to home timber. These latter are now modified, but whether or not the Post Office still boycotts home produce I cannot say.

However it is come about—and there are no doubt various effective causes—this undervaluing of home-grown timber is quite unreasonable, and the slur cast upon it is undeserved, so far as its quality is concerned. At the same time, there is ground for saying that the difficulties, occasioned in this and other ways, of disposing of home timber at renumerative prices are due to causes not altogether beyond the control of landowners who grow timber.

It is generally admitted that with a more regular and certain supply, as well as a larger amount in different districts, home timber would have a better chance of holding its own in the market. This is just what scientific forestry would bring about. Given a systematic cultivation of forest on scientific principles of rotation, and the conditions are prepared for a steady output of timber by annual cut, as well as for a supply of raw material for utilisation in the manufacture of the many subsidiary products derivable from forest growth. If landowners would only provide such supplies, they would alter altogether, and to their own advantage, the conditions under which they dispose of so much of their home wood. The timber merchant who now travels hither and thither over the country picking up small lots where they may occur for transport to his, probably distant, mills, at a cost which eats a big hole in the value of the trees to the landowner, would find it worth his while—and for that matter, it would be worth while for the landowner himself—to erect in the vicinity of the forest, mills for the purpose of converting and preparing the timber, and to put up machinery for the extraction of useful products from the waste wood. In such conditions a steady market could be created in which the advantage would lie altogether on the side of the home-grown article, and materials, the débris of the forest, now thrown aside as useless, would be turned to account to the greater benefit of the landowner. Encouragement, too, would be given to the establishment of local industries dependent upon forest growth, through which fresh outlets for forest produce would be provided.

The amount of profit returnable from timber cultivation must of course vary with the circumstances of the area in each case, but in comparing values it must always be borne in mind that timber land is land which can yield no agricultural rent. The official statistics relating to continental State forests show us the result of forestry on a large scale, and it is interesting to note how, under what we must believe to be an equally efficient system of forestry management, the net revenue from the several areas differs greatly. Thus from its two million acres of forest area Bavaria draws a little over five shillings per acre per annum; Wurtemburg, with nearly half a million acres, gets a return of about eleven shillings; and Saxony, with a somewhat less area, receives over seventeen shillings per acre per annum. For this country we have no such figures. Our State forests result in a loss. It is unfortunate, too, that no returns are available from private forests and woodlands, either in Britain or abroad. Estimates of possible profits in this country we have abundantly, but solid figures of expenditure and receipt in relation to timber growing there are none. By the favour of Mr. Munro-Ferguson, M.P., who, as a landowner, exhibits a most enlightened spirit in regard to forestry, I am, however, able to cite the case of a pine and larch wood at Novar, in Ross-shire, twenty-four acres in extent, which was clean cut in 1883, and gives instructive figures. After sixty-one years' growth on land similar to that which in the neighbourhood yields a grazing rent of from one to two shillings per acre, it is found to have yielded a net sum equal to a revenue to the landlord during the whole period of its growth of over nine shillings per acre per annum, or an increased value of quite seven shillings per acre per annum. Although it refers to only a single wood of limited extent, this return shows how profitable waste land may become under timber. No doubt from the estates of other of our landlords who own extensive woodlands, where, if there is not the highest scientific forestry, there is certainly good wood management, results of an equally instructive kind could be obtained—many would be better; and it is much to be desired in the interest of forestry that they should be made known as an object-lesson to those who doubt the profit of tree-growing.

But in the return I quote from there is another interesting point which I must not fail to note. During the period of growth of the wood, the outlay upon labour in connection with it amounted to a sum equal to an expenditure of over thirty-one shillings per acre per annum. That is to say, this sum was distributed in wages to the people of the neighbourhood. This exhibits the benefits brought in the train of forestry, which are no less important to the community at large than is the profit of the crop to the landowner. The scientific treatment of woodlands and cultivation of forests for profit on a proper scale involve the employment of a considerable amount of labour, much of it at a time when there is little else doing in country districts, not only in the actual tending of the forest area, but in the manipulation and subsequent preparation of the timber, and in the manufacture of the numerous by-products obtainable from it. In these days of congestion in cities the importance of the development of such an industry which can provide occupation in the country, and thus may aid in restraining migration to the towns, has not escaped notice, and it cannot be too often or too greatly emphasised.

The influences, to which we have just given attention, that have prevailed in bringing about the present limited area of woodland in Britain are, it will be seen, not wholly irremovable, nor are the obstacles to betterment insurmountable. And the question we have now to discuss is—How are these to be counteracted and overcome? By what means is it possible to bring forestry in Britain more in line with that of other nations? At the outset I would say that if forestry is to be established on a sound commercial basis, the only one on which it should rest, if we are to have a national home-timber industry, it can only be when the issues involved are more fully realised than they are nowadays. As in agricultural practice failure can only be obviated by the application of scientific methods in farm cultivation, so is it with forestry. To become a profitable industry it must be practised as an applied science, and not as an empirical routine.

We live beyond the days when it would be possible to apply the autocratic remedy for want of woodlands introduced in Scotland by the Jacobean statute, which compelled the landlords not only to plant wood and forest and make hedges, but also enjoined them under penalties to see that each of the tenants planted one tree for every marke of land. Nor, indeed, can much be said of the success of the compulsion. And I do not imagine anything could be gained nowadays by the method adopted in Scotland in the middle of last century by the "Select Society," as it was called, of offering a premium to farmers who planted the most trees within a specified time. That such processes were deemed necessary is interesting as showing how old standing has been the recognition of the want of sufficient woodland area in the country. At the present time there are those who would reverse, as it were, the process of the old statute, and who look to the acquisition by the State of large areas of waste land, and their afforestation by it, for the solution of this forestry question. It is, no doubt, a wise policy which encourages private enterprise to deal with the details of industries, and only invokes State aid as a directive and controlling force when its need can be clearly shown. That there is need for State aid in the case of forestry I do not deny, but it is not required to the extent just mentioned.

I unhesitatingly say that the State ought to treat the forest areas now in its possession in a reasonable and scientific manner, instead of leaving them as objects for the finger of scientific scorn. They might be made, in part at least, models of the best forestry practice. It is no use to dispute with the sentiment and taste which have prevailed in making the New Forest what it now is, and it is hopeless to expect an unanimous verdict as to the destiny of State woods and upon the method of treatment to which they should be subject. We have had recently, in the lively discussion regarding the management of Epping Forest, an illustration of how large is the number of people who have views upon the subject of the management of woodlands, and how the majority of them, if they had their way, would, through ignorance, defeat the very object they desire to accomplish. We must be prepared in any proposal for utilisation of State forests to incur the opposition of those who regard all scientific handling of woods as vandalism, although I do not know that forestry in itself involves a want of recognition of the beautiful, or dulls the feelings which a sylvan landscape invokes in the minds of those in touch with nature. It is allowed there are areas in our State forests sacred by many memories, possessing a grandeur and picturesqueness with which no hand, whether of forester or landscapist, would venture to meddle. But, on the other hand, there are tracts which without damage to the natural beauty, and without depriving in any sensible degree the people of their privileges of recreation they prize so much, might be and should be dealt with as forest cultivated on scientific principles. These might serve as instruction areas, showing all that is best for the information of foresters. The creation of some such experimental teaching stations in State forests is one of the essentials for forestry in Britain. I would go further and say that the area of State ownership should be increased to the extent of the establishment of forest stations, of an acreage sufficient to allow of a satisfactory rotation, in other parts of the country as centres of instruction. There have been, as you are aware, proposals for the afforestation of some of the three million and more acres of waste land in the Highlands of Scotland capable of growing timber, and we await with some interest the report of the Deer Forest Commission, which has taken evidence on the subject. If, as has been suggested may be possible, afforestation is attempted through any system of State-aided planting, an opportunity would be afforded for securing what would be of so much advantage to the country. Beyond this system of model experimental stations, the State ownership of forest in Britain does not seem to me to be necessary in the cause of forestry.

Replying recently to Sir John Lubbock in the House of Commons, the President of the Board of Agriculture, after recounting what his Board is now doing for forestry in Britain, added: "I shall always be glad to receive and to consider any suggestion for the increase of sound technical knowledge on this subject." Well, now, I have a suggestion to make. In a practical science like forestry "an increase of sound technical knowledge" can only be possible when facilities for practical instruction are provided. I would, therefore, ask the President to consider what I have just said with regard to State forest experimental areas. These cannot, of course, be created by a stroke of the pen, but the initiative for their formation would naturally come from the Board of Agriculture. It is possible that, with betterment in forestry practice, landowners might be found who would be willing to devote portions of their land for the purposes of instruction, following for forestry the noble example of Sir John Lawes in his work for agriculture; and everyone interested in forestry must hope this may be so. But when the State has already in its hands the means through which a large national industry can be fostered, it is surely incumbent on it to utilise them for the purpose. And mark you, in asking for this, one does not make a large demand upon the Treasury. The whole could be done at no ultimate cost, for the profits from the areas could unquestionably more than repay any outlay incurred upon them.

The true solution of the forestry question in Britain is to be found in the diffusion of accurate knowledge of forest science. The landowner has to be convinced that through scientific forestry a sound and profitable investment for his capital is to be found in woodlands; the factor or land agent must be instructed in the scientific principles of tree-growing for profit to enable him to secure a steady income to the landowner from his invested capital; and the working forester has to be taught methods of cultivation based upon science, by which his faith in traditional practice, when it is, as is so often the case, unscientific, may be dispelled. It is through education alone that we can arrive at improved forestry.

This was recognised by the Select Committee upon Forestry of the House of Commons in its report in 1887, which performed a very valuable service by its exposure of the prevalent ignorance of scientific forestry and of well-known facts of tree-cultivation amongst those professedly engaged in its practice and study—an ignorance the continued existence of which manifests itself in some of the writings in current periodicals. The remedy it suggested of a State Forest Board, including representatives of science and of bodies interested in forestry, charged with the superintendence of the formation of forest schools and the preparation of forest literature, was superseded by the later institution of the Board of Agriculture, in which were absorbed such functions in regard to forestry as the Government of the day accepted. We are so accustomed to anomalies in our administrative system that the discovery of an additional one hardly surprises us. Yet it is difficult to understand why it is that a Board which deals with subjects so essentially based on science as does the Board of Agriculture should not have on its staff scientific men representative of the fields of science within its purview. But I do not know that either agriculture or forestry is so represented. It seems odd that this Board should be dependent for scientific advice upon outsiders, and now that it proposes to undertake the responsibility of the publication of a journal which, I take it, will be a means for the circulation of accurate information upon scientific questions, I do not see how its functions can be adequately performed without scientific help from within. No one of us would expect to see, either to-day or to-morrow, in this country a Board of Agriculture with an organisation like that of the similar department in the United States, which excites our admiration by the excellence of the practical information it circulates. But there is a wide interval between the completeness of the American department and the incompleteness of ours; and if I may make another suggestion to the President of the Board of Agriculture, I would ask him to consider whether it would not strengthen the Board in the discharge of its rapidly growing functions if it had competent scientific advisers upon its staff. Such a man for forestry would, I believe, do much for "the increase of sound technical knowledge" in Britain, and promote to no little extent its interests.

Since 1887 we have made some advances along the lines of improved literature and of teaching pointed out by the Select Committee as those by which reform could be accomplished.

If one looks at the literature available up to a recent period to anyone desirous of learning something about forestry, one need feel little surprise at the ignorance which prevailed. It was alike meagre in amount and deficient in quality, consisting chiefly of the records of empirical practice of men who had had no scientific training. It is satisfactory to note that these are now being replaced by works having some pretension to scientific method and accuracy. From Coopers Hill there is issuing, more slowly than could be wished, Prof. Schlich's excellent "Manual of Forestry," and from his colleague Prof. Fisher we may, I believe, soon expect an important forestry book. You all know Prof. Marshall Ward's lucid little books on timber and plant-diseases, and we are promised immediately, under his editorship, a translation of Hartig's "Diseases of Trees," by Prof. Somerville. A most valuable and interesting contribution to forestry literature is the book by Dr. Nisbet, recently issued from the Clarendon Press, containing the lectures he delivered in the University of Oxford during the past year; and to his marvellous energy we shall owe the new edition of "Brown's Forester," which is shortly to appear, and an English version of Hartig's "Text-Book" for foresters. All this activity shows an increasing interest in forestry, but it is only the beginning of a movement to make up for the preceding dearth. Botanists are greatly indebted to the Delegates of the Clarendon Press—and it is fitting I should here acknowledge the obligation—for the splendid series of standard foreign works on botany they have brought within the reach of English-speaking students, and which have done so much for the progress of botany in Britain. If we have now got beyond the stage of dependence in pure botany, we are far from it in scientific forestry, and I would hope that the Clarendon Press will add to its botanical series some of the standard foreign forestry books, and thus aid in the dissemination of the knowledge so essential to progress in the subject.

I must not omit to refer here to the excellent opportunity that is afforded for the circulation of scientific information by the new journal of the Board of Agriculture, of which intimation has recently been made, and it is to be hoped that forestry will find a place in it side by side with agriculture.

The attention paid to the teaching and study of forestry by continental States, their many schools and copious literature of forestry, make it remarkable that, apart altogether from the economic side, forestry as a subject of study and investigation has not been long ago introduced in some of our teaching centres. I think the Sibthorpian Chair of Rural Economy of the University of Oxford was for long the only one through which forestry was recognised as within the sphere of University education. So far the limited tenure of this chair, in its new dress, has been held by agriculturists—in their line the most distinguished men; but I should like to think that one may look forward to a time when forestry shall have its turn, if by that time it has not come about that it is otherwise provided for.

It was, however, only the necessities of India which, at a comparatively recent date, led to the first starting of forestry teaching in Britain, and then only at the cost of India, and for those destined to serve there as foresters. Coopers Hill College, the outcome of these, with its excellent equipment—including now, I believe, a slice of Windsor Forest for purposes of practical work—possesses the elements of a successful forestry school, and it has within recent years opened its doors to outsiders who may wish to learn forestry. But, so far as I am aware, it does not draw the young landowners of the country as it should do. Possibly the expense of the special education, which equals that of the universities without offering the advantages in other directions they afford, may be deterrent; but I am inclined to think that if the authorities made the fact better known that men other than foresters for India are admitted to the college, more would avail themselves of the opportunity.

Beyond this and some slight notice of forestry at agricultural colleges, there have been no facilities for forestry-teaching in Britain until within the last half-dozen years. I leave out of reckoning mere examining boards. Can we wonder, then, that there is a general want of intelligent appreciation of scientific forestry? Even now all that has resulted from the agitation in favour of more attention being given to this subject is—a lectureship on forestry in the University of Edinburgh, supported partly by the Board of Agriculture and partly by an endowment from subscriptions among landowners and others (and, I may mention here, forestry is now included as an optional subject in the university curriculum for an agricultural degree); a chair, or part of one, in the Royal College of Science at Newcastle, founded conjointly by the Board of Agriculture and the County Council; a course of instruction in science for practical foresters in the Royal Botanic Garden at Edinburgh, maintained by the Board of Agriculture; and a lecture course on forestry in the Glasgow and West of Scotland Technical Institute, similarly provided for. I must not omit to mention, too, the beginning, just made, by the Surveyors' Institute of the formation of a forestry museum in London, which should have an important educative influence. Little though it is, I think there is occasion for congratulation that even so much has been done to provide instruction, and I would have you note that in this education the different classes concerned with forestry are all recognised. Valuable as the teaching so being given is, it must have an effect in showing the need there is for more. In one way the teaching of all these bodies is incomplete, and must be imperfect, inasmuch as they have not the means for practical forestry work. Until this is provided, as I have indicated already, the teaching of forestry cannot be thoroughly carried out.

But, after all, what has been done in the way of supplying our wants in the way of teaching is nothing to what is required if forestry is to be adequately taught in Britain. Dr. Nisbet, who in his book already mentioned, has had the last say on this question, boldly states the requirements at six forestry chairs in universities, and four schools of practical sylviculture in the vicinity of forests. I do not think he puts the needs one whit too high. I should be even disposed to add to them, because I note he has omitted to take into account the claim of Wales, whence there has recently been a request for the establishment of forestry teaching.

But there are two questions strictly pertinent to this demand, which need answering if the proposals are to be brought within the sphere of practicability—firstly, whence are the funds to be obtained for this organisation; and, secondly, where are we to get the teachers?

Dr. Nisbet puts his hand in the Treasury pocket for the money—some five thousand pounds per annum—required by his scheme. I do not think many of us will be so sanguine as to expect the whole financial aid could be directly obtained in this way. But it may be, I think, of significance in regard to this to consider the sources from which money has been forthcoming for what has already been done. The Government, through the Board of Agriculture, has given most, the remainder has come from the County Councils and from private contributions.

There is no reason to suppose that the Board of Agriculture will be less willing in the future than it has been to aid in the establishing of forestry teaching in suitable centres; but its support from the limited funds—eight thousand pounds—at its disposal for educational purposes, is always given as a grant in aid, and is contingent upon evidence of local effort towards the end desired, which we must therefore look to in the first instance.

It is of no use to speculate upon the prospects of private munificence providing equipment in any centre. We may hope for it, but I do not think times are such as to lead us to expect large pecuniary aid from landowners. After vigorous effort amongst them, extending over some years, to secure an endowment for a chair of forestry in Edinburgh, a sum a little over two thousand pounds is all that has been raised.

But forestry is one of those subjects to the teaching of which we may be more sanguine of support from County Councils. It will always be a matter of regret to scientific men, and those interested in the industrial progress of the country, that the grand opportunity furnished by the fund dealt with under the Local Taxation Act (1890) was not taken more advantage of by the Government of the day. Distributed, even in part, through representative educational institutions, it could have provided equipment for technical education of the highest kind beyond our dreams. Thrown at the heads of the County Councils, before these bodies had had time to settle to their prescribed work, there has been, in the opinion of those well qualified to judge, no little waste. You could not create all at once the machinery requisite for the most efficacious expenditure of half a million of money on technical teaching. Much of the work done by these bodies is admirable. It is indeed surprising in the whole circumstances how efficiently technical instruction has been carried out, and no doubt it will improve. But it had a most extravagant start. It is difficult to trace, in the general returns of the technical education undertaken by the County Councils, the details of their work, and I have not been able to discover how far forestry has been treated as a subject of instruction. It has not, I think, been often included. But the example of Northumberland and Durham in respect of the Newcastle chair is one that gives encouragement for thinking that if the due importance of forestry to the community were made clear, County Councils, in districts favourable for forestry and its concomitant industries, might come forward with some of the financial support needed for the provision of the educational equipment.

It appears to me that whilst we must obtain from the Government the institution of sylvicultural areas for practical instruction, our best chance of success in acquiring the necessary endowment for the rest of the teaching lies in the line of combination between the Board of Agriculture and the County Councils, with, it may be, aid from private benefactors. But if we were to draw financial support from County Councils, or from private sources, we must as a first step towards this make known, more thoroughly than it is, the nature of the national interests involved. We must disabuse landowners, land agents, and practical foresters of the notion that forestry consists in the random sticking in of trees, which anyone, no matter how unskilled, may accomplish. We must bring home to the people's minds that in science is to be found the only sure guide to proper timber-growing, and that scientifically managed forests are alike a profit to the producer, a benefit to the community of the region in which they are reared, and a source of national wealth. Once we have got so far as to create this opinion, the funds for as extended a scheme of forestry education as may be necessary will, I venture to think, be forthcoming.

There is still the other question to answer—Whence are the teachers to come? This is, I think, fundamental. For, given a competent teacher, he will soon find opportunity for teaching. If to-morrow the whole or even a half of the chairs suggested by Dr. Nisbet as essential were founded, how should we meet the demand for men to fill them? We might, of course, draw upon the Indian Forest Service, but I do not know where you would find teachers in Britain. But if there is no prospect of such immediate requirement of teachers, that does not make the fact of their deficiency of any less moment. There is surely something wrong when men capable of giving scientific instruction in so important a practical subject are so scarce.

This is how it touches us botanists, and upon our shoulders I am disposed to throw the blame for the present outlook. We do not seem to have realised, except in relation to medicine, that modern botany has an outlet. Perhaps it has been the influence of medicine that has engendered this. We find chemists and physicists devoting their science to the furtherance of practical aims. Zoologists have applied theirs to the elucidation of problems bearing on the fishery industry, and we see in that monument to the ability and energy of Prof. Ray Lankester, the marine biological laboratory at Plymouth, an experimental station which, while it contributes to the nation's prosperity, serves at the same time as a home of pure research. But where is the practical outcome of modern botany? I must not overlook such brilliant work as that of Marshall Ward, full of purpose, and significant as it is to many large industries, nor that of Oliver in its bearings on horticulture. But it does seem to me that the general trend of botanical work in Britain is not utilitarian. Perhaps as good an illustration as could be given of the slight practical importance attached by the lay mind nowadays to botany is the fact that the Scottish Universities Commissioners have made it—though I must add it is bracketed with zoology—optional with mathematics for the degree in agriculture!

It is matter of history that its utilitarian side gave the first impetus to the scientific study of botany. The plant-world, as the source of products of economic value and drugs, attracted attention, and out of this grew, by natural development, the systematic study of plants. The whole teaching of botany was at the first, and continued for long to be, systematic and economic, and it was from this point of view that, the herbalist having become the physician, botany became so essential a branch of medical study. It is noteworthy that as an early practical outcome of the study came the establishment of botanic gardens, which, at their institution, were essentially what we would now style experimental stations, and contributed materially to the introduction and distribution of medicinal and economic plants, and to the trial of their products. If they are now in many instances simply appendages of teaching establishments, or mere pleasure-grounds, we at least in Britain are fortunate in possessing an unrivalled institution in the Royal Gardens at Kew, which still maintains, and under its present able Director has enormously developed, the old tradition of botanic gardens as a centre in our vast empire, through which botany renders scientific service to our national progress.

In Britain, consequent perhaps on our colonial and over-sea possessions, the systematic side of botany continued predominant long after morphological and physiological work had absorbed the attention of the majority of workers and made progress on the continent. Not that we were wanting in a share of such works, only it was overshadowed by the prevalent taxonomy, which in the hands of many no longer bore that relation to its useful applications which had in the first instance given it birth, and had become little more than a dry system of nomenclature.

The reaction of a quarter of a century ago, which we owe to the direct teaching of Sachs and De Bary and the influence of Darwin, many of us can remember; in it some who are here to-day had a share. Seldom I think is a revolution in method and ideas of teaching and study so rapidly brought about as it was in this instance. The morphological and physiological aspect of the subject infused a vitality into the botanical work which it much needed. The biological features of the plant-world replaced technical diagnosis and description as the aim of teachers and workers in this field of science. No weightier illustration of the timeliness of this change could be found than in the attitude of medicine. But a few years ago he would have been rash who would predict that botany would for long continue to be recognised as a part of university training essential to medical students. Its utility as ancillary to materia medica had lost point through the removal of pharmacy from the functions of the physician. But what do we see now? Not the exclusion of botany from the university curriculum of medical study, but the recognition to such an extent of the fundamental character of the problems of plant-life, that it is now introduced into the requirements of the colleges.

But if the old taxonomic teaching was stifled by its nomenclature, there is, it seems to me, a similar element of danger in our modern teaching, lest it be strangled by its terminology. The same causes are operative as of old. The same tendency to narrowing of the field of vision, which eventuates in mistaking the name for the thing, is apparent. With the ousting of taxonomy, and as the laboratory replaced the garden and museum, the compound microscope succeeded the hand-lens, and for the paraphernalia of the systematist came the stains, reagents, and apparatus of microscopical and experimental work as the equipment necessary for the study of plants, the inwards rather than the outwards of plants have come to form the bulk of the subject matter of our teaching, and we are concerned now more with the stone and mortar than with the general architecture and plan of the fabric; we are inclined to elaborate the minute details of a part at the expense of its relation to the whole organism, and discuss the technique of a function more in the light of an illustration of certain chemical and physical changes than as a vital phenomenon of importance to the plant and its surroundings. This mechanical attitude is quite a natural growth. It is a consequence of specialisation, and it is reflected in our research. But it must be counteracted if botany is in the future to be aught else than an academic study, as it was of old an elegant accomplishment. It has come about very much because of that want of recognition by botanists, to which I have already referred, of the natural outlets of their study—of their failure so far to see the lines through which the subject touches the national life. Modern botany has not yet found in this country its full application. It has not yet rendered the State service as it ought, and as was done by the taxonomic teaching it supplanted.

It is from this point of view that I wish to point out to you to-day that through forestry—and although I have particularly dealt with this branch of Rural Economy, what I say is equally true of horticulture and agriculture—modern botanical study should find a sphere of application by which it may contribute to our national well-being, and which would have a directive influence upon its teaching, taking it out of the groove in which it tends to run. What we botanists need to do in this connection is to teach and to study our subject from a wider platform than that of the mere details of individual form, and to encourage our pupils to study plant-life not merely in water-cultures in the laboratory, but in the broader aspects exhibited in the competitive field of nature.

If forestry is ever to thrive in Britain, botanists must lay the foundation for it in this way. We cannot expect to make our pupils foresters, nor can they yet get the practical instruction they require in Britain. In this we must depend yet a while on continental schools; the stream of continental migration, which needs no longer to flow in morphological and physiological channels, must now turn in the direction of forest schools. But we can so mould their studies and give bias to their work as will put them on the track of this practical subject. If we had only a few men so trained as competent foresters, and capable of teaching forestry, there would be an efficient corps with which to carry on the crusade against ignorance and indifference, the overcoming of which will be the prelude to the organisation of forestry schools and scientific sylviculture in Britain. The influence of the individual counts for much in a case like this. The advent of a capable man started forestry teaching in Scotland, which years of talk had not succeeded in doing. And so it will be elsewhere

I have endeavoured, thus briefly, to sketch the position, the needs, and the prospects of forestry in Britain. Its vast importance as a national question must sooner or later be recognised. It is a subject of growing interest. Its elements are complex, and it touches large social problems; but the whole question ultimately resolves itself into one of the application of science. To botanists we must look in the first instance for the propagation of the scientific knowledge upon which this large industry must rest. They must be the apostles of forestry. And forestry in turn will react upon their treatment of botany. Botany cannot thrive in a purely introspective atmosphere It can only live by keeping in touch with the national life, and the path by which it may at the present time best do this is that offered by forestry.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY CAPTAIN W. J. L. WHARTON, R.N., F.R.S., PRESIDENT OF THE SECTION.

YOU will not be surprised if, having called upon an hydrographer to preside over this Section, he takes for the subject of his review the Sea. Less apparently interesting, by reason of the uniformity of its surface, than the land which raises itself above the level of the waters, and with which the term geography is more generally associated, the ocean has, nevertheless, received much attention of later years. In Great Britain, especially, which has so long rested its position among the nations upon the wealth which our merchant fleets bring to its shores, and upon the facilities which the sea affords for communication with our numerous possessions all over the globe, investigation into the mysteries, whether of its ever moving surface or of its more hidden depths, has been particularly fascinating. I purpose, therefore, to attempt a brief survey of our present knowledge of its physical condition.

The very bulk of the ocean, as compared with that of the visible land, gives it an importance which is possessed by no other feature on the surface of our planet. Mr. John Murray, after a laborious computation, has shown that its cubical extent is probably about fourteen times that of the dry land. This statement appeals strongly to the imagination, and forms, perhaps, the most powerful argument in favour of the view, steadily gaining ground, that the great oceans have in the main existed in the form in which we now see them since the constituents of the earth settled down into their present condition.

When it is considered that the whole of the dry land would only fill up one-third of the Atlantic Ocean, the enormous disproportion of the two great divisions of land and sea becomes very apparent.

The most obvious phenomenon of the ocean is the constant horizontal movement of its surface waters, which in many parts take well-defined directions. These great ocean currents have now been studied for many years, and our knowledge of them is approaching a point beyond which it is doubtful whether we shall ever much advance, except in small details. For though, while indisputably the waters continually move in each great area in generally the same direction, the velocities vary, the limits of the different streams and drifts vary, mainly from the ever-varying force and direction of the winds.

After long hesitation and much argument, I think it may be now safely held that the prime motor of the surface currents is the wind. Not, by any means, the wind that may blow, and even persistently blow, over the portion of water that is moving, more or less rapidly, in any direction, but the great winds which blow generally from the same general quarter over vast areas. These, combined with deflection from the land, settle the main surface circulation.

I do not know if any of my hearers may have seen a very remarkable model, devised by Mr. Clayden, in which water disposed over an area shaped like the Atlantic, and sprinkled over with lycopodium dust to make movement apparent, was subjected to air impelled from various nozzles, representing the mean directions of the permanent winds. It dispelled the last doubt I held on the subject, as not only were the main currents reproduced, but the smaller effects and peculiarities of the Atlantic drifts were produced with surprising accuracy.

There is a small current, long shown on our charts, but which I had always regarded with suspicion. I refer to the stream which, after travelling from the Arctic Ocean southward along the east coast of Greenland, turns sharply round Cape Farewell to the northward into Davis Straits, where it again doubles sharply on itself to the southward. This is exhibited, in the model, in all its details, and is evidently caused by the pressure of the water forced by the mimic Gulf Stream into the Arctic region, where it has no escape except by this route, and is pressed against the land, round which it turns as soon as it can. This is, no doubt, the explanation of the real current.

The very remarkable winter equatorial current, which runs in a narrow belt eastwards, just north of the main stream travelling west, was also reproduced with extraordinary fidelity.

The winds, however, that are ordinarily considered permanent vary greatly, while in the monsoon areas the reversal of the currents caused by the opposite winds exercise a great influence on the movements of the water far beyond their own limits, and anything like a prediction of the precise direction and rate of an oceanic stream can never be expected.

The main facts, however, of the great currents can be most certainly and simply explained in this manner.

The trade winds are the prime motors. They cause a surface drift of no great velocity over large areas in the same general direction as that in which they blow. These drifts after meeting and combining their forces eventually impinge on the land.

They are diverted and concentrated and increase in speed. They either pour through passages between islands, as into the Caribbean Sea, are pressed up by the land, and escape by the only outlets possible—as, for example, the Strait of Florida, and form a great ocean current like the Gulf Stream—or, as in the case of the Agulhas current and the powerful stream which runs north along the Zanzibar coast, they are simply pressed up against and diverted by the land, and run along it with increased rapidity.

These rapid currents are eventually apparently lost in the oceans, but they in their turn originate movements of a slower character, which on again passing over shallow water or on meeting land develop once more into well-defined currents.

We find an analogous state of things on the western side of the Pacific, where the Japan current is produced in a similar manner.

The fact that on all western shores of the great oceans towards which the trade winds blow we find the strongest currents running along the coast, is almost enough of itself to prove the connection between them.

The westerly winds that prevail in higher northern and southern latitudes are next in order in producing great currents. From the shape of the land they in some cases take up and continue the circulation commenced by the trade winds; in others they themselves originate great movements of the water.

Compared to the great circulation from this source the effect of differences of temperature or of specific gravity is insignificant, though no doubt they play their part, especially in causing slow under-circulation, and in a greater degree the vertical mixing of the lower waters.

No drop of the ocean, even at its greatest depth, is ever for one moment at rest.

Dealing with minor points, the American officers of the Coast and Geodetic Survey have found after long and patient investigation that the velocity of the Gulf Stream in its initial and most marked part, the Strait of Florida, is greatly affected by the tide, varying as much as one-half its maximum rate during the twenty-four hours.

These American investigations are of greatest interest. They have extended over the whole area of the Caribbean Sea and its approaches, the Gulf of Mexico, and the Gulf Stream proper and its vicinity. In no other part of the ocean has observation of this detailed character been carried out, and they throw a great light on oceanic circulation. The *Blake*, the vessel specially fitted for the purpose, has during the several years in which she was employed on this work anchored in over 2000 fathoms water, or a depth of considerably more than two miles; a feat which would a short time ago have been deemed impossible.

One great point that has come out very strongly is the continual variation in the strength and direction of the currents, and the varying depths to which the surface current extend.

Eastward of the chain of the Windward Islands the general depth of the surface movement may be said to be about 100 fathoms, below which tidal influence is very distinct.

There is also a very plain backward flow of water, at depths which vary, caused by the submarine ridge which connects the Windward Chain of the West Indian Islands. These observations also generally support what I have already mentioned; that the velocity of a current depends on the strength of winds, possibly thousands of miles distant, which have given the original impetus to the water, and this, combined with tidal action when the current approaches or runs along a coast, will always cause uncertainty on the resultant velocity.

Dealing for yet another moment with the Gulf Stream, there are two points which have not been much dwelt upon, but which have a great effect on its power of bringing the modifying influence of its warm water as far as our shores.

The first is the prevention of its spreading, as it leaves the Strait of Florida, by the pressure of the portion of the equatorial current which, unable to get through the passages betweeen the Windward Islands, is diverted to the north of the Bahamas, and bears down on the eastward side of the Gulf Stream proper, compressing it between itself and the cold water flowing southward along the American coast, and at the same time adding to its forces and maintaining its high temperature.

The second is that by the time the Gulf Stream has lost its velocity as a current, in about the vicinity of the Bank of Newfoundland, it has arrived in the region of the westerly winds, that is of winds whose average direction is from west; whose influence, causing a surface drift somewhat comparable to that of the trade winds, bears the water onward to the British Islands and Norway. Without tnese prevailing westerly winds the warm water of the Gulf Stream would never reach these shores.

The depth to which the surface currents extend in other parts is little known. Direct observations on under-currents have been rare.

In the first place, it is not an easy observation to make. Apparatus has generally to be improvised. This has usually consisted of some form of flat surface lowered to the required depth, and suspended in the water by a buoy, which presents to the resistance of the upper stratum a very much smaller area than that of the surface below.

More perfect machines have been devised, notably, that used by the Americans in their West Indian experiments.

These, however, are delicate, and require so much care and experience in working, and so much time is wanted for such observations, that under the pressure of the more urgent requirements on surface movements in the interests of navigation very little has been done.

The *Challenger* made some observations on the depth of the equatorial current in mid-Atlantic, but they were not very conclusive for lack of suitable appliances. They, however, tended to show that below 100 fathoms there was but little current.

It has been calculated theoretically that winds blowing steadily in one direction with the ordinary force of the trade winds would in 100,000 years by friction between the particles put the whole of a mass of water 2000 fathoms deep, not otherwise influenced, into motion in that direction; but the direction and force of the trade winds are ever changing, and the actual strong currents of the ocean are not in the trade wind areas, but are the result of these drifts meeting one another and being compressed by the conformation of the land. We cannot, therefore, expect this theoretical effect to be realised.

One instance of the underrunning of one current by another is brought very plainly to our notice in the North Atlantic, to the east of the Great Banks of Newfoundland, where the icebergs borne by the Arctic current from Baffin Bay pursue their course to the southward across the Gulf Stream running eastward.

These great masses of ice, floating with seven-eighths of their volume under the surface, draw so much water that they are all but wholly influenced by the under-current. A large berg will have its bottom as much as six or seven hundred feet below the surface. The only reason that these bergs continue their journey southward is the action of the cold under current.

It was my good fortune to be ordered in 1872 to undertake a series of experiments of the currents and under-currents of the Dardanelles and Bosporus. They proved most interesting.

It was well known that a surface stream is almost continuously passing out of the Black Sea through the Bosporus into the Sea of Marmara, and again through the Dardanelles into the Mediterranean. Certain physicists, of whom Dr. W. Carpenter was one, were, however, of opinion that a return current would be found under the surface running in the opposite direction, and this I was enabled to demonstrate.

Though from the imperfection of our apparatus, which we had to devise on the spot, we were unable to exactly proportionate the quantities of water moving in the two directions, we found, whenever the surface current was rushing south-westward through these straits, that for a certain distance, from the bottom upwards, the water was in rapid motion in the opposite direction. It was an astonishing sight to behold the buoys which supported a wooden framework of 36 square feet area, lowered to depths from 100 to 240 feet tearing up the straits against a strong surface current of as much as three and four miles an hour. It was as perfect an ocular demonstration of a counter under-current as could be wished, and the Turks, who watched our proceedings with much suspicion, were strongly of opinion that the devil had a hand in it, and only the exhibition of the Sultan's firman saved us from interruption. In the investigation of these currents we found, as usual, that the wind was the most potent agent. Though the surface water from the Black Sea is almost fresh, and the bottom water of the heavy Mediterranean density of 1·027, it was found that when calm had prevailed the surface current slackened, and at times became nil, whilst the under-current responded by a similar slackening.

The ordinary condition of wind in the regions of the Black Sea and Sea of Marmara is that of a prevalent north-east wind. This causes a heaping up of the water on the south-west shores of those seas, precisely where the straits open, and the surface water therefore rapidly escapes.

These straits no doubt present abnormal characters, but, so far as surface currents are concerned, the long series of observations then made convinced me of the inadequacy of differences of specific gravity, which were here at a maximum, to cause any perceptible horizontal flow of water.

I have said that we were unable to define by direct observation the exact position of the dividing line between the opposing currents, but the rapid change in the specific gravity at a certain depth, which varied on different days, gave a strong indication that the currents changed at this point.

A Russian officer, Captain Makaroff, afterwards made similar experiments in the Bosporus, but with more perfect appliances, and he found that at the point where the specific gravity changed the currents also changed.

I have been anxious to obtain similar observations at the Straits of Babel Mandeb, the southern outlet of the Red Sea, where somewhat similar conditions prevail. Here the winds are governed by the monsoons. For half the year the wind blows from the north down the whole length of the sea, causing a surface flow outwards into the Gulf of Aden, and a general lowering of the whole level of the sea of about two feet. For the other half of the year the wind at the southern end of the sea is strong from the south-east, causing a surface set into the Red Sea, over which the general level of the water rises, while the northerly wind continues to blow throughout the northern half.

At either of these times I think it is highly probable that there is an under-current in the opposite direction to that at the surface, but unfortunately the sea disturbance is great and observations are very difficult.

Observations were, however, made by Captain W. U. Moore in H.M.S. *Penguin* in 1890, but at a time when the change of monsoon was taking place.

The result was peculiar, for it appeared that at a depth of about 360 feet the movement of the water was tidal, while the surface water was moving slowly in one direction—a result generally similar to that obtained by the Americans in the West Indies—but the direction of the tidal flow was directly opposite to what might have been expected, viz. the water ran in while the tide fell, and *vice versâ*.

More observations are, however, needed here before any certain conclusions can be formed.

The depth of the ocean is the next great feature which demands attention.

On this our knowledge is steadily, though slowly, increasing. The whole of it has been gained during the last fifty years.

Commenced by Sir James Ross, whose means were very small, but who nevertheless demonstrated that the so-called unfathomable ocean was certainly fathomable everywhere, the sounding of the ocean has continuously proceeded. The needs of submarine cables have constantly demanded knowledge in this particular, and the different cable companies have had a large share in ascertaining the facts.

Expeditions, whose main object has been to obtain soundings, have been sent out, Great Britain and the United States taking the first place; but most maritime nations have aided.

In the immediate past the additions have mainly been from the soundings which H.M. surveying ships continually take whenever on passage from one place to another, from the work of our cable companies, and from United States vessels.

We have, as a result, a very fair general knowledge of the prevailing depths in the Atlantic, but of the Indian and Pacific Oceans it is very fragmentary. We have enough to give us a general idea, but our requirements increase as years roll on. It is a vast task, and, it may be safely said, will never be completed; for we shall never be satisfied until we know the variations of level under the water as well as we know those on the dry land.

It is hopeless to do more than to briefly sketch the amount of our knowledge.

First, as to the greatest depths known. It is very remarkable, and from a geological point of view significant, that the very deepest parts of the ocean are not in or near their centres, but in all cases are very near land.

One hundred and ten miles outside the Kurile Islands, which stretch from the northern point of Japan to the north-east, the deepest sounding has been obtained of 4655 fathoms, or 27,930 feet. This appears to be in a deep depression, which runs parallel to the Kurile Islands and Japan; but its extent is unknown, and may be very large.

Seventy miles north of Porto Rico, in the West Indies, is the next deepest cast known, viz. 4561 fathoms, or 27,366 feet; not far inferior to the Pacific depth, but here the deep area must be comparatively small, as shallower soundings have been made at distances sixty miles north and east of it.

A similar depression has been sounded during the last few years west of the great range of the Andes, at a distance of fifty miles from the coast of Peru, where the greatest depth is 4175 fathoms.

Other isolated depths of over 4000 fathoms have been sounded in the Pacific. One between the Tonga or Friendly Islands of 4500 fathoms, one of 4478 fathoms near the Ladrones, and another of 4428 fathoms near Pylstaart Island, all in the Western Pacific. They all require further investigation to determine their extent.

With these few exceptions, the depth of the oceans, so far as yet known, nowhere comes up to 4000 fathoms, or four sea miles; but there can be little doubt that other similar hollows are yet to be found.

The sea with the greatest mean depth appears to be the vast Pacific, which covers 67 millions of the 188 millions of square miles composing the earth's surface.

Of these 188 millions, 137 millions are sea, so that the Pacific comprises just one-half of the water of the globe, and more than one-third of its whole area.

The Northern Pacific has been estimated by Mr. John Murray to have a mean depth of over 2500 fathoms, while the Southern Pacific is credited with a little under 2400 fathoms. These figures are based on a number of soundings which cannot be designated otherwise than very sparse.

To give an idea of what remains to be done, I will mention that in the eastern part of the Central Pacific there is an area of 10,500,000 square miles in which there are only seven soundings, whilst in a long strip crossing the whole North Pacific, which has an area of 2,800,000 square miles, there is no sounding at all. Nevertheless, while the approximate mean depth I am mentioning may be considerably altered as knowledge increases, we know enough to say that the Pacific is generally deeper than the other oceans. The immensity, both in bulk and area, of this great mass of water, is difficult to realise; but it may assist us when we realise that the whole of the land on the globe above water level, if shovelled into the Pacific, would only fill one-seventh of it.

The Indian Ocean, with an area of 25,000,000 square miles, has a mean depth, according to Mr. Murray, of a little over

2000 fathoms. This also is estimated from a very insufficient number of soundings.

The Atlantic, by far the best sounded ocean, has an area of 31,000,000 square miles, with a mean depth of about 2200 fathoms.

The temperature of this huge mass of water is an interesting point.

The temperature of the surface is most important to us, as it is largely on it that the climates of the different parts of the world depend. This is comparatively easy to ascertain. We know so much about it that we are not likely to improve on it for many years. We are quite able to understand why countries in the same latitude differ so widely in their respective mean temperatures; why fogs prevail in certain localities more than others; and how it comes about that others are subject to tempestuous storms.

On the latter point nothing has come out plainer from recent discussion than the fact that areas where great differences of surface temperature of the sea prevail are those in which storms are generated.

It is a matter of observation that in the region south of Nova Scotia and Newfoundland many of the storms which travel over the Atlantic to this country have their rise.

An examination of surface temperature shows that in this region the variations are excessive, not only from the juxtaposition of the warm water of the Gulf Stream and the cold water of the Arctic current flowing southward inside of it, but in the Gulf Stream itself, which is composed of streaks of warm and colder water, between which differences of as much as 20° F. exist.

The same conditions exist south of the Cape of Good Hope, another well-known birthplace of storms. Here the Agulhas current of about 70° F. diverted by the land pours into the mass of water to the southward, colder by some 25°, and the meeting-place is well known as most tempestuous.

South-east of the Rio de la Plata is another stormy area, and here we find the same abnormal variations in surface temperature.

Yet another is found off the north-east coast of Japan with the same conditions.

These differences are brought about by the mingling of water carried either by the flowing of a powerful current turned by the land into a mass of water of different temperature, as is the case off the Cape of Good Hope, or by the uprising of lower strata of cooler water through a shallow surface stream, as appears to be the case in the Gulf Stream.

A remarkable point recently brought to light by the researches of Mr. John Murray in Scotch lochs is the effect of wind on the surface temperature. It has been observed that wind driving off a shore drifts the surface water before it. This water is replaced by the readiest means, that is to say, by water from below the surface rising to take its place. As the lower strata are in all cases cooler than the surface a lowering of the temperature results, and we find, in fact, that near all sea shores off which a steady wind blows the water is cooler than further to seaward.

This has an important bearing on coral growth, and explains why on all western coasts of the great continents off which the trade winds blow we find an almost absolute dearth of coral, while on the eastern coasts, on which warm currents impinge, reefs abound, the coral animal flourishing only in water above a certain temperature.

Observations of the temperature of the strata of water between the surface and bottom have been of late years obtained in many parts. Compared with the area of the oceans they are but few, but our knowledge steadily increases every year.

The subject of the vertical distribution of temperature has not yet been thoroughly investigated in the light of the whole of the information which we now possess, but Dr. Alex. Buchan has been for some time devoting his spare time to the task, and it is a heavy labour, for the data obtained here and there over the world by different ships of all maritime nations are very difficult to collect and to appraise, but I understand that before long we shall have the result, which will prove very interesting, in the last volume of the *Challenger* series.

It will readily be understood that observations on temperatures at great depths require great care. In the first place the thermometers must be most carefully manufactured. They must be subjected to rigorous tests, and they must be carefully handled during the operation. All observations are not of the same value, and the discussion, therefore, presents considerable difficulty and demands much discretion.

In the meantime we can state certain known facts.

We have learnt that the depth of the warm surface water is small.

In the equatorial current between Africa and South America, where the surface is of a temperature of 78°, at 100 fathoms it is only 55°, a difference of 23°, and a temperature of 40° is reached at 400 fathoms. In this region, so far as knowledge goes, the fall in temperature as we descend is most rapid, but generally speaking the same variations prevail everywhere.

In the tropical Pacific the temperature falls 32° from the surface, where it stands at 82°, to a depth of 200 fathoms, 40° being reached at from 500 to 600 fathoms below the surface.

Below the general depth of from 400 to 600 fathoms, the temperature decreases very slowly, but there is considerable variation in the absolute amount of it when we get to great depths in different parts of the ocean.

One of the most interesting facts that has been recognised is that in enclosed hollows of the ocean the bottom temperature is apparently much less than that of the stratum of water at a corresponding depth in the waters outside the submarine ridge that forms the enclosing walls, separating them from deeper areas beyond, and is, in all cases that have been observed, equal to that on the ridge. From this fact we are enabled to supplement our imperfect knowledge of depths, because if in a certain part of an ocean we find that the temperature at great depths is higher than we know exists at similar depths in waters apparently connected, we can feel certain that there is a submarine ridge which cuts off the bottom waters from moving along, and that the depth on this ridge is that at which is found the corresponding temperature in the outer waters. As a corollary we also assume that the movement of water at great depths is confined to an almost imperceptible movement, for if there was a motion that we could term, in the ordinary acceptation of the word, a current, it would infallibly surmount a ridge and pour over the other side, carrying its lower temperature with it.

A notable instance is the bottom temperature of the North Atlantic. This is nowhere below 35° F., although the depths are very great. But in the South Atlantic at a depth of only 2800 fathoms the bottom temperature is but a little above 32° F., and we are therefore convinced that somewhere between Africa and South America, though soundings do not yet show it, there must be a ridge at a depth of about 2000 fathoms.

We also come to the same conclusion with regard to the eastern and western portions of the South Atlantic, where similar differences prevail.

Again, the few temperatures that have been obtained in the eastern South Pacific show a considerable difference from those in the South Atlantic, and we are compelled to assume a ridge from the Falkland Islands to the Antarctic continent.

It is interesting that the investigation into the translation of the great seismic wave caused by the eruption of Krakatoa in 1883 led to a similar and entirely independent conclusion. The wave caused by the explosion in the Straits of Sunda reached Cape Horn, where by good chance a French meteorological expedition had erected an automatic tide gauge, but instead of one series of waves being marked on the paper there were two. A little consideration showed that the South Pole having directly interposed between Sunda Straits and Cape Horn, the waves diverted by the land about the pole would arrive from both sides.

One wave, however, made its appearance seven hours before the other.

Study showed that the earliest wave coincided in time with a wave travelling on the Pacific side of the pole, with a velocity due to the known depth, while the later wave must have been retarded in its journey *via* the South Atlantic. The only possible explanation is that the wave had been impeded by comparatively shallow water.

The evidence from bottom temperature was then unknown, and thus does one branch of investigation aid another.

In the Western Pacific the water is colder, a few bottom temperatures of a little over 33° F. having been found in the deep trough east of the Tonga Islands; but the North Pacific, though the deeper ocean—of enormous area and volume—is apparently again cut off by a submarine ridge. The north-western part of the Indian Ocean is for similar reasons assumed to be divided from the main body, the shallower water probably running from the Seychelles to the Maldive Islands.

Mr. Buchanan has pointed out why some parts of oceans, deep and vast though they be, are when cut off from communication with others warmer at the bottom.

Water can only sink through lower layers when it is the heavier, and though a warm surface current becomes from evaporation denser, its heat makes it specifically lighter than the strata below.

It is only when such a current parts gradually with its heat, as in travelling from tropical to temperate regions, that it sinks and slowly but surely carries its temperature with it, modifying the extreme natural cold of the bottom layers.

In the North Atlantic and Pacific we have such a condition. The great currents of the Gulf Stream and Japan current as they flow to the north sink, and in the course of ages have succeeded in raising the bottom temperature three or four degrees.

In the southern seas this influence is not at work, and, directly connected with the more open water round the South Pole, there is nothing to carry to the abysmal depths any heat to raise them from their normal low temperatures, due to the absence of any heating influence.

The ice masses round the South Pole have probably little or no effect on bottom temperature, as the fresher, though colder, water will not sink; and, as a matter of fact, warmer water is found at a few hundred fathoms than at the surface.

The lowest temperature ever obtained was by Sir John Ross in the Arctic Ocean in Davis Straits at a depth of 680 fathoms, when he recorded a reading of 25° F. This probably requires confirmation, as thermometers of those days were somewhat imperfect.

In the great oceans the greatest cold is found on the western side of the South Atlantic, where the thermometer stands at 32°·3 F., but temperatures of 29° F. have been obtained of recent years east of the Færoe Islands, north of the ridge which cuts off the deeper waters of the Arctic from the Atlantic.

Though scarcely within the limits of my subject, which is the sea itself, I must say a few words on the sea floor.

The researches carried on in the *Challenger* revealed that while for a certain distance from the continents the bottom is composed of terrestrial detritus, everywhere in deep water it is mainly composed of the skeletons or remains of skeletons of the minute animals that have lived in the water.

In comparatively small depths we find remains of many shells. As the depth increases to 500 fathoms or so we get mainly the calcareous shells of the globigerinæ which may be said to form by far the greater part of the oceanic floor.

In deeper water still, where pressure, combined with the action of the carbonic acid, has dissolved all calcareous matter, we find an impalpable mud with skeletons of the silicious radiolaria of countless forms of the greatest beauty and complexity. Deeper still, *i.e.* in water of—speaking generally—over 3000 fathoms, we find a reddish-coloured clayey mud, in which the only traces of recognisable organic remains are teeth of sharks and cetacea, many belonging to extinct species.

What the depths of these deposits may be is a subject of speculation. It may be that some day, as mechanical appliances are improved, we shall find means of boring, but up to the present no such operation has been attempted.

On the specific gravity of the water of the sea I can say but little except that it varies considerably.

It is not yet known for certainty how far the specific gravities observed at various points and depths remain appreciably constant.

In localities where evaporation is great, and other influences do not interfere, it is evident that the specific gravity of the surface will be high; a consideration which observations confirm, but there are many complications which require more observation before they can be resolved.

In some few places repeated observations permit deductions, but taking the sea as a whole we are yet very ignorant of the facts bearing on this point.

The waves which for ever disturb the surface of the sea demand much study.

The greatest of these, and the most regular, is the tidal wave. On this many powerful intellects have been brought to bear, but it still presents many unsolved anomalies.

Lord Kelvin and Prof. Darwin have demonstrated that the tidal movement is made up of many waves depending upon different functions of the moon and sun, some being semi-diurnal, some diurnal. The time of transit over the meridian, the declination of both bodies, create great variations; the changing distance and position of the moon and the position of her node, also have great effect, while the ever-varying direction and force of the winds, and the different pressure of the atmosphere play their part, and sometimes a very large part, on what is somewhat loosely known as the meteorological tide.

The amplitude of the oscillation of the water depending upon each of the astronomical functions varying for every point on the earth, the effect is that, each having a different period, the resulting mean movement of the water has most astonishing variations.

In some places there is but one apparent tide in the day; in others this phenomenon only occurs at particular periods of each lunation, while in the majority of cases it is the movements of each alternate tide only that appear to have much to do with one another.

Though after long observation made of the times and ranges of tides at any one spot, they can now be predicted with great accuracy, for that particular place, the meteorological tide excepted, by the method of harmonic analysis, perfected by Prof. G. Darwin, no one can yet say what the tide will be at any spot where observations have not been made.

Observations all over the world have now shown that there is no part where the tidal movement is so regular and simple as around the British Islands. This is more remarkable when it is found that the tides on the other side of the Atlantic—at Nova Scotia, for instance—are very complicated.

The minor tides, which in most parts of the world, when combined in one direction, amount to a very considerable fraction of the principal lunar and solar tides, and consequently greatly increase or diminish their effects, are in Great Britain so insignificant that their influence is trifling; but why this should be, I have never yet found anyone to explain.

Nevertheless there are many very curious points about our tides which are plainly caused by interference, or, in other words, by the meeting of two tidal waves arriving from opposite directions, or from the rebound of the tidal waves from other coasts.

This effect, also, it has been so far found impossible to predict without observation. On our southern coasts, for instance; in the western part the tide rises about 15 feet, but as it travels eastward the range becomes less and less until, about Poole, it reaches a minimum of 6 feet. Farther east again it increases to Hastings, where the range is 24 feet. Yet farther east it again gradually diminishes. This is due to the reflection from the French coast, which brings another wave which either superposes itself upon, or reduces the effect of, the main tide advancing up the English Channel; but the details of such reflection are so complex that no one could forecast them without more knowledge than we possess.

There can be little doubt that to this cause, reflection, is mainly due the variations in the amount of mean range of tide which are found on many coasts at different parts; and as these reflected waves may arrive from great distances, and be many in number, we may cease to wonder at the extraordinary differences in range of tide which prevail, though it will be understood that this is wholly separate from the varying heights of each successive tide, or of the tide at different parts of each lunation, or at different times of the year, which depend upon the astronomical influences.

The actual height of the tide in deep water is small, but on passing into shallow water when approaching a shore, and especially when rolling up a gulf of more or less funnel shape, it becomes increased by the retardation caused by friction, and by compression laterally, and hence the height of the tide on a coast affected by other causes is greater than in the open sea.

The oceanic tide wave is supposed to be from 2 to 3 feet in height, but as this has been assumed from observations made at small oceanic islands, where, although the magnifying influences mentioned are at a minimum, they still exist, we wait for precise information until some means of actually measuring the tide in deep water is devised.

The waves due to wind, though not so far-reaching in their effects as the majestic march of the tide wave, are phenomena which are more apparent to the traveller on the ocean.

The deep sea in a heavy gale presents, perhaps, the most impressive manifestation of the powers of nature which man can behold, and doubtless many of us have experienced feelings that may vary from awe and wonder to sheer delight, according to the temperament of each individual, at for the first time finding himself face to face with this magnificent sight, though I rather fear that discomfort is the prevailing feeling that many carry away.

The height to which storm waves may rise has never been very satisfactorily determined. Apart from the difficulty of the task and the small number of people who will address themselves to it when they have the chance, it is but rarely that any individual sees really abnormal waves, even though he may be at sea all his life.

Different heights for what are called maximum waves have been recorded, and they vary from 40 to 90 feet from crest to hollow.

All we can say is that the most probable figure is about 50 or 60 feet.

These great storm waves travel very far. In some cases they convey a warning, as their velocity always far exceeds that at which the storm is travelling. In others they intimate that a gale of which no more is seen has occurred somewhere—it may be many miles distant.

When they have travelled beyond the limits of the wind which raised them, they lose the steepness of slope which characterises them when under its influence, and become an undulation which is scarcely noticed when in deep water.

On approaching shallow water, however, they are again apparent, and the "rollers" that occur unperiodically at various places in latitudes where gales never occur would seem to be caused by such waves, originating in areas many thousands of miles distant. Such appears to be the origin of the well-known rollers at Ascension and St. Helena, where the rocky and exposed nature of the landing has caused this phenomenon to be especially noticed.

Other rollers are, however, undoubtedly due to earthquakes or volcanic eruptions occurring in the bed of the sea.

Many of the great and sudden waves which have caused devastation and great loss of life on the shores of western South America are referable to this cause.

Observations to enable the focus of such a disturbance to be traced have generally been lacking, but it is probable that where the wave has been large the point of origin has not been far distant.

In one notable instance the conditions were reversed. The point of origin was known, and the distance to which the resulting wave travelled could be fairly satisfactorily traced.

This was the great eruption in the Straits of Sunda, in August 1883, which locally resulted in the disappearance of the major part of the island of Krakatoa, and the loss of nearly 40,000 lives, on the neighbouring shores of Java and Sumatra, by the huge wave which devastated them.

The records of automatic tide gauges and the observations of individuals enabled the waves emanating from this disturbance to be followed to great distances. These waves were of great length, the crests arriving at intervals of about an hour, and moving with a velocity of about 350 miles an hour, were about that distance apart.

The waves recorded at Cape Horn were apparently undoubtedly due to the eruption, and travelled distances of 7500 miles and 7800 miles in their course on either side of the south polar land.

They were only five inches in height above mean level of the sea, while the waves recorded at places on the southern part of Africa, at a distance of about 5000 miles from the scene of the eruption, were from one to two feet high, the original long waves being of an unknown height, but probably did not exceed ten or fifteen feet.

No other such opportunity of testing the distances to which great waves may travel has ever occurred, and as such a catastrophe as gave rise to them could scarcely be repeated without similar loss of life, it may be hoped we shall not live to see another, interesting though the discussion of the numerous phenomena were.

The movement of the particles of water due to the tide wave extends to the bottom of the deepest water, and doubtless plays an important part in keeping up a constant motion in the abysses, but the depth to which the action of the surface waves originating in wind reach is still but little known by observation.

If, however, we study the contour of the bottom off the shores of land exposed to the full influence of the great oceans, we are struck by the very general rapid increase of slope after a depth of about 80 to 100 fathoms (500 to 600 feet) has been reached.

It appears very probable that this is connected with the depth to which wave action may extend, the fine particles brought down by rivers or washed from the land by the attrition of the breakers being distributed and gradually moved down the slope.

When we examine banks in the open sea we find, however, that there are a great many with a general depth of from 30 to 40 fathoms, and the question arises whether this may not be the general limit of the power of oceanic waves to cut down the mass acted upon when it is fairly friable.

The question has an interesting bearing on the subject of the ever-debated origin of coral atolls, for this is the general depth of many large lagoons; and granted that the sea can cut down land to this depth, we have at once an approach to the solution of the problem of the formation of bases of a suitable depth and material upon which the coral animal can commence operations.

This question also awaits more light, and I merely offer this remark as a suggestion.

It is, however, somewhat remarkable that in recent cases of volcanic islands piled up by submarine eruptions, they have all been more or less rapidly washed away, and are in process of further diminution under the surface.

Observations on the mean level of the sea show that it constantly varies, in some places more than others.

This subject has not yet been worked out.

In some localities it is plainly due to wind, as in the Red Sea, where the summer level is some two feet below that of winter, owing to the fact that in summer the wind blows down the whole length of the sea, and drives the water out.

In many places, as in the great estuary of the Rio de la Plata, the level is constantly varying with the direction of the winds, and the fluctuation due to this cause is greatly in excess of the tidal action.

In others the cause is not so clear.

At Sydney, New South Wales, Mr. Russell found that during eleven years the level was constantly falling at about an inch a year, but by the last accounts received it was again stationary.

The variations in the pressure of the atmosphere play an important part in changes of sea level.

A difference of one inch in the barometer has been shown to be followed by a difference of a foot in the mean level of the sea, and in parts of the world where the mean height of the barometer varies much with the seasons, and the tidal range is small, this effect is very marked.

Of any secular change in the level of the sea little is known. This can only be measured by comparison with the land, and it is a question which is the more unstable, the land or the water—probably the land, as it has been shown that the mass of the land is so trifling, compared with that of the ocean, that it would take a great deal to alter the general mean level of the latter.

All the points connected with the sea that I have had the honour of bringing before you form part of the daily observation of the marine surveyor when he has the chance, but I cannot refrain from also mentioning other duties, which are indeed in the present state of our knowledge and of the practical requirements of navigation the principal points to which he has to pay attention, as it may explain why our knowledge on so many interesting details still remains very imperfect.

Working as we do in the interests of the vast marine of Great Britain, the paramount necessity of good navigational charts requires that the production of such charts should be our principal aim.

It is difficult for a landsman and difficult even for a sailor who has never done such work to realise the time that is necessary to make a really complete marine survey. The most important part, the ascertainment of the depth, is done, so to speak, in the dark—that is to say, it is by touch and not by sight that we have to find the different elevations and depressions of the bottom of the sea.

In making a map of the land, an isolated rock or hill stands up like a beacon above the surrounding land, and is at once localised and marked, but a similar object under the sea can only be found by patient and long-continued sounding, and may very easily be missed.

When it is considered that marine surveying has only been seriously undertaken for about 100 years, with a very limited number of vessels, we shall, I think, understand how in the vast area of the waters, taking only those bordering the shores, many unsuspected dangers are yearly discovered.

Very, very few coasts have been minutely surveyed, and setting aside for a moment the great changes that take place off shores where sandbanks prevail, I should be sorry to say that even on our own coasts charts are perfect.

Yearly around Great Britain previously unknown rocks come to light, and if this is the case at home, what are we to think of the condition of charts of less known localities!

Our main efforts, therefore, are directed to the improvement of charts for safe navigation, and the time that can be spared to the elucidation of purely scientific problems is limited.

Nevertheless, the daily work of the surveyor is so intimately connected with these scientific problems that year by year, slowly but surely, we add to the accumulation of our knowledge of the sea.

SECTION G.

MECHANICAL SCIENCE.

OPENING ADDRESS BY PROF. A. B. W. KENNEDY, LL.D., F.R.S., M.INST.C.E., PRESIDENT OF THE SECTION.

The Critical Side of Mechanical Training.

WHILE there is no place in the kingdom more suitable for a meeting of the British Association than Oxford, and certainly no place in which it is more delightful for the members to meet, it is yet to be admitted that there are few places which have much less in common with the special work of Section G. Nominally devoted to "Mechanical Science," the Section has for many years specially dealt with those branches of applied mechanical science which constitute the business of the engineer—to quote the well-known words of the Royal Charter, "the art of directing the great sources of power in nature for the use and convenience of man." The association of this ancient and learned city with boilers and chimneys, with the noise and racket of ordinary mechanical work, seems an incongruity. Even the harmless necessary railway-station is kept as far away as possible, and the very river flows with a quiet dignity which seems to shut out the thought of anything more mechanical than the most ancient and futile of water-wheels.

Naturally enough these considerations did not tend to make more easy the choice of a subject for this address, and I have come very near to agreement with a recent critic in the opinion that presidential addresses are, in fact, almost immoral in the nature of things and fit only to be abolished. Finally I decided upon taking up my present subject, as being one in which the academic rather than the technical side of our work comes to the front, while at the same time it does not lead me out of lines in which I have been able, in past years, to work myself. It is now twenty years since I first took any active part in the scientific training of engineers, and five since I ceased to do so. I have often wished that I may have been at all as successful in teaching others at University College as I was, at the same time, in teaching myself. And since I have ceased to teach I seem to have been spending my time in finding out how much better I could now do it than was possible when I was actually engaged in it. This may be pure imagination on my part; there is nothing more easy, as we all know, than to suppose that we know best how to do the things that other people do, and not the things we have to do ourselves. Indeed, I understand that this is the recognised attitude of the really superior critic. If, however, in anything which I have to say, it should seem that I am finding fault with what is now being done, I may at least point out that most of all I am finding fault with myself for not having done right when I had the opportunity—an opportunity which can now never recur. Indeed, instead of the decorous and unobtrusive heading which I have given to this address, I might have indicated its general lines almost as truly if I had entitled it "The Regrets of an Emeritus Professor"—a name which, on a suitable binding, might even have secured it a sale at the railway bookstalls.

I know well—too well—that in the present congested state of the engineering profession there are many of us who do not like to bear the word "training" mentioned at all. It seems to mean merely the preparation of more lads to struggle for a share of work that is even now insufficient to go round. There is no doubt much to be said for this point of view. But against it one must remember that all other professions are equally full, and that, after all, lads must do something. The fault is surely that there are too many lads! If our population is really to go on increasing as rapidly as at present—the benefits of which Sections D, E, and F might have a joint meeting to discuss, if not to discover—it is inevitable that demands should come for more and more complete professional preparation. The man of exceptional parts will come to the front under any conditions, training or no training, in the future as in the past. But for ordinary men—that is for 99 per cent. of us—it is essential that no advantage should be given to a rival in the fierce competition of life, and for them therefore it is of an importance hardly to be exaggerated to obtain the most complete and perfect training possible. At the same time, and on purely general grounds, it can hardly be denied that to raise the standard of our profession is indirectly to confer a benefit on the whole community. I hope, therefore, that in making certain suggestions about the training of engineers, it will not be thought that I am desirous of increasing their number, which is really an end as far as possible from my own wishes. Whether the number increases or stands still or falls off, it is of importance from every point of view that those who come forward should be as well prepared as possible. And even the most conservative of us are compelled to recognise that the standard required in engineers' offices now is enormously higher than it was thirty years ago. This may truly be either the cause or the effects of improved training, but in either case it has made the training itself a necessity.

The particular aspect of mechanical training of which I wish to speak is its critical side. I do not know how a man should be trained to be an inventor. I would not tell anyone if I did! To be a creator in mechanical matters—which, however, is a quite different thing,—is a faculty given only to a very few, and with them it is "born, not made." Many of us, however, without being either inventors or creators, have sufficient natural aptitude or inclination towards things mechanical to form a basis for the trainer or educator to work on, with some hope that he may be of service. About the sciences which should be taught to such men, or the methods of teaching them, about the extent and nature of their experience in shops or on works, I do not intend to speak. I shall confine myself to one aspect of the training only, an aspect which is perhaps not always sufficiently clearly kept in view—the aspect which I have just called the critical side of mechanical training.

An engineer is a man who is continually being called upon to make up his mind. It may be only as to the size of a bolt; it may be as to the type of a Forth Bridge; it may be as to the method of lighting a city; or only as to the details of a fire-grate. But, whatever it is, once it is settled it is decided irrevocably—it is translated into steel and iron and copper, and cannot be revoked by an Act passed in another session. The time given him in which to decide may be a day, or a month, or a year, but in any and every case (so far as my own experience goes) it is about one-tenth part of the time which he would like to have. It is only in rare cases that the decision is obvious—most often there are more courses open than even the most facile politician ever dreamt of. The matters are too complex to be dealt with mathematically or even physically; even if they were not, there are few engineers who would have the special capacity to handle them. Moreover, their solutions are seldom "unique." From this point of view, the whole use of college training, of workshop practice, of practical experience, is to provide the engineer later on with the means of critically examining each question as it comes up, of reviewing systematically the *pros* and *cons* of each method of dealing with it, of coming finally, rapidly and positively to some defensible decision, which may then be irrevocably carried out.

In the case of a problem in pure mathematics or physics, where only one right solution can exist, that solution is arrived at by the help of a thorough knowledge of the science in question—there is little room for the critical faculty except as to method—the result is either right or wrong. With our work, on the other hand, solutions of all problems except the very simplest—in other words, decisions on all points which present themselves—can be arrived at only by a process of criticism applied to the problems, to their statement, to their condition, to all their many possible solutions. The development of the necessary critical faculty should be one of the chief aims of every teacher and every student.

A scientific training cannot make a man an engineer. Perhaps it is impossible for anything to make a man an engineer unless he has grown that way from the beginning! But a scientific training may make him, or at least give him the possibility of making himself, a critic.

In the vigorous attempts which have been made to specialise the education of engineers very early, I am afraid that the idea of teaching *subjects* is sometimes too prominent, to the neglect of matters less obviously useful. It is, of course, one thing to know a subject from the examination point of view, and quite another to be able to think about it, and still another to be able to write about it. In particular, I have often regretted to find how little attention has been given to a matter which perhaps may be called literary rather than scientific, but which is all-important in criticism, I mean to the power of expression. It is not easy to overrate the importance to the engineer, as to other folk, of the power of saying clearly what he means, and of saying just what he means. I do not mean only of doing this for its own sake, but because if a man cannot say or write clearly what he means it is improbable that he can *think* clearly By the power of expression I do not mean, of course, the mere power of speaking fluently in public, a thing which appears physically impossible to some people; I mean rather the power of expression in writing, which carries with it clearness and consecutiveness of thought. It is difficult to know how this matter can be taught, but at least it can be insisted upon probably to a much greater extent than is commonly the case. A man requires to see clearly not only the exact thing which he wants to say, but the whole environment of that thing as it appears to him. Not only this, but he must see the whole environment of the same thing as it appears to the persons for whom he is writing, or to whom he is speaking. He has to see what they know about the matter, what they think, and what they think they know, and if he wishes to be really understood has got to do much more than merely write the thing he means. He has carefully to unwrite, if I may use the expression, the various things that other people will be certain to think that he means. For after all the great majority of people are very careless listeners and readers, and it is not for the small minority who are really exact in these matters that one has to write. Moreover, it is a great help to clearness of thought and expression to keep before one always an ideal audience of people who will certainly misunderstand every single sentence about which any misunderstanding is in any way possible, and some others as well.

In attempting to think out or to discuss any question, whether it be technical or non-technical—in fact as long only as it is non-political—the first necessity is probably a knowledge of the question itself; and not only this, but also a proper understanding of its whole environment. This knowledge must be of such a kind as to distinguish what parts of it are important, what parts of it are unimportant, what parts can be described in two sentences, and what others may require as many paragraphs; what parts affect the result but little, however large they seem; and which ones must be considered vital, although their very existence is difficult to discover. The faculty which enables a man to handle his knowledge in this fashion may be summed up in the single expression, "sense of proportion." Moreover, the knowledge, to be of real value, must be as totally free from prejudices and prepossessions as in the most rigorous branch of pure science, and as thoroughly imbued with a healthy spirit of scepticism.

One is accustomed to think of engineering work as mainly constructive. But after all it is quite as much critical. In almost every department of mechanical work there are half a dozen ways of solving any particular problem. In some fashion or other the engineer must be able to judge between these various methods, methods which are often very much alike, but each of which may possess certain particular advantages and certain particular drawbacks. The arithmetical criticism which merely counts the advantages and the drawbacks, and puts an equal number of the one against an equal number of the other, is common enough, but obviously useless. The very first necessity to the critic is that he should have what I have just called the sense of proportion, a sense which will enable him to distinguish mere academical objections from serious practical difficulties, which shall enable him to balance twenty advantages which can be enumerated on paper by one serious drawback which will exist in fact, which will enable him in fact to place molehills of experience against mountains of talk. It is perhaps a doubtful point how far this sense of proportion can be taught at all. No doubt it can only be built up upon some natural basis. I am sure that in engineering we all know men whose judgment as to whether it was advisable to take a particular course we would accept implicitly, because we know that it is based on large general criticism, in spite of the most elaborate and specious arguments against it set down on paper.

Any third-year student—not to go still further back—can criticise perfectly along certain very narrow lines, just as anyone can learn the rules of harmony and can write something in accordance with them which purports to be music. But after all the music may be music only in name, and the criticism may not be worth the paper it is written upon, however formal it may appear to be, unless the writer is thoroughly imbued with a sense of the proportionate value of the different points which he makes. To take the commonest possible case, I dare say we have all of us heard certain methods, mechanical, chemical, or other, stigmatised as totally wrong and absolutely useless because they contain certain easily provable errors I am sure, too, that most of us could give illustrations of cases in which this has has been said with the very greatest dogmatism when the errors of the impugned method are not one-tenth part as great as the equally unavoidable errors of observation in the most perfect method.

Probably the best special education in proportion which a man can have is a course of quantitative experimental work. I say *quantitative* with emphasis, as meaning something much more than mere qualitative work. Here, I think, comes in the usefulness of the engineering laboratory. We require that the training should be not only in absolute measurement, but in relative measurement, the latter being quite as important as the former. Many kinds of measurements stand more or less upon a level as a training of the faculties of observation in themselves, but no single kind of measurement is sufficient as a training in proportion. A year spent in calibrating thermometers or galvanometers might make an exceedingly accurate observer in a perticular line, but it would not give the observer a knowledge of what even constituted accuracy in other directions; for accuracy is a relative and not an absolute term. In most engineering matters the conditions are, unfortunately, of a most complex kind; so complex that our problems are incapable of any solution sufficiently exact to satisfy the mathematician or physicist. The temptation to treat these problems as the mathematician treats those with which he deals—namely, to alter the assumed conditions in order to get an exact solution—is a very strong one. I am afraid it is most strong often in those engineers who are the best mathematicians. It is a temptation, however, steadily to be resisted. We must assume our conditions to be what they actually are, and not what we should like them to be; and if we cannot obtain an exact solution of our problem with its actual conditions, so much the worse for us, not so much the worse for the conditions. Our first duty is generally to find out the conditions; if they are disadvantageous (in fact I mean, and not merely in the problem) to alter them if they can be altered, but not to ignore them because they are inconvenient. We have then to find out the extent to which the known conditions permit any exactness of solution at all, and, finally, we have to keep this in view as a measurement of the highest accuracy which is attainable. To work out certain branches of the problem with such minuteness as to give us apparently very much greater accuracy than this is not only useless, but is apt to be positively misleading, as giving an impression of an accuracy which has no real existence.

The relative value of accuracy in different sets of observations is in itself a matter in which a sense of proportion is wanted, and often very badly wanted. Where one has to measure half a dozen things of which two are very easily measured and the remaining four are only measurable with great difficulty, it is only human nature that we should spend our energies on getting extremely accurate results with the first two and roughly do our best with the others. It is very difficult under such circumstances to remember that the accuracy of the whole is not the accuracy of the best part of our work, but of the worst.

The extraordinary effect of a want of sense of proportion is nowhere better shown than in the absurd statements which are constantly made as to technical matters in public prospectuses, and the still more absurd statements made in those very numerous documents of a similar kind of which some of us see a great many, but which do not finally emerge into public view. Fortunes are apparently to be made by inventions which, although doubtless ingenious, yet only concern one way of doing a thing which could be done equally well in half a dozen other ways. Every one is expected to run after a piece of apparatus which is to save 50 per cent. of something, the total cost of that something, however, being so very small that nobody cares to save in it at all. I need hardly mention the all too common case where a contemplated saving of 10 per cent in the cost of a material works out yearly to an amount much more than equal to the whole cost of the original article.

I believe that experimental work in an engineering laboratory can educate this critical sense of proportion very admirably in a number of ways. In the first place, it directs quantitative work into very varied channels, and not along one particular line. Secondly, it compels the observer to combine a number of measurements in such a way that the relative importance of accuracy in each can be seen. In the case of an engine trial, for instance, the combined results are affected by the accuracy of measurements of the dimensions of the machine, by the apparatus and methods used for measuring the water, by the indicator, and by its springs, by the speed counter, by the thermometers, and so on. An error of 1 per cent. in counting the revolutions is just as important as an error of 1 per cent. in measuring the water, or in measuring the mean pressure. I am afraid that one could point to a good many cases in which this has been more or less forgotten. Then, by making a series of measurements all in absolute quantities, the relative importance of each quantity to the desired total result can be seen. Thus it will be found that changes in certain quantities affect the total result to a very small extent, while changes in others affect it very largely, so that not only is the accuracy with which different quantities can be determined very different, but also the same degree of accuracy is of very different importance according to the particular quantity to which it refers. Once it is found that a final result is exceedingly little affected by a particular set of changes, it ceases to be of importance to measure or observe those changes in any extremely minute way, and of course the reverse holds equally good. Finally, and this perhaps is the most important matter of all, measurements in such a laboratory are made to a great extent under the complicated conditions under which the actual final result has to be obtained in practical work. They are not made under the conditions which insure the greatest individual accuracy of each result.

It will be seen that throughout, but particularly in the two last points which I have mentioned, the work of an engineering laboratory is in intention and in essence different from that of a physical laboratory. The aim of the latter is to make its problems as simple as possible, to eliminate all disturbing elements or influences, and to obtain finally a result which possesses the highest degree of absolute accuracy. In most physical investigations the result aimed at is one in which practically absolute accuracy is attainable, although attainable only if infinite pains be taken to get it. It is the business of the physicist to control and modify his conditions, and to use only those which permit of the desired degree of accuracy being reached. In such investigations it sometimes becomes almost immoral to think of one condition as less important than another. Every disturbing condition must be either eliminated or completely allowed for. That method of making the experiment is the best which ensures the greatest possible accuracy in every part of the result. The business of the engineer, on the other hand, is to deal with physical problems under conditions which he can only very partially control, and the conditions are a part of his problem. He does not, for instance, experiment with a steam engine so made that it can work with a Carnot cycle. It is in the nature of the case that he must experiment with a much less perfect machine. In burning fuel he does not use apparatus especially made to absorb the whole heat of combustion, but in the nature of the case has to investigate the behaviour of apparatus in which a very large part of that heat is unavoidably wasted. So one might go on through an immense number of instances. Perhaps the whole matter may best be summed up by saying that in a physical laboratory the conditions of each experiment are under the control of the experimenter, and are subservient to the experiment itself. In an engineering laboratory the conditions form part of the experiment. However much more difficult or complicated they render it, they still unavoidably form part of it—an experiment under any other conditions, or with those conditions removed, would *ipso facto* be irrelevant.

A critical training in matters mechanical is, however, only too similar to the celebrated training of the Mississippi pilot which so nearly broke the heart of Mr. Mark Twain. Whenever the whole matter seems to be completely mastered from one point of view, it is only to find, with a little more experience, that from another point of view everything looks different, and the whole critique has to be started afresh. Machines cannot be finally criticised—that is to say, they cannot be pronounced good or bad—simply from results measurable in a laboratory. One wishes to use steam plant, for instance, by which as little coal shall be burnt as possible. But clearly it would be worth while to waste a certain amount of coal if a less economical machine would allow a larger saving in the cost of repairs. Or it might be worth while to use a machine in which a certain amount of extra power was obviously employed, if only by means of such a machine the cost of attendance could be measurably reduced. In fact, what may be summed up in the phrase the "worth-whileness" of economies, is in itself a matter upon which a whole paper might be written. Unfortunately, the latter points which I have mentioned are just such as cannot easily be measured in laboratory work, or, indeed, in any other way whatever, except by actually using the apparatus in question. All that can be said is that a careful training in the critical measurement of comparatively simple points fits a man more than anything else to gauge accurately the importance of such other matters as I have mentioned. No doubt there are many men in whom the critical faculty is insufficiently developed to allow them ever to be of use in these matters, but to those who are intellectually capable of the "higher criticism" it must be, I think, of inestimable benefit to have had a systematic training in the lower.

Is there, then, any general standpoint from which mechanical criticism can be directed? Certain points are obvious, but probably the whole matter cannot easily be generalised. A city has to be supplied with water; there are three requisites: that the water should be of proper quality, of sufficient quantity, and that it should be brought in at a reasonable cost. But in such a case the first two are so enormously more important than the third, that the ideal is comparatively simple (of course, this is quite a different thing from being simply reached). A city has to be supplied with electric light: the essential conditions are similar. But in this case there are so many qualities which are equally proper, and there are so many different ways of bringing it in in sufficient quantity, that the third point—namely, the cost—becomes especially important. A factory has to be driven by steam power: the amount of power that is wanted can be produced by so many different types of engine and boiler—all capable of approximately equal economy, and all claiming equal freedom from breakdowns—that the choice is a peculiarly difficult one from the critical point of view.

It seems almost impossible that a criticism on any one basis could meet all the three cases which I have supposed unless that basis were that the thing supplied should be the absolutely fittest, having regard to all the conditions of each case and the relative importance of each condition. Possibly in all cases we could get at some generalisation which would show us which was the absolutely fittest, if only the necessary data were in any way complete, which they very seldom are. Perhaps in one sentence we may say that that scheme, or system, or machine, will be the absolutely best in any particular case which will the longest survive and maintain its place in its particular environment. I cannot doubt that this development of Darwinian ideas in the world of the inorganic is a legitimate one. Of course the problem would be comparatively easy in each particular case if only the environment would stand still. It would even be comparatively easy if we knew how the environment was going to alter, but this we are unable to do. We only know that it certainly *will* change and will go on changing, and that therefore the things which we make now have not got to survive in the conditions in which we make them, but have got to survive through some new sets of conditions of which we know nothing. I do not think the difficulty is in any way met by the popular method of guessing at what will be wanted fifty years hence, which generally means simply guessing at something very big. It is of no use making our ships or our engines of a type which we choose to imagine will be that of fifty years hence. If we do they will be of no use to-day, and for that very reason they will not even be in existence, useful or other, at the end of the fifty years. Sufficiently sad illustrations of this will occur to everyone in very different directions. I hope I shall not be considered churlish in saying that I do not think that the men who have worked on this principle have really been far seeing, or have really brought us much forward. They have been men often of genius, often of great personal fascination, always of immense imagination. But they have proceeded by methods essentially opposed to anything like the gradual evolution which must occur in technical as it does in natural matters, and in too many cases the results of their labours have not even been giants, but only monsters.

As to what causes one thing to survive rather than another we can only speak very generally. Mere survival may come about by the accident of a peculiarly tough constitution. A few engines built in the time of James Watt are still to be found at work in our own day, but can no more be taken as the fittest type than some solitary megatherium would be who, having outlived all his contemporaries, was able in after ages to look down upon his pigmy and short-lived successors. Mere length of life in such a case may be a mere accident, and is not itself a proof of fitness. We have it thrown at us every now and then that our engines nowadays do not last like the old ones, as if the mere existence of a very old machine were a proof of its virtues. It is certainly a proof of the excellence of its construction—or, as one may say, of its constitution—and perhaps also of the very small amount of work it has done in proportion to its life and its dimensions.

It is sometimes, I am afraid, rather humiliating to have to remember that, to a very great extent, the question of the fittest, so far as it affects us, is a financial one. In manufacturing processes efficiency and economy tend to survival because they lead to decreased cost of production. In structures or other large permanent works those types tend to perpetuate themselves which require the least material—that is, in which the material used is disposed to the best advantage—and in which the outlay on labour is also smallest, assuming, of course, equal fitness in other respects. There is, no doubt, at present a tendency to dispute this altogether, and to treat all reductions in cost of labour as disadvantageous, unless, indeed, the labour be very highly skilled, in which case its remuneration must necessarily be brought down for the sake of equality! I imagine this tendency will last exactly as long as the faithful can get some other people to pay the increased cost, and will thereafter determine itself somewhat suddenly. It can no more stand in the way of natural progress in engineering matters than could the somewhat similar outcry against the introduction of machinery into manufactures two generations ago. It would be as wise to paint a generation of cats green, in the hope of compelling natural selection to work along new lines.

I think we may fairly assume, therefore, that efficiency and economy are both legitimate criteria as to ultimate fitness, and will remain so. Moreover, they are both matters in which measurements can be made, and as to which judgment can be guided by such measurements. But there are other characteristics, not directly measurable, by which we can in some degree form an opinion as to the ultimate fitness of things or processes.

One set of considerations which has great critical importance is summed up in the word *simplicity*. This does not mean fewness of parts. Reuleaux showed long ago that with machines there was in every case a practical minimum number of parts, any reduction below which was accompanied by serious practical drawbacks. Nor is real simplicity incompatible with considerable apparent complexity. The purpose of machines is becoming continually more complex, and simplicity must not be looked at as absolute, but only in its relation to a particular purpose. There are many very complex-looking pieces of apparatus in existence which work actually so directly along each of their many branch lines as to be in reality simple. I believe it almost always happens that the first attempt to carry out by a machine a new purpose is a very complicated one. It is only by the closest possible examination of the problem, the getting at its very essence, that the machine can be simplified, and this is a late and not an early stage of design. If a mechanical problem is really only soluble by exceedingly complicated apparatus, it generally becomes a question whether the solution is worth having. There is no impossibility in making a machine that will do anything. But the very simplest possible form of apparatus which would wash our hands for us in a suitable manner is probably so very complicated that for many years to come at least that operation will be performed by manual labour.

Very closely allied to simplicity is what I may call directness. In nearly all mechanical processes certain transformations are unavoidable. In many mechanical processes, as I have recently had occasion to mention, a very large number of transformations is at present practically unavoidable. I myself cannot help thinking that probably one of the most distinct signs of fitness is a reduced number of transformations, the bringing of the final and the initial stages as close together as possible, and cutting out altogether the apparently worthless middle processes. But any generalisation of this kind must be very cautiously handled; these apparently useless processes are no doubt in certain cases as indispensable as is the much abused middle-man in matters economic.

In a critical view of any case where similar results are aimed at by hand-work and by mechanical means, it is important to recognise that the similarity of result should very seldom become identity. In the first machine to do anything mechanically which has before been done by hand, the error is often made of trying to imitate the hand-work rigorously. The first sewing machines were, I believe, made to stitch in the same way as a seamstress. It was not until a form of stitch suitable for a machine, although unsuitable for hand, was devised that the sewing machine proved successful as a practical matter. In another but analogous line too you may remember that the first railway carriages were practically stage coaches put upon trucks, from which the present carriages have only very slowly been evolved.

The critic has also to remember that very often the attainment of some very unimportant point, or point of which the importance has been greatly exaggerated, is made the reason mechanically for very great complication. The question of proportion comes in here again, and it has to be considered in any particular case whether the academically perfect machine, which is also extremely complicated, is not inferior to the *almost* equally good machine which has been constructed in a practicable shape,—it almost always is so.

I have endeavoured in my remarks to indicate what appears to me to be the attitude of the engineer towards a very large portion of the work which comes into his hands. In order to deal with the work it is necessary for him first of all to have a certain definite knowledge of "things," that is to say, both of the various subjects which form part of the curricula of all technical schools, and of the further matters which form as it were his professional alphabet. These last he learns not from books or lectures as a student, but by example and attempt, as does an artist. Of this part of his training I have said nothing; it has been perhaps sufficiently talked about of late years, and there is little to say which I could have made interesting to a general gathering like this. I cannot leave it altogether, however, without dealing with one matter. Exceptional men are all-round mathematicians or physicists, still more exceptional men are both; but for ordinary folk the study of one side of mathematics or of a single branch of physics is the work of a lifetime. The engineer is bound to know his own profession, by hypothesis, and it is in itself no small matter. Yet in addition he must know some mathematics, some physics, some chemistry, even also some geology, if he is to take any high rank in it. It is, therefore, surely in the very nature of things impossible that he should be a great mathematician or a great physicist, or should devote as much study to those most fascinating sciences as if they themselves were the work of his life. Therefore I beseech my friends of Section A to do what they can to modify their natural attitude of superiority—even of contempt—towards us, especially when we are students. The young engineer—I speak as a member of the great majority of the ordinary kind—would probably never have chosen his profession if he had had special aptitude for mathematical work. Having chosen it, he has to look at mathematics simply as a tool, a means to an end, not an end in itself. I cannot myself see that this point of view is one disrespectful to the parent of all the sciences, and I am confirmed by the knowledge that one or two of the greatest mathematicians in the country are of the same opinion and have the courage to act on it—with infinitely beneficial results to the young men they have to deal with. But I know that to mathematicians in general—the physicists are not so bad—the very name of engineering student is odious, indicating only a man who wilfully refuses to make mathematics his "first subject," and who therefore deserves neither consideration nor quarter, to whom it is privilege sufficient that he should be allowed to pick up such crumbs as he can digest from a table prepared for his betters. I humbly protest that we deserve better treatment. It is no doubt a great misfortune to us that we cannot afford to spend our training-time preparing for examinations, and that we have been compelled to choose for our future a career in which mathematics plays only a secondary part. It is our further misfortune that we have to solve twenty real live problems, each demanding a real live answer, for every single one which otherwise we would have worked out on paper. Perhaps it is also our misfortune—or it may be only our thickheadedness—to believe that in consequence of this we are quite able to judge for ourselves what units it is most convenient for us to work in, what nomenclature satisfies our requirements, and that we are as capable of getting our "*g*'s" in their right places as even some of our distinguished critics. But this is the end of the nineteenth century; philanthropy fills our breasts. May not our misfortunes call out some pity and not alone contempt? In spite of solemn warnings which I have lately received in the press against the monstrous idea that a presidential address should contain any individual opinions, I venture to repeat here what I had lately an opportunity of saying before a Royal Commission, that in cases where a University or University College takes in hand the preparation of engineers (and I hope that such cases will grow in number) they should provide for them special training in mathematics, and probably also in physics, distinct from the general training in these subjects most suitable for Degrees. I say this with the full knowledge that I may be accused of wishing to degrade the purity of scientific work, and, at the same time, with the full knowledge that I have no such wish. On the contrary, this special training is the only means by which the rank and file of us will ever know any mathematics at all. And I can say from my own knowledge that, if only we can be made what I may call mathematically articulate beings, we shall be able to repay the kindness by placing before the man of pure science problem after problem of transcendent difficulty, of immense interest, and having no single drawback whatever except that its solution may really be "useful"; and, after all, this need not be brought too prominently under his notice.

This digression has turned out a long one. I have only further to say that my main object in this address has been to indicate, as well as I could, the general attitude which the engineer must of necessity take up towards much of his work,—the point of view from which he must look at it. I shall be extremely glad if anything which I have said should cause this attitude, this,—this point of view,—to be more clearly kept in mind in the period of training than probably has been hitherto the case.

SECTION H.

ANTHROPOLOGY.

Opening Address by Sir W. H. Flower, K.C.B., LL.D., Sc.D., F.R.S., President of the Section.

It is not usual for the President of a Section of this Association to think it necessary to give any explanation of the nature of the subjects brought under its cognisance, or to emphasise their importance among other branches of study; but so general is the ignorance, or at all events vagueness of information, among otherwise well-instructed persons, that I will ask your permission to devote the short time accorded to me before the actual work of the Section begins to giving some account of the history and present position of the study of Anthropology in this country, and especially to indicate what this Association has done in the past, and is still doing, to promote it.

It is only ten years since the Section in which we are now taking part acquired a definite and assured position in the organisation of the Association. The subject, of course, existed long before that time, and was also recognised by the Association, though with singular vicissitudes of fortune and position. It first appeared officially in 1846, when the "Ethnological sub-Section of Section D" (then called "Zoology and Botany") was constituted. This lasted till 1851, when Geography parted company from Geology, with which it had been previously associated in Section C, and became Section E, under the title of "Geography and Ethnology." In 1866 Section D changed its name to "Biology," with Physiology and Anthropology (the first occurrence of this word in our official proceedings) as separate "Departments"; but the latter does not seem to have regained its definite footing as a branch of Biological Science until three years later (1869), when Section E, dropping Ethnology from its title, henceforward became Geography alone. The Department for the first two years (1869 and 1870) was conducted under the title of Ethnology, but in 1871 it resumed the name of Anthropology, given it in 1866, and it flourished to such an extent, attracting so many papers and such large audiences, that it was finally constituted into a distinct Section, to which the letter H was assigned, and which had its first session at the memorable meeting at Montreal, exactly ten years ago, under the fitting and auspicious presidency of Dr. E. B. Tylor.

The history of the gradual recognition of Anthropology as a distinct subject by this Association is an epitome of the history of its gradual growth, and the gradual recognition of its position among other sciences in the world at large, a process still in operation and still far from complete. Although the word Anthropology had certainly existed, but used in a different sense, it was not till well into the middle of the present century that it, or any other word, had been thought of to designate collectively the scattered fragments of various kinds of knowledge bearing upon the natural history of man, which were beginning to be collected from so many diverse sources. Indeed, as I have once before upon a similar occasion remarked, one of the great difficulties with regard to making Anthropology a special subject of study, and devoting a special organisation to its promotion, is the multifarious nature of the knowledge comprehended under the title. This very ambition, which endeavours to include such an extensive range of subjects, ramifying in all directions, illustrating and receiving light from so many other sciences, appears often to overleap itself, and give a looseness and indefiniteness to the aims of the individual or the institution proposing to cultivate it. The old term Ethnology, or the study of peoples or races, has a limited and definite meaning. It treats of the resemblances and modifications of the different groups of the human species in their relations to each other, but Anthropology, as now understood, has a far wider scope. It treats of mankind as a whole. It investigates his origin and his relations to the rest of the universe. It invokes the aid of the sciences of zoology, comparative anatomy and physiology, in its attempts to estimate the distinctions and resemblances between man and his nearest allies, and in fixing his place in the scale of living beings. In endeavouring to investigate the origin and antiquity of man, geology must lend its assistance to determine the comparative ages of the strata in which the evidences of his existence are found, and researches into his early history soon trench upon totally different branches of knowledge. In tracing the progress of the race from its most primitive condition, the characteristics of its physical structure and relations with the lower animals are soon left behind, and it is upon evidence of a kind peculiar to the human species, and by which man is so preeminently distinguished from all other living beings, that our conclusions mainly rest. The study of the works of our earliest known forefathers—"prehistoric archæology" as it is commonly called—is now almost a science by itself. It investigates the origin of all human culture, endeavours to trace to their common beginning the sources of our arts, customs, and history. The difficulty is, what to include and where to stop; as, though the term prehistoric may roughly indicate an artificial line between the province of the anthropologist and that which more legitimately belongs to the archæologist, the antiquary and the historian, it is perfectly evident that the studies of the one pass insensibly into those of the others. Knowledge of the origin and development of particular existing customs throws immense light upon their real nature and importance; and conversely, it is often only from a profound acquaintance with the present or comparatively modern manifestations of culture that we are able to interpret the slight indications afforded us by the scanty remains of primitive civilisation.

It is considerations such as these that have caused the gradual introduction of the term Anthropology as a substitute for Ethnology—a change which I have traced in the history of this Association, and which is seen in other organisations for the cultivation of our science.

The first general association for the study of man in this country was founded in 1843, under the name of the "Ethnological Society" (three years therefore, before the Ethnological sub-Section of Section D of this Association). It did excellent work for many years under that title, but partly from personal considerations, and partly from a desire to undertake a wider and somewhat different field of research another and in some senses a rival society, which adopted the name of "Anthropological," was founded in 1863. For some years these existed side by side, each representing in its most active supporters different schools of the science. This arrangement naturally involved a waste of strength, and it was felt that the interests of the subject would be promoted by an amalgamation of the two societies. Many difficulties, chiefly, as is usual in such cases, of a personal nature, had to be overcome, one of the principal being the selection of a name for the united society. It was generally felt that "Anthropological" would be most appropriate, but the members of the old Ethnological Society could not bring themselves absolutely to sink the fact of their priority of existence, and all that they had done for science for so many years, by merging their society into that of their younger and active rivals: so after much discussion a compromise was effected, and the new organisation which arose from the coalescence of the two societies adopted the rather cumbrous title of "Anthropological Institute of Great Britain and Ireland." This was in 1871, and since that period, the *Society*, as it is to all intents and purposes both in structure and function, has pursued a peaceful and useful course of existence, holding meetings at stated periods throughout the session, at which papers are read and subjects of interest to anthropologists exhibited and discussed. It has also published a quarterly journal, which has been the principal means in this country of communicating new information upon such subjects. The Institute has for twenty-three years performed this duty in a business-like and unostentatious manner, the only remarkable circumstance connected with its history being the singular want of interest taken by the outside world in its proceedings, considering their intrinsic importance to society, especially in an empire like ours, which more than any other affords a field for the study of man, under almost every aspect of diversity of race, climate, and culture. At the present time it numbers only 305 ordinary members, whose subscriptions afford barely sufficient means to maintain the library and journal in a state of efficiency. The kindred Geographical and Zoological Societies have respectively 3775 and 2985 fellows, so far greater is the interest taken in the surface of the earth itself, and in the animals which dwell upon it, than in its human inhabitants!

Societies similar in their object to that the history of which I have just sketched have sprung up, and are now in a more or less flourishing condition, in every civilised country of the world. But confining our retrospect to our own country, we may take a glance at what has been done in recent years to promote the organised study of Anthropology otherwise than by means of this Association (to which I shall refer again later) or the Society of which I have just spoken.

One of the most potent means of registering facts, and making them available for future study and reference, is to be found in actual collections of tangible objects. To very considerable branches of anthropological science this method of fixing the evidence upon which our knowledge of the subject is based is particularly applicable. These branches are mainly two, very distinct from each other, and each representing one of the principal sides in which Anthropology presents itself.

I. Collections illustrating the physical structure of man, and its variations in the different races.

II. Collections showing his characteristic customs and methods of living, his arts, arms and costumes, as developed under different circumstances and also modified by different racial conditions.

It is very rarely that these two are combined in one general arrangement, and they are almost always studied apart, the characteristics of mind, the general education and special training which are required for the successful cultivation of either being rarely combined in a single individual; and yet the complete history of any race of mankind, especially with regard to its relation to other races, must be based upon a knowledge both of its physical and psychical characteristics, and customs, habits, language, and tradition largely help, when anatomical characters fail to separate and define.

The anthropological museums of this country, as well as elsewhere, are all of recent growth, and they are making progress everywhere with steadily accelerating speed. This cannot be better illustrated than in the place where we are at the present time. Many of those who are now in this room can remember when the materials for the study of either branch of the subject in Oxford were absolutely non-existent. I can myself recall the time when the site of the handsome building which now houses the scientific treasures of the University was a bare field. All who know the modern history of Oxford must be aware that it was mainly owing to the enthusiastic zeal and steady perseverance in the cause of scientific education of one who is happily still amongst us, the veteran Regius Professor of Medicine, Sir Henry Acland, that that building was erected. The possession of a well-selected and representative collection illustrating the anatomical characters of the human species is chiefly owing to the energetic labours of Prof. Rolleston, one of the brightest and noblest of Oxford's sons, a man of whom I cannot speak without feelings of the strongest affection and most profound regret for his untimely loss to the University and the world.

The collection illustrating the arts and customs of primitive people the University owes to the ingenuity and munificence of General Pitt-Rivers, who not only provided the material on which it is based, but also the original and unique scheme of arrangement, which adds so greatly to its value as a means of education, and is so admirably calculated to awaken an interest in the subject, even in the minds of the most superficial visitor. In speaking thus of the method of displaying the Pitt-Rivers collection, I must not be supposed to imply any disparagement of others arranged on different plans. Provided there is a definite and consistent arrangement of some sort, it is well that there should be a diversity in the treatment of different collections, and for such a vast and exhaustive collection as that under the care of Sir Wollaston Franks, at the British Museum, the geographical system which has been adopted is certainly the best. In it every specimen of whatever nature at once finds a place, in which it can at any time be discovered and recognised.

In referring to our great national collection, I cannot refrain from saying that there seemed till lately to be only one element wanting to make it all that could be desired, and that was space, not only for the proper preservation and exhibition of what it already contains, but also for its inevitable future expansion. The provision in this respect was totally inadequate to do justice to the importance of the subject. Happily this consideration will be no longer a bar to the development of the collection. The provident action of the authorities of the Museum, aided by the liberality of the Duke of Bedford, and the wisdom of Her Majesty's Government, has secured for many years to come the necessary room for the expansion of the grandest of our national institutions.

More modern even than museums has been the introduction of any systematic teaching of Anthropology into this country. This is certainly most remarkable, considering that there is no nation to which the subject is of such great importance. Its importance to those who have to rule—and there are few of us now who are not called upon to bear our share of the responsibilities of government—can scarcely be over-estimated in an Empire like this, the population of which, as I have just said, is composed of examples of almost every diversity under which the human body and mind can manifest itself. The physical characteristics of race, so strongly marked in many cases, are probably always associated with equally or more diverse characteristics of temper and intellect. In fact, even when the physical divergences are weakly shown, as in the different races which contribute to make up the home portion of the Empire, the mental and moral characteristics are still most strongly marked. As the wise physician will not only study the particular kind of disease under which his patient is suffering before administering the approved remedies for such disease, but will also take into careful account the peculiar idiosyncrasy and inherited tendencies of the individual, which so greatly modify both the course of the disease and the action of remedies, so it is absolutely necessary for the statesman who would govern successfully, not to look upon human nature in the abstract and endeavour to apply universal rules, but to consider the special moral, intellectual, and social capabilities, wants, and aspirations of each particular race with which he has to deal. A form of government under which one race would live happily and prosperously may to another be the cause of unendurable misery. All these questions then should be carefully studied by those who have any share in the government of people belonging to races alien to themselves. A knowledge of their special characters and relations to one another has a more practical object than the mere satisfaction of scientific curiosity; it is a knowledge upon which the happiness and prosperity or the reverse of millions of our fellow-creatures may depend. The ignorance often shown upon these subjects, even in so select an assembly as the House of Commons, would be ludicrous if it were not liable to lead to disastrous results.

Now let us consider what, amid all the complex, diverse, and costly machinery of education in this country, is being done to satisfy the demands for such knowledge. We may say at once as regards all institutions for primary and secondary education, absolutely nothing. The inhabitants of the various regions of our own earth are treated with no more consideration and interest in all such institutions than if they lived on the moon or the planets. We must turn straight to the higher intellectual centres in the hope of finding any anthropological teaching. Here at Oxford, if anywhere, we may expect to find it, and here, first among the British Universities, have we seen, since the year 1883, among the list of the subjects taught the word "Anthropology," but the teacher, though one of the most learned of men in the subject the country has produced, still only bears the modest title of "Reader." A professorship of Anthropology does not exist at present in the British Isles, and even here the subject, though recognised as a "special," offers little field for distinction in the examinations for degrees, and has therefore never been taken up in a thorough manner by students. Dr. Tylor's lectures must, however, have done much to have spread an intelligent interest in some branches of Anthropology, and have proved a valuable complement to the Pitt-Rivers collection, as have also the courses which have been given by Mr. Henry Balfour upon the arts of mankind and their evolution, one of which I am glad to see is announced among the advantages offered to the University Extension students at present with us. Physical Anthropology has also been taken up by Prof. A. Thomson, who, I understand, gives instructive lectures upon it, open to the members of his class of human anatomy. At the opposite end almost of the subject must be mentioned the extension and organisation of the Ashmolean Museum under the care of Mr. Arthur Evans, which has a bearing upon some branches of Anthropology, and the foundation of the Indian Institute under the auspices of Sir Monier Monier-Williams, which must give an impetus to the study of the characteristics of the races of our great Empire in the East. Last, but by no means least in its bearing upon the origin, divisions, and diffusion of races, is the world-famous linguistic work of Prof. Max Müller and Prof. Sayce, both of whom have presided over this Section at former meetings of the Association.

Of the sister University I wrote thus in 1884: "In Cambridge there are many hopeful signs. The recently appointed Professor of Anatomy, Dr. Macalister, is known to have paid much attention to Anatomical Anthropology, and has already intimated that he proposes to give instruction in it during the summer term. An Ethnological and Archæological Museum is also in progress of formation, which, if not destined to rival that of Oxford, already contains many objects of great value, and a guarantee of its good preservation and arrangement may be looked for in the appointment of Baron Anatole von Hügel as its first curator."

Ten years have passed, and it is satisfactory to know that the teaching of Anthropology has not only been fairly established, but the subject has also found a place in the scheme of University examination. The learned Professor of Human Anatomy continues to take a wide view of its functions, giving a course during the Easter term on the methods of Physical Anthropology, and also museum demonstrations on craniometry and osteometry, by the aid of a greatly increased and continually augmenting collection of specimens. Those students who take anatomy as their subject for the second part of the Natural Science Tripos have both paper work and practical examination in Anthropology, each man having a skull placed in his hands of which he is expected to make a complete diagnostic description. For the first part of the tripos each candidate has one or more questions on the broad general principles of the subject. Prof. Macalister informs me that he has always at least six men who go through a very thorough practical course with their own hands. There has also lately been established a course of lectures on the Natural History of the Races of Man, delivered during the Michaelmas and Lent terms by Dr. Hickson, of Downing College, and Baron von Hügel gives a course of museum demonstrations on the weapons, ornaments, and other objects in the Ethnological Museum, which is open to all students, and of which many take advantage.

In London, owing to the chaotic condition of all forms of higher instruction, which has been brought so prominently into notice by the universal demand for a teaching University (an aspiration which the labours of the late Gresham Commission certainly seem to have brought nearer to realisation than ever appeared possible before), all systematic anthropological teaching has been entirely neglected. The great collections to which I have already alluded, that of arts and customs at the British Museum, and that of osteological specimens at the Royal College of Surgeons, have by their steady augmentation done valuable service in preserving a vast quantity of material for future investigation and instruction, and students have at present all reasonable facilities for pursuing their own researches in them. Lectures have never formed any part of the official programme of the British Museum, but at the College of Surgeons it is otherwise, and though the contents of the collections are specially indicated as the subject on which they should be delivered, for the last ten years at least, Anthropology, notwithstanding the magnificent material at hand for its illustration, has had no place in the annual syllabus. It is also entirely ignored in the examination scheme of the University of London, an institution which prides itself as being on a level with modern educational requirements; and the managers of the new Imperial Institute, casting about in all directions for some worthy object to occupy their energies and their spacious buildings, do not appear to have taken into serious consideration the value to the world and the appropriateness to their original design of a great central school of Anthropology, from which might emanate a full and satisfying knowledge of the characteristics of all the various races of which the Empire is composed.

In Scotland the recent Universities Commission has recognised Physical Anthropology as a branch of human anatomy in their scheme for graduation in pure science, the examination on this subject embracing a knowledge of race characters as found in the skull and other parts of the skeleton, in the skin, eyes, hair, features, and the external configuration of the body generally; the methods of anthropometrical measurement, both of the living body and the skeleton; the possible influence of use and of external surroundings in producing modifications in the physical characters of man, and an acquaintance with the "types" of mankind and the structural relations of man to the higher mammals. These regulations came into operation in the University of Edinburgh in 1892, and in accordance with them Prof. Sir William Turner delivers a special course of twenty-five lectures on Physical Anthropology, and in addition ten practical demonstrations on osteometry. The museum under his charge has greatly increased of late in number and value of the specimens. But "Human Anatomy, including Anthropology," being only one of a series of nine subjects in any three or more of which a final science examination on a higher standard has to be passed, there is not at present any considerable number of students who take it up, and the other Scotch Universities have not yet thought it necessary to establish distinct courses of Physical Anthropology, although it is becoming more and more a regular part of the anatomical teaching to advanced students.

For the following account of what is being done to further the knowledge of our subject in the sister isle I am indebted to Prof. D. J. Cunningham. The only place in Ireland where anthropological work is done is Trinity College. For many years those in charge of the museum have been collecting skulls, and they were fortunate in obtaining the greater part of Sir William Wilde's collection. To these great additions have been recently made, principally in the form of Irish crania from different districts. All the anthropological specimens are lodged in one large room, which is also used as an anthropometric laboratory. Though there has never been any systematic teaching of Anthropology in Trinity College, Dr. C. R. Browne (Prof. Cunningham's able assistant), who takes charge of the laboratory, attends for two hours on three days a week, and gives demonstrations in anthropological methods to any students who are interested in the subject. The laboratory was opened in June 1891, the instruments being provided by a grant from the Royal Irish Academy, and about 500 individuals have already been measured, the greater number of them students of the College. This is, however, only part of the work carried out by the laboratory. Every year the instruments are taken to some selected district in Ireland, and a systematic study of the inhabitants is made. The Aran Islands, and also the islands of Inishboffin and Inishshark, have been already worked out, and this year excursions are organised to Kerry, to a district in Wicklow, and to another in the west of Ireland. The Academy makes yearly grants to the Committee for carrying on this work, the results of which have been published in admirable memoirs by Prof. A. C. Haddon and Dr. C. R.

Browne. The Science and Art Museum in Dublin, under the direction of Dr. V. Ball, contains a small collection, arranged with a view to general instruction, showing by means of skulls and casts the physical characteristics of the different races of man, those of each race being explained by a short printed label, and its range shown on a map.

Though the development of anthropological science has thus not been greatly advanced, in this country at least, by means of endowments, or by aid of the State or, till very recently, by our great scholastic institutions, but has been mainly left to the unorganised efforts of amateurs of the subject, its progress in recent years has been undeniably great. I will give an instance of the strides that have been made in one of its most important branches.

Physical or Anatomical Anthropology, or the study of the modifications of the human body under its various aspects, the modifications dependent upon sex and age, the modifications dependent upon race, and those dependent upon individual variability, studied not many years ago in a vague and loose manner, has gradually submitted to a rigorous and, therefore, strictly scientific method of treatment. The generalities which were formerly used to express the differences that were recognised between the various subjects compared with each other have been replaced by terms conveyed in almost mathematical precision. No one acquainted with the history of the development of this branch of Anthropology can fail to recognise how much it was accelerated by the genius of Broca, and the school which he established in France, although all cultivated nations are now vying with each other in the practice of exactitude in anthropological research, and the time seems rapidly approaching when a common agreement will be arrived at, by which all the observations which may be made, under whatever diverse circumstances, and by whatever different individuals, will be available for comparison one with another.

This branch of our science has received the name of "Anthropometry." Although, as the name implies, measurement is one of its principal features, it includes such other methods of comparison as can be reduced to a definite standard, or to which definite tests can be applied, such as the colour of the hair, eyes, and complexion, the form of the ear and nose. The great desiderata that have been sought for, and gradually attained, in measuring either the skeleton or the living person have been two in number: (1) Exact definition of the points between which the measurements should be taken. (2) Exact methods and instruments of measurement. In both these cases the object looked for has been not only that the measurements taken by the same observer at different times and under different circumstances should coincide, but also that those taken by different observers should be comparable. These requirements seem so simple and natural at first sight that the majority of persons whom I am addressing will wonder that I should allude to them. Only those who are seriously occupied, or perhaps I should rather say, only those who were seriously occupied a few years ago, with the endeavour to solve these problems can have any idea of their difficulty. The amount of time and labour that has been spent upon them is enormous, but the result has, I think, been quite commensurate with it.

We have attained at last to methods of measurement and standards of comparison which, in the hands of persons of ordinary intelligence, and with a moderate amount of training, will give data which may be absolutely depended upon. From these we hope to be able to formulate accurate information as to the physical conformation of all the groups into which mankind is divided, and so gradually to arrive at a natural classification of those groups, and a knowledge of their affinities one to another.

But the exact methods of modern Anthropometry are not only important on account of the aid they give in studying the race characteristics of man. As has so often happened when scientific observation has been primarily carried out for its own sake, it ultimately leads to practical applications undreamt of by its earlier cultivators. The application of Anthropometry not to the comparison of races, but to elucidate various social problems such as the laws of growth, of heredity, of comparative capacities of individuals within a community, and the effects of different kinds of education and occupation, as worked out first by Quetelet in Belgium, and subsequently by Francis Galton, Roberts, and others in this country, and its still more concrete application as an aid in administering justice by methods perfected by Bertillon in France—are striking illustrations of the practical utility of labours originally undertaken under the influence of devotion to science pure and simple.

The importance of being able to determine the identity of an individual under whatever circumstances of disguise he may be presented for examination has, of course, long been apparent to all who have had anything to do with the administration of the criminal law, and rough and ready methods of recognition, depending mainly upon the more or less acute faculty of perception and recollection of differences and resemblances, possessed by the persons upon whom the duty of identification has devolved, have long been in operation. The general conformation, height, form of features, and colour of complexion, hair, and eyes, have also been noted. Much additional assistance has been obtained by the registration of definite physical characteristics, the results either of natural conformation, or of injury, such as mutilations, tattoo-marks, and scars, inflicted by accident or design. The application of one of the most important scientific discoveries of the age, photography, was eagerly seized upon as a remedy for the difficulties hitherto met with in tracing personal identity, and enormous numbers of photographs were taken of persons, the peculiarities of whose career led them to fall into the hands of the police, and who were likely to be wanted again on some future occasion. No doubt much help has been derived from this source, but also much embarrassment. Even among photographic portraits of one's own personal friends, taken under most favourable circumstances, and with no intention of deception, we cannot often help exclaiming how unlike they are to the person represented. With portraits of criminals, the varying expression of the face, changes in the mode of wearing the hair and beard, differences of costume, the effects of a long lapse of time, years perhaps passed in degradation and misery, may make such alterations that recognition becomes a matter at least of uncertainty. That photographs are extremely valuable as aids to identification, when their true position in the process is recognised, cannot be doubted, but as a primary method they have been found to be quite inapplicable, owing partly to the causes just indicated, but mainly to the difficulty, if not impossibility, of classifying them. The enormous expenditure of time and trouble that must be consumed in making the comparison between any suspected person and the various portraits of the stock which accumulates in prison bureaus may be judged of from the fact that, in Paris alone, upwards of 100,000 such portraits of persons interesting to the police have been taken in a period of ten years.

The primary desideratum in a system of identification is a ready means of classifying the data upon which it is based. To accomplish this is the aim of the Bertillon system. Exact measurements are taken between certain well-known and fixed points of the bony framework of the body, which are known not to change under different conditions of life. The length and breadth of the head, the length of the middle finger, the length of the foot, and the length of the forearm, are considered the best, though others are added for greater certainty, as the height, span of arms, length of ear, colour of eyes, &c. All these particulars of every individual examined are recorded upon a card, and by dividing each measurement into three classes, long, medium, and short, and by classifying the various combinations thus obtained, the whole mass of cards, kept arranged in drawers in the central bureau, is divided up into groups, each containing a comparatively small number, and therefore quite easily dealt with. When the card of a new prisoner is brought in, a few minutes suffice to eliminate the necessity of comparison with any but one small batch, which presents the special combination. Then photographs and other means of recognition, as distinctive marks and form of features, are brought into play, and identification becomes a matter of certainty. On the other hand, if the combination of measurements upon a new card does not coincide with any in the classed collection in the bureau, it is known with absolute certainty that the individual being dealt with has never been measured before.

One of the most striking results of the introduction of this system into France has been that, since it has been brought fully into operation, a large proportion of old offenders, knowing that concealment is hopeless, admit their identity at once, and save a world of trouble and expense to the police by ceasing to endeavour to conceal themselves under false names.

Various representations upon this subject have been addressed to the Home Secretary of our own Government during the last few years, and among others one from the Council of this Association, which originated in a resolution of this Section, adopted by the General Committee at the meeting at Edinburgh in 1892, to this effect:

"That the Council be requested to draw the attention of Her Majesty's Government to the Anthropometric Method for the measurement of criminals, which is successfully in operation in France, Austria, and other continental countries, and which has been found effective in the identification of habitual criminals, and consequently the prevention and repression of crime."

In consequence of these representations a Committee was appointed, on October 21, 1893, by Mr. Asquith, consisting of Mr. C. E. Troup, of the Home Office; Major Arthur Griffiths, Inspector of Prisons; and Mr. Melville Leslie Macnaghten, Chief Constable in the Metropolitan Police Force; with Mr. H. B. Simpson, of the Home Office, as Secretary, "to inquire (*a*) into the method of registering and identifying habitual criminals now in use in England; (*b*) into the 'Anthropometric' system of classified registration and identification in use in France and other countries; (*c*) into the suggested system of identification by means of a record of finger marks: to report whether the anthropometric system or the finger-mark system can with advantage be adopted in England either in substitution for or to supplement the existing methods; and, if so, what arrangements should be adopted for putting them into practice, and what rules should be made under Section 8 of the Penal Servitude Act, 1891, for the photographing and measuring of prisoners."

The Report of this Committee, with minutes of evidence and appendices, was issued as a Parliamentary Blue-book in March last, and not only contains a lucid and concise description of the methods of identification already in use in this country, but also most striking testimony from impartial but well-qualified persons to the value of a more scientific mode of dealing with the subject. No pains seem to have been spared to obtain, both by personal observation and by the examination of competent witnesses, a thorough knowledge of the advantages of the Bertillon system as practised in France, and the result has been the recommendation of that system, with certain modifications, for adoption in this country, with the addition of the remarkably simple, ingenious, and certain method of personal identification first used in India by Sir William Herschel, but fully elaborated in this country by Mr. Francis Galton, that called the "finger-mark system," about which I shall have a few more words to say presently.

With the concluding words of the Committee's Report I most fully concur: "We may confidently anticipate that, if fairly tried, it will show very satisfactory results within a few years in the metropolis; but the success of its application in the country generally will depend on the voluntary co-operation of the independent county and borough police forces. This, we feel sure, will not be withheld. When the principles of the system are understood and its usefulness appreciated we believe it will not only save much time and labour to the police in the performance of an important duty, but will give them material assistance in tracing and detecting the antecedents of the guilty, and will afford, so far as its scope extends, an absolute safeguard to the innocent."

It is very satisfactory to be able to add that in the House of Commons on June 26, in answer to a question from Colonel Howard Vincent, the Home Secretary announced that the recommendations of the Committee have been adopted; and that, in order to facilitate research into the judicial antecedents of international criminals, the registers of measurements would be kept on the same plan as that adopted with such success in France, and also in other continental countries.

I have just mentioned the "finger-mark system" and of all the various developments of Anthropology in recent times none appears to be more interesting than the work done by Mr. Galton upon this subject; for though, as indicated above, he is not quite the first who has looked into the question or shown its practical application in personal identification, he has carried his work upon it far beyond that of any of his predecessors, both in its practical application and into regions of speculation unthought of by anyone else. Simple and insignificant as in the eyes of all the world are the little ridges and furrows which mark the skin of the under-surface of our fingers, existing in every man, woman, and child born into the world, they have been practically unnoticed by everyone until Mr. Galton has shown, by a detailed and persevering study of their peculiarities, that they are full of significance, and amply repay the pains and time spent upon their study. It is not to be supposed that all the knowledge that may be obtained from a minute examination of them is yet by any means exhausted, but they have already given important data for the study of such subjects as variation unaffected by natural or any other known form of selection, and the difficult problems of heredity, in addition to their being one of the most valuable means hitherto discovered of fixing personal identity.

As an example of the importance of some ready method to prove identity, apart from its application to the detection, punishment, and prevention of crime, to which I have already referred, I may recall to your recollection that remarkable trial which agitated the length and breadth of the land rather more than twenty years ago; a trial which occupied so many months of the precious time of our most eminent judges and counsel, and cost the country, as well as several innocent persons—I am afraid to say how many—thousands of pounds, all upon an issue which might have been settled in two minutes if Roger Tichborne, before starting on his voyage, had but taken the trouble to imprint his thumb upon a piece of blackened paper. It is wonderful to me, on reading again the reports of the trial, to see how comparatively little attention was paid by counsel, judge or jury, to the extremely different physical characteristics of the two persons claimed to be identical, but which were so strongly marked that they ought to have disposed of the claim, without any hesitation, at the very opening of the case. It was not until the 102nd day of the first trial that the attention of the jury was pointedly called to the fact that it was known that Sir Roger Tichborne had been tattooed on the left arm with a cross, anchor, and a heart, and that the Claimant exhibited no such marks. When this was clearly brought out and proved, the case broke down at once. The second trial for perjury occupied the court 188 days, the Lord Chief Justice's charge alone lasting eight days. The issues were, however, more complex than in the first trial, as it was not only necessary to prove that the Claimant was not Tichborne, but also to show that he was someone else. I feel convinced that at the present time the greater confidence that is reposed in the methods of Anthropometry or close observance of physical characters, and in the persistence of such characters through life, would have greatly simplified the whole case; and I would strongly recommend all who have nothing about their lives they think it expedient to conceal to place themselves under the hands of Mr. Galton, or one of his now numerous disciples, and get an accurate and unimpeachable register of all those characteristics which will make loss of identity at any future period a sheer impossibility.

Partly with this object in view, the Association has, for several years past, during each of its meetings, opened, under the superintendence of Dr. Garson, an Anthropometric Laboratory, on the plan of the admirable institution of the same name which has been carried on in the South Kensington Museum since the beginning of the year 1888, under the direction and at the sole cost of Mr. Francis Galton, in which up to the present time more than 7000 complete sets of measurements have been made and recorded. The results obtained at the British Association meetings have been published in the Annual Reports of the Association, and though on a smaller scale than Mr. Galton's, the operations of the laboratory have been most useful in diffusing a knowledge of the value of anthropometric work, and of the methods by which it is carried on.

For many years an "Anthropometric" Committee of the Association, in which the late Dr. W. Farr, Mr. F. Galton, Mr. C. Roberts, Dr. Beddoe, Sir Rawson Rawson, and others, took an active part, was engaged in collecting statistical information relating to the physical characters, including stature, weight, chest-girth, colour of eyes and hair, strength of arms, &c., of the inhabitants of the British Isles; and their reports, illustrated by maps and diagrams, were published in the annual volume issued by the Association. This Committee terminated its labours in 1883, although, as was fully acknowledged in the concluding report, the subject was by no means completely exhausted.

A great and important work which the Association has now in hand, in some sense a continuation of that of the Anthropometric Committee, though with a more extended scope of operation, is the organisation of a complete ethnographical survey of the United Kingdom based upon scientific principles. In this work the Association has the co-operation of the Society of Antiquaries of London, the Folk-lore Society, the Dialect Society, and the Anthropological Institute. Representatives of these different bodies have been formed into a committee, of which Mr. E. W. Brabrook is now chairman. It is proposed to record in a systematic and uniform character for certain typical villages and the neighbouring districts (1) the physical types of the inhabitants, (2) their current traditions and beliefs, (3) peculiarities of dialect, (4) monumental and other remains of ancient culture, and (5) historical evidence as to continuity of race. The numerous corresponding societies of the Association scattered over various parts of the country have been invited to co-operate, and the greater number of them have cordially responded, and special local committees have been formed in many places to carry out the work.

The result of a preliminary inquiry as to the places in the United Kingdom which appeared especially to deserve ethnographic study, mainly on account of the stationary nature of the population for many generations back, was given in the first Report of the Committee presented at the Nottingham meeting of the Association last year, in which it was shown that in the British Isles there are more than 250 places which, in the opinion of competent authorities, would be suitable for ethnographic survey, and in which, notwithstanding the rapid changes which have taken place during the last fifty years in all parts of the country, much valuable material remains for the committee to work upon. Without doubt, as interest in the subject is aroused, this number will be greatly increased.

A most important step in securing the essential condition that the information obtained should be of the nature really required for the purpose, and that the records of different observers should be as far as possible of equal value and comparable one with another, has been the compilation of a very elaborate and carefully prepared schedule of questions and directions for distribution among those who have signified their willingness to assist, and as a guarantee that the answers obtained to the questions in the schedules will be utilised to the fullest extent, certain members of the committee specially qualified for each branch of the work have undertaken to examine and digest the reports when received.

It may be remarked in passing that the Anthropological Society of Paris has within the past year formed a Commission of its members to collect in a systematic manner the scattered data which, when united and digested, shall form "une anthropologie véritablement nationale de la France," and has issued a circular with schedules of the required observations. These are, however, at present limited to the physical characters of the population.

Among the many services rendered to the science of Anthropology by the British Association, not the least has been the aid it has afforded in the publication of that most useful little manual entitled "Notes and Queries on Anthropology," of which the first edition was brought out exactly twenty years ago (1874), under the supervision and partly at the expense of General Pitt-Rivers. Since that time the subject has made such great advances that a second edition, brought up to the requirements of the present time, was urgently called for. A Committee of the British Association, appointed to consider and report upon the best means of doing this, recommended that the work should be placed in the hands of the Anthropological Institute of Great Britain and Ireland. This recommendation was approved by the Association, and grants amounting to £70 were made to assist in defraying the cost of publication. The council of the Anthropological Institute appointed a committee of its members to undertake the revision of the different subjects, with Dr. J. G. Garson and Mr. C. H. Read as editors respectively of the two parts into which it is divided. The work was published at the end of the year 1892, and is invaluable to the traveller or investigator in pointing out the most important subjects of inquiry, and in directing the observations he may have the means of making into a methodical and systematic channel.

Besides those I have already mentioned, the Association has aided many other anthropological investigations by the appointment of committees to carry them out, and in some cases by the more substantial methods of giving grants from its funds, and by defraying the cost of publication of the results in its Journal. Among these I may specially mention the series of very valuable reports upon the physical characters, languages, and intellectual and social condition of the north-western tribes of the Dominion of Canada, drawn up by Mr. Horatio Hale, Dr. F. Boas, and others, the importance of which has been recognised by the Canadian Government in the form of a grant in aid of the expenses.

Another very interesting investigation into the habits, customs, physical characteristics, and religion of the natives of Northern India, initiated by Mr. H. H. Risley, and carried on under his supervision by the Indian Government, though it has received little more than moral support from the Association, may be mentioned here on account of the illustration it affords of the value of exact anthropometric methods in distinguishing groups of men. Although a practised eye can frequently tell at a glance the tribe or caste of a man brought before it for the first time, the special characters upon which the opinion is based have only lately been reduced to any definite and easily comparable method of description. In Mr. Risley's examination, the nose, for instance (which I have always held to be one of the most important of features for classificatory purposes), instead of being vaguely described as broad or narrow, is accurately measured, and the proportion of the greatest width to the length (from above downwards), or the "nasal index," as it is termed (though it must not be confounded with the nasal index as defined by Broca upon the skull), gives a figure by which the main elements of the composition of this feature in any individual may be accurately described. The average of mean nasal indices of a large number of individuals of any race, tribe, or caste offer means of comparison which bring out most interesting results. By this character alone the Dravidian tribes of India are easily separated from the Aryan. "Even more striking is the curiously close correspondence between the gradations of racial type indicated by the nasal index and certain of the social data ascertained by independent inquiry. If we take a series of castes in Bengal, Behar, or the North-Western Provinces, and arrange them in the order of the average nasal index, so that the caste with the finest nose shall be at the top, and that with the coarsest at the bottom of the list, it will be found that this order substantially corresponds with the accepted order of social precedence. The casteless tribes—Kols, Korwas, Mundas, and the like—who have not yet entered the Brahmanical system, occupy the lowest place in both series. Then come the vermin-eating Musuhars and the leather-dressing Chamárs. The fisher castes of Bauri, Bind, and Kewat are a trifle higher in the scale; the pastoral Goala, the cultivating Kurmi, and a group of cognate castes—from whose hands a Brahman may take water—follow in due order; and from them we pass to the trading Khatris, the landholding Bábhans, and the upper crust of Hindu society. Thus, it is scarcely a paradox to lay down as a law of the caste organisation in Eastern India that a man's social status varies in inverse ratio to the width of his nose." The results already obtained by this method of observation have been so important and interesting that it is greatly to be hoped that the inquiry may be extended throughout the remainder of our Indian Empire.

But for want of time I might here refer to the valuable work done in relation to the natives of the Andaman Islands, a race in many respects of most exceptional interest, first by Mr. E. H. Man, and more recently by Mr. M. V. Portman, and for the same reason can scarcely glance at the great progress that is being made in anthropological research in other countries than our own. The numerous workers on this subject in the United States of America are, with great assistance from the Government, very properly devoting themselves to exploring, collecting, and publishing, in a systematic and exhaustive manner, every fact that can still be discovered relating to the history, language, and characters of the aboriginal population of their own land. They have in this a clear duty set before them, and they are doing it in splendid style. I wish we could say that the same has been done with all the native populations in various parts of the world which have been, to use a current phrase, "disestablished and disendowed" by our own countrymen. We are, however, now, as I have shown, not altogether unmindful of what is our duty to posterity in this respect; a duty, perhaps, more urgent than that of any other branch of scientific investigation, as it will not wait. It must be done, if ever, before the rapid spread of civilised man all over the world, one of the most remarkable characteristics of the age in which we live, has obliterated what still remains of the original customs, arts, and beliefs of primitive races; if, indeed it has not succeeded—as it too often does—in obliterating the races themselves.

NOTES.

THE death is announced of Prof. Rudolph Weber, Berlin, at the age of sixty-five, and of Prof. M. P. J. Rollet, of Lyons Observatory, a correspondent in the Médecine et Chirurgie Section of the Paris Academy of Sciences.

THE University of Halle, on the occasion of the recent bi-centenary celebrations, conferred the honorary degree of Ph.D. upon Prof. Victor Horsley, F.R.S.; Mr. F. G. Kenyon and Mr. H. L. D. Ward, both of the British Museum; Mr. G. A. Grierson, and Prof. W. W. Skeat.

A REUTER telegram reports that Mr. Aagaard, the United States Consular Agent at Tromsö, has despatched Captain Bottolfsen on board the fast-sailing cutter *Malygen* to Spitzbergen with a supply of provisions and clothing for the Wellman Expedition, for which the *Malygen* will search, and which, if possible, it will take back to Tromsö.

THE President of the Photographic Society of Great Britain has received a communication from the Secretary of State to the effect that the Queen has given her consent to the proposal to call the Society "The Royal Photographic Society of Great Britain."

HERR OTTO LILLENTHAL, whose aërial excursions were described in these columns a short time ago, recently met with a serious accident. The wings of his flying machine collapsed while he was at an altitude of about two hundred feet, causing him to fall to the ground. His fall was broken to some extent, but he was badly injured.

AN earthquake disturbance is reported to have occurred at Aci Reale, Sicily, shortly before six o'clock on the morning of August 8. Great damage was done at Zafarana, where six persons were killed and several injured. Both there and at Aci San Antonio, nearly all the houses have fallen in. Slight shocks were felt in Catania and several other communes in the neighbourhood of Mount Etna, but no damage was done.

THE *Times* correspondent at Calcutta, writing on August 12, reports that the Gohna Lake rose 24 ft. 6 in. last week, and is now within 57 ft. of the top of the dam. Its full length is now 4½ miles, the average width being half a mile. The greatest depth is 720 ft. The percolation is very heavy. This, combined with heavy rain, has washed away a large portion of the lower part of the dam, leaving an almost perpendicular drop of 400 ft. The section thus displayed shows a layer of boulders on the top, below which is pulverised rock. The lake is expected to overflow within fifteen days.

WE learn that the arrangements have now been completed for the fourteenth congress and exhibition of the Sanitary Institute, to be held in Liverpool near the end of next month. On Monday, September 24, the Lord Mayor of Liverpool will receive members at the Town-hall, and the President, Sir F. S. Powell, M.P., will deliver the inaugural address in the large theatre of University College; while in the evening the Lord Mayor will formally open the exhibition. Next day there will be conferences in University College on a variety of subjects. In the conference on "Domestic Hygiene," the Lady Mayoress will preside, and the ladies will afterwards hold a reception. At night Dr. G. B. Longstaff lectures at University College. On September 26, Section I., "Sanitary Science and Preventive Medicine," meet under the presidency of Dr. Klein, in the college, and the discussion will be continued next day. The Lord Mayor gives a reception in the Walker Art Gallery on Wednesday evening. Section II., "Engineering and Architecture," meets on Thursday, and the discussions will be continued on the following day, when also Section III., "Chemistry, Meteorology, and Geology," meet under the presidency of Dr. T. Stevenson. The closing general meeting of the congress takes place in the college on Friday evening, September 28, and later, Sir James Crichton Browne will address the working classes in the Picton Lecture-hall. The exhibition will remain open three weeks.

THE tenth meeting of the International Congress of Americanists was held at Stockholm, August 3-8, and was attended by the President, Dr. Rudolph Virchow, Baron Nordenskiöld, Mrs. Zelia Nuttall (of Dresden), M. Charnay, and Dr. Robert Munro, among others. Prof. Gustav Retzius, M. E. W. Dahlgren, and M. O. Montelius were some of the members of an influential executive committee, of which M. Carl Bovallius acted as general secretary. H.M. the King of Sweden, with S.A. the Crown Prince, attended the morning sitting on August 6, and heard the following communications read:—"Recent Finds from South American Tombs," by Dr. R. Virchow; "The Cliff Dwellers," by M. Charnay; and "Remarks on the Calendar System of the Ancient Mexicans," by Mrs. Zelia Nuttall. This lady paid a graceful tribute to the memory of that ardent "Americanist," the late Mrs. Hemmenway, of Boston, whose death was a sad loss to the cause of American archæology, and gave a summary in French of the chief results of her own investigations on the calendar system of the ancient Mexicans. Her paper on this subject was printed in English for distribution among the members of the Congress. The same evening the King gave a *fête* to the members of the Congress at the Palace of Drottningholm, and proposed the toast of "The Americanist Congress" at supper, to which Dr. Virchow suitably replied.

THE letter on a recent change in the character of April, which appeared in our issue of July 12, has led Dr. O. Z. Bianco to examine the meteorological statistics of Turin for evidence of a similar variation. By tabulating the values of the mean temperature in April at that place since 1865, and smoothing them in averages of five, he finds that, in the thirty years considered, the lowest average temperature occurred in 1889 at Turin as well as at Greenwich. The temperature appears to have gradually fallen to this minimum since 1865, and is now rising. If the results of observations are represented diagrammatically, a figure is obtained which agrees very closely with that accompanying the letter to which we have referred. Taking simply the monthly mean temperature in different years, the lowest values belong to 1879 and 1891, and are 10°·1 C. and 10°·2 C. respectively. For Greenwich the corresponding point was a temperature of 43°·5 F. (6°·4 C.) in 1879 and 1888. In the latter year the mean temperature of April in Turin was 10°·8 C., which is nearly a degree below the normal value. Further inquiry may perhaps lead to an explanation of the change to which attention has been directed.

WE have received the first four numbers of a series of Electrical Engineering Leaflets by Prof. E. J. Houston and Mr. A. E. Kennelly, which are being issued in weekly parts. These leaflets are divided into three grades: elementary, which is suited for the use of electrical artisans, wiremen, and elementary students; intermediate, suited to students in technical schools; and advanced, suited to students taking a course in electrical engineering. Although, to judge from the four first numbers, these leaflets will be hardly suitable to form by themselves a complete text-book in this subject, since the points treated are of too wide a scope to admit of sufficient detail and explanation being given in the moderate size of the work (some 300 pages small octavo) to ensure a student, without some other source of information, being able to grasp the subject. They will, however, be found very useful as a book of reference, and for revising and keeping fresh information which has already been acquired, forming as they do a compact and clearly expressed synopsis of the subject. Another useful feature in the numbers under consideration are tables of physical quantities, such as the electromotive force of different cells, specific resistance of solids and liquids, the temperature coefficient being in most cases given as well as the temperature at which the value of the resistance given is measured, together with the observer's name. An elaborate scheme of prefixes used to denote multiples and submultiples of the different units is given, which, as long as the scheme is printed on the opposite page to the table in which these prefixes are used, saves a good deal of space, but will probably cause a great deal of unnecessary confusion if they are used in other parts of the work, unless the value is in every case also given in the index notation.

IN a short communication, made to the French Academy of Science, M. Moureaux says that on examining the magnetograph records of the Parc Saint-Maur Observatory for the night of July 11-12, he finds a disturbance which corresponds in time with the earthquake shock that caused so much destruction at Constantinople. As M. Moureaux has taken the precaution to have non-magnetic copper bars suspended alongside the magnetograph needles, and the records from these bars show no disturbance, it is evident that the effects observed were due to magnetic causes, and not to a mechanical shock. As the magnetic disturbance occurred sixteen minutes before the time at which the earthquake shock was felt at Constantinople, and since the two places are separated by a distance of 3000 kilometres, it would appear that the disturbance travelled at the rate of only three kilometres per second. This is certainly a very slow rate of propagation, and it would be of great interest if the observers at other observatories where a permanent magnetic record is kept, were to examine their curves, and see whether they show a similar disturbance, and if so, if the rate of propagation is about the same as the above. If the values obtained vary much, it is probable that the disturbance noted by M. Moureaux was of solar rather than of terrestrial origin, or at any rate was not connected with the earthquake at Constantinople.

ANYTHING respecting Corea is of special interest at the present time, and the short article on the "Cultivation of Cotton" in that little-known country, which a recent number of the *Journal of the Society of Arts* contains, is certain to have many readers. According to this article, which is based upon a report of the Commissioner of Corean Customs at Fusan, the total area under the cultivation of cotton in Corea is roughly computed to be 872,000 acres, the yield of seed cotton from which per annum is put at 1,200,000,000 lbs. The yearly consumption of "cleaned" or raw cotton is estimated at 300,000,000 lbs. The Corean fibre is reported to be superior to that produced in Japan. The method of cultivation is as follows:—The ground is usually ploughed up during the early winter, and allowed to remain in this condition until the frost is well out of it, when it is broken up with a hoe, and manure, mixed with wood ashes, spread over it. The fields are now ready for the reception of the seed, which is generally sown about April to May. The seed, of which there is but one kind, is not placed in drills, as is done in Japan, but is sown broadcast, and then trodden in and covered up with the feet, sesamum seed being very often sown in the same field with it. The young shoot shows above ground about the tenth day, and at maturity attains a height of from 2 feet to 2½ feet. The plant blossoms in August, and on an average bears forty pods, each containing four cells, as a rule within a double capsule. The gathering of the crop, which begins about October, continues until frosts sets in, some time in November. No attention is paid or skill displayed in the cultivation once the seed is in the ground; everything is then left to nature. No further manure is added, nor are they ever thinned out or given water in times of drought. The crops are principally gathered by women, who also are largely employed afterwards in separating the seed.

DURING the last few years, alloys of tin and lead have been employed in manufactures in which the constancy of melting points after successive meltings played an important part. Rudberg, one of the earliest workers in this field, noticed that the thermometer stopped at two points during the solidification of these alloys; the higher point varied with their composition, while the lower was constant, being about 187°, and was identical with the melting point of the "chemical alloy" represented by the formula $PbSn_3$. In the current number of *Wiedemann's Annalen*, Bernhard Wiesengrund gives the results of a complete series of experiments with tin-lead alloys ranging from $PbSn_{12}$ to $Pb_{12}Sn$. They were melted in a crucible of sheet iron covered with a lid provided with two brass tubes to admit and withdraw dry hydrogen during heating. An iron tube closed at the bottom was attached to the lid. It dipped into the alloy, and served to contain the thermometer, the bulb of which was surrounded by mercury. The thermometer was graduated from 0° to 360° C., and contained nitrogen above the mercury column. The crucible was surrounded by a sheet-iron water-jacket kept at 150° C., and the heating was done by means of a triple Bunsen burner. As regards the densities of the alloys, it was found that they were all lighter than might have been expected from the densities of their constituents. This increase of volume was greatest in the case of the "chemical alloy" $PbSn_3$, and decreased as one or the other constituent preponderated. The process of solidification showed Rudberg's two points distinctly. The higher one, called the melting point, was really a point at which the cooling became somewhat less rapid. The lower, called the point of solidification, was a truly stationary point, except in the alloys containing much lead. The most regular curve of cooling is shown by the alloy $PbSn_3$. At about 178° there is a dead stop lasting for seven minutes, not preceded by a perceptible stop at the melting point. The latter becomes more pronounced as the percentage of tin increases, and appears as a point of inflexion in the alloy $PbSn_{12}$. As the lead is increased, the melting point rises, the point of solidification falls slightly and becomes less pronounced, and all breaks in the curve of cooling tend to disappear. The author gives a plausible explanation of the phenomena analogous to the theory of saline solutions, tin being regarded as the solvent. After twenty-four successive remeltings a mechanical rearrangement was observed, producing a slight elevation of the fusing point and an approximation of the point of solidification to that of the "chemical alloy." This was due to the excess of the heavy lead, or the light tin gradually separating out from the alloy $PbSn_3$.

THE *Transactions and Proceedings* of the New Zealand Institute (vol. xxvi.), containing papers read before the Institute during 1893, has been published, and is obtainable from Messrs. Trubner and Co.

THE *Quarterly Journal* of the Geological Society (No. 199, August) has been issued. It contains five plates, illustrating papers by Mr. A. Harker, Mr. W. W. Watts, Mr. Frank Rutley, and Sir J. W. Dawson and Dr. W. Hind.

THE August number of the *Journal* of the Royal Microscopical Society is almost entirely taken up with summaries of current researches. The only two papers are by Mr. F. Chapman and Mr. T. Comber, the former dealing with the foraminifera of the gault of Folkestone, and the latter with the characters generally accepted for specific diagnosis in the Diatomaceæ.

THE Romanes Lecture on "The Effect of External Influences upon Development," delivered by Prof. Weismann, at Oxford, last May, and reported in these columns (vol. l. p. 31) has been published in English by the Clarendon Press. The translation has been done by Mr. Gregg Wilson. In the preface, Prof. Weismann adds his tribute to the many that have been paid to the memory of the late Dr. Romanes.

MESSRS. J. AND A. CHURCHILL will shortly publish a new edition of Dr. F. Kohlrausch's indispensable handbook to practical physics—"An Introduction to Physical Measurements." The edition has been translated from the seventh German edition, published in 1892, and it contains nearly four times the number of pages that the first one did in 1869. Mr. T. H. Waller and Mr. H. R. Procter are the translators.

GLACIAL action in Australasia has much attention devoted to it in the *Proceedings* of the Royal Society of Tasmania for 1893. Mr. R. M. Johnston contributes an elaborate review of the evidences of former glaciation in Australasia, with critical observations upon the principal hypotheses which have been advanced to account for glacial epochs generally, and there are several papers on the discovery of glacial action in Tasmania.

IN the current number of *Mind*, Mr. Francis Galton contributes an article on "Discontinuity in Evolution," which should be read by all who are interested in modern biological theory. It owes its origin to the publication of Mr. Bateson's recent work, and contains a summary of the views on discontinuous or "transilent" variation and on "organic stability," which Mr. Galton has published in "Natural Inheritance," in "Finger Prints," and in the preface to a reprint of "Hereditary Genius." The data on which these views are based lie somewhat off the beaten track of biological inquiry, and Mr. Galton's conclusions have not received the consideration due to results based on careful and prolonged observation.

THE Royal Meteorological Institute of the Netherlands has published a new edition of "The Tides on the Dutch Coast," containing, among other useful information, the results of tidal observations made at several stations during recent years. The tables show that on the North Hinder Bank, for instance, the temperature of the air from September to February is lower than that of the sea surface; but from March to August it is higher, and that the prevalence of thunderstorms increases with the latitude. Tide rips are most frequent in the month of April and during the first four days of full and new moon.

THE Meteorological Council have recently issued a second edition of a Barometer Manual for the use of seamen, in which many alterations and improvements have been made. The work contains carefully drawn charts showing the mean atmospheric pressure and prevailing winds for January and July, and also many valuable hints on the management of the barometer. The portions dealing with winds and storms, and especially with practical rules for seamen in tropical cyclones, are of especial value, and this small work of forty pages contains all the necessary information for the safe navigation of a vessel which may be in the vicinity of these storms.

WE have received the *Journal of the Anthropological Institute* for August, containing papers read at meetings of the Institute during the first quarter of this year. Among other papers, we notice one on flint implements of a primitive type from old (pre-glacial) hill-gravels in Berkshire, by Mr. P. A. Shrubsole, and a note on the poisoned arrows of the Akas, by Prof. L. A. Waddell. The Akas are one of the Lohitic tribes of the Asam Valley, occupying independent territory to the north of the Brahmaputra. They poison their arrows for use in warfare, the poison being derived, as has been found in other cases, from the roots of a species of *Aconitum*. A translation of the second part of "Shamanstoo," being Prof. Mikhailovskii's important account of Shamanism in Siberia and European Russia, is contributed by Mr. O. Wardrop.

A THIRD edition, enlarged and partly rewritten, of "Select Methods in Chemical Analysis," by Prof. W. Crookes, F.R.S., has been published by Messrs. Longmans, Green, and Co. During the eight years which elapsed between the publication of the second edition and the preparation of this, various new processes have been introduced, and old ones have either been displaced, or become so well known in ordinary laboratories that their retention in a "select" work, like that of Prof. Crookes', is unnecessary. For it will be remembered that the work is "not intended to provide the student with a complete text-book of analysis, but rather with a laboratory companion, containing information not usually found in ordinary works on analysis." In the present edition, volumetric operations have been almost entirely omitted, and also processes of technical importance. These omissions have made room for the addition of a series of electrical separations, and other processes from Dr. Classen's "Quantitative Chemical Analysis by Electrolysis." As Prof. Crookes only includes in the volume such methods as have been proved in his own laboratory, their practicability is assured. A disadvantage of this eclectic method, however, is that good methods of analysis are passed over because they do not happen to have been personally tested by the author.

THE additions to the Zoological Society's Gardens during the past week include a Black Ape (*Cynopithecus niger*, ♂) from the Celebes, presented by Mr. Gambier Bolton; a Slender Loris (*Loris gracilis*) from Ceylon, presented by Mr. Thos. E. Remington; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Captain Philip Langdale; four Alpine Newts (*Triton alpestris*), European, presented by Mr. Malcolm O. Smith; four Land Crabs from Jamaica, presented by Mr. Percy Walter Jarvis; a Black-backed Jackal (*Canis mesomelas*) from South Africa, deposited; a Weka Rail (*Ocydromus australis*) from New Zealand, purchased; a Cayenne Lapwing (*Vanellus cayennensis*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

RECENT OBSERVATIONS OF MARS.—Mars now rises shortly after nine p.m., and is on the meridian between four and five o'clock in the morning. He will be in opposition on October 20. Two important papers, containing the results of recent observations of the planet, are contributed to the August number of *Astronomy and Astro-Physics*. Mr. Percival Lowell, whose observatory was described in these columns on June 14, began to observe the planet at the end of May, and the observations recorded in his article were made between then and June 24. The clearness of the atmosphere at Flagstaff, Arizona, where the observatory is situated, is responsible for the early date at which it was possible to scrutinise the face of the earth's ruddy brother. And the success with which his features were made out may be judged from the fact that Mr. Lowell recognised a dozen of Schiaparelli's canals two and a half months before the summer solstice of the planet's southern hemisphere. At the beginning of the period of observation, the southern snow-cap was found to have a diameter of about forty-seven degrees; that is, it covered nearly the whole frigid zone. On June 19, the cap measured thirty-nine degrees. Throughout all the period, the outer edge appeared to be perfectly elliptical, indicating that the boundary line of the cap was really a circle. The snow was continuously bordered by a dark streak of nearly uniform width. Mr. Lowell thinks that this belt was water at the edge of the melting snow; in fact, a polar sea. His view finds support in the observation that the streak was widest where the dark markings on the planet's face—the markings intrepreted as seas—were greatest in extent. Several brilliant star-like points flashed out upon the snow-cap at different times and disappeared after being conspicuously visible for a few minutes. The imaginative mind may think that these flash lights represent signals from the Martians, but a more probable explanation is that they are produced by snow slopes being illuminated in such a manner that the sunlight after glancing across them is reflected at a particular angle to the Earth. The great rift in the snow-cap was observed and found to be about twelve hundred miles long, and rather more than two hundred miles wide. Mr. Lowell did not see any irregularities upon the terminator of Mars, so he concludes that there are few, if any, great mountains on the planet. The first canal, thought to be Cerberus, was observed on June 7, and two days later it was seen double for an instant. Other canals were glimpsed from time to time, and some were seen well enough to be sketched. Prof. W. H. Pickering has also observed Mars at the Lowell Observatory. He remarks: "What appears to me to be the most important conclusion deducible from our work is that Mars does not always present the same appearance at the corresponding time upon two successive Arean years. This remark does not apply merely to small details, but to large and prominent features. Moreover, this difference does not seem to be due simply to the fact that one season is a few weeks later than the other, but that the phenomena presented upon the two years are really different." Prof. Pickering has noticed slight notches in the terminator, but he thinks these are produced by variations in the inclination of the surface of the planet rather than by differences of level.

THE ROTATION OF THE TERRESTRIAL POLES.—Dr. S. C. Chandler has lately been investigating the question whether either component of the polar rotation deviates from a uniform circular motion (*Astr. Jour.* No. 323, July 27). The discussion furnishes clear proof that the figure described by the pole of rotation and pole of figure approximates to an ellipse with a major axis of about 0''·55 and a minor axis of about 0''·30. Dr. Chandler refers this departure from circular, or rather epicyclical motion, to the annual term alone. A computation based upon this assumption shows that the figure is "a very eccentric ellipse with a major axis of 0''·32, lying in the line 53°–233°, and a minor axis of about 0''·10; the period being manifestly about a year, and the motion being from west to east. The angular velocity seems to stand in some inverse relation to the radius."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 6.—M. Lœwy in the chair.—On the variations of *Spirifer Verneuli*, by M. Gosselet.—New anthropological and palæontological researches in the Dordogne. Abstract of a memoir by M. Émile Rivière. Certain details are given concerning palæolithic remains from the "Grottes des Combarelles," the "Grotte Rey," the "Grotte de Cro Magnon," and the "Grotte de la Fontaine," including bones from a numerous fauna and carved and sculptured fragments. Neolithic remains from Pageyral, Sireuil, and Pagenal will be described in a future communication.—The Secretary announced the deaths of the following correspondents: M. A. Hannover, July 7; M. Rollit, August 2.—On groups of substitutions isomorphous with symmetrical or alternate groups, by M. Maillet.—On the zeros of certain discontinuous functions. Principle of the method for finding the zeros of certain functions, by M. Desaint.—On the equations of dynamics, by M. R. Liouville. A claim for priority in reference to the subject matter of two notes by M. W. Vladimir de Tannenberg, of dates July 30 and May 25 respectively.—On carbonic hydrate and the composition of hydrates of gases, by M. P. Villard. The author determines the composition of a hydrate of carbon dioxide formed by himself to be $CO_2.6H_2O$, and calls attention to the remarkable resemblance between this substance and the hydrate of nitrogen monoxide $N_2O.6H_2O$. They have apparently the same crystalline form, the same heat of formation, and are both optically inactive. The hypothesis is made that hydrates of gases should, in general, have a composition expressed by the formula $M.6H_2O$. This assumption is supported by the formulæ found by the author for the similar compounds of sulphur dioxide and methyl chloride. The hydracids are excepted from the rule. Doubt is thrown upon the formula $Cl_2.8H_2O$ for chlorine hydrate.—Basic salts of calcium, by M. Tassilly. The best method of preparation and thermal data concerning calcium oxybromide and calcium oxyiodide are given. These substances have an exactly similar composition to that of André's oxychloride, $CaCl_2.3CaO.16H_2O$. They have the same heat of solution and a heat of formation increasing with increasing atomic weight of the halogen present.—On the use of selected ferments, by M. Charles Fabre. The following conclusions are given—(1) The selected ferment cannot be employed with *any* must for the production of high-class wines. (2) The must in which the ferment is sown should have been obtained from grapes belonging to or vines long acclimatised in the region from which the selected ferment has been obtained.—Peripheric applications of alkaloids in the treatment of acute maladies with cutaneous determination, by MM. L. Guinard and Gustave Geley. The external application of sparteine in cases where the skin is the active seat of disease has been found to give remarkable curative results, more particularly in cases of erysipelas.—On coprolitic bacteria of the Permian age, by MM. B. Renault and C. Eg. Bertrand. *Bacillus permiensis*, occurring in coprolites from the Permian at Autun, consists of rectilinear bacillus elements, isolated or in pairs, and having the dimensions 14 to 16μ by 2·5 to 3·3μ by 0·4μ. It sometimes occurs curved or twisted in spirals or chains.—On the nature of the great crevasse caused by the last earthquake at Locrides, by M. Socrate A. Papavasilion.—On the existence of *lentilles récifales* with Ammonites in the *Barrêmien* near Châtillon-en-Diois, by MM. G. Sayn and P. Lory.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Aborigines of Western Australia: A. F. Calvert (Simpkin).—Theoretical Mechanics—Fluids: J. E. Taylor (Longmans).—A Treatise on Astronomical Spectroscopy: Prof. Dr. J. Scheiner, translated, &c., by E. B. Frost (Ginn).—Controversen in der Ethnologie, IV., Fragestellungen der Finalursachen: A. Bastian (Berlin, Weidmann).—Coal Dust an Explosive Agent: D. M. D. Stuart (Spon).—Geological Guide-Book for an Excursion to the Rocky Mountains: S. F. Emmons (K. Paul).—British Rainfall, 1893: G. J. Symons and H. S. Wallis (Stanford).—Systema Naturæ; Regnum Animale, editio decima 1758: C. Linnæi (Leipzig, Engelmann).—Le Centre de l'Afrique, Autour du Tchad: P. Brunache (Paris, Alcan).—Memoirs of the International Congress of Anthropology: edited by C. S. Wake (K. Paul).—The Water Supply of Towns and the Construction of Waterworks: Prof. W. K. Burton (Lockwood).

PAMPHLETS.—Supplement to 41st Report of the Department of Science and Art (Eyre and Spottiswoode).—Representation and Suffrage in Massachusetts, 1620-1691: Dr. G. H. Haynes (Baltimore).

SERIALS.—School Review, June (Hamilton, New York).—Proceedings of the Royal Physical Society, Session 1892-93 (Edinburgh).—American Journal of Science, August (New Haven).—Papers and Proceedings of the Royal Society of Tasmania for 1893 (Hobart).—Zeitschrift für Physikalische Chemie, xiv. Band, 4 Heft (Leipzig, Engelmann).—Engineering Magazine, August (Tucker).—Notes from the Leyden Museum, January to April (Leyden, Brill).—Astronomy and Astro-Physics, August (Wesley).—Journal of the Royal Microscopical Society, August (Williams and Norgate).—Sechzehnter Jahres-Bericht über die Thätigkeit der Deutschen Seewarte für das Jahr 1893. Beiheft i. (Hamburg).

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THURSDAY, AUGUST 23, 1894.

THE PHYSIOLOGY OF THE CARBOHYDRATES.

The Physiology of the Carbohydrates: their Application as Food, and Relation to Diabetes. By F. W. Pavy, M.D., F.R.S. (London: Churchill, 1894.)

AMONG the most debated subjects of physiology the ultimate fate of carbohydrates within the body stands out as one of the greatest difficulty. A great amount of work has been expended on it, but still many points of vital importance remain undecided. We accordingly hail with pleasure a work containing the results and conclusions of one whose name is indissolubly associated with the subject, as the author of one of the two rival theories around which much of the work of the last thirty years has centred. The book before us contains a revised description of the many researches of the author upon this subject, with a criticism of his earlier results by the light of his later work, and the greatly increased knowledge of the chemistry of the carbohydrates which is now available. Embodying as it does the results of a "life's labour, attended with unceasing laboratory work," we turn to it with more than ordinary interest.

The book is arranged in sections, in the first of which the author gives us a short account of the main chemical characters of the principal carbohydrates, and special stress is laid upon the production of osazones as enabling us to distinguish the different sugars from one another. This is followed by an account of the hydrations produced by ferment action and the changes known to occur through the agency of protoplasm. Succeeding sections deal almost entirely with Dr. Pavy's researches, arranged not in the order in which they appeared, but in such a manner as to gradually unfold the author's argument.

Thus we find described the experiments upon which he concludes that many proteids have the constitution of glucosides. Next the path of absorbed sugar is traced to the liver, and his experiments proving its conversion into glycogen are given. Many experiments upon the amounts of sugar present in arterial and venous blood, in blood from the portal and hepatic veins, and in the liver and other tissues, are given, as well as quantitative results of the amount of glycogen and other carbohydrates present in these positions. The sugar in urine is next discussed, and here he brings evidence to prove that normal urine contains sugar.

Dr. Pavy for his quantitative results relies almost entirely upon the ammoniated cupric solution, and contends that the results obtained by its careful use are thoroughly trustworthy. Where he gives duplicate estimations, however, we note that there are often considerable differences in the two values obtained. Thus, his figures give a further confirmation of the difficulty, if not impossibility, of obtaining very accurate results as to the quantity of sugar present in a solution, by means of a standard copper solution. It is of essential importance to keep this constantly in mind in those cases, such as determination of the quantity of sugar in blood from portal and hepatic veins, or from carotid artery and jugular vein, in which the results, which we know must be very close to one another, are to be compared. For this reason especially we do not consider that Dr. Pavy has satisfactorily established his position, though it is a most important one for his further conclusions.

His experiments upon the glucoside constitution of proteids are very suggestive and important, but before they could be conclusive it would be necessary to pay much greater attention to the proper purification both of the proteid with which he starts and the "cleavage carbohydrate" which he obtains, and to give quantitative analyses of this latter body. For instance, in the case of egg albumin, which is one of the bodies he uses, we know that it contains a considerable amount of glycogen, and that it is extremely difficult to completely free the proteid from it. But as this latter point does not seem to have been thoroughly attended to in these experiments, we must await further corroboration.

There are many other points about which we expect much discussion may arise, and among these we may mention his conclusions—firstly, that sugar is present in urine; and secondly, that it is present in proportion to the amount present in the blood. In connection with the first of these two points we would refer to the recently published paper of Carl Baisch,[1] who uses the benzoyl chloride method, which is certainly to be regarded as capable of producing more accurate results than the use of the copper test. He, in confirmation of Dr. Pavy, finds that a reducing carbohydrate is present, and he further shows that dextrose is present to the extent of ·04 to ·09 per 1000 of urine. total-reducing carbohydrates amounting to as much as ·06 to ·16 per 1000. Dr. Pavy, on the other hand, finds a much larger quantity, which, calculated as glucose, he states, amounts to as much as ·5 per 1000.

Now, if we compare the figures given on page 189 as to the amount of sugar present in urine as a consequence of an abnormal small excess in the blood, with the result he gives as present in normal urine, we cannot, from their study, at all agree that these amounts are proportional to that present in the blood. Still less would this conclusion be acceptable were we to take the above-quoted figures of Baisch.

Perhaps the conclusions upon which Dr. Pavy would lay by far the greatest amount of stress is that the major part of the sugar absorbed from the alimentary canal is immediately combined with the peptone simultaneously absorbed to form a proteid, which is then transmitted to the general circulation, and thus to the tissues generally. Dr. Pavy considers that this synthesis is in part effected by the epithelial cells covering the villi. Under one set of conditions, viz. defective oxidation, &c., this proteid may break down and result in the production of fat, or again under another set, *e.g.* excessive oxygenation of the blood associated with vaso-dilatation, a second form of katabolism is produced, characterised by the production of sugar, which is then eliminated in the urine. Before, however, we can accept these views it will be necessary that much of Dr. Pavy's work should be corroborated. It is of course known, that under the right conditions within the body, fat or sugar can be formed as a result of unusual proteid katabolism; but that proteid is usually syn-

[1] *Zeit. fur Physiol. Chemie*, xix. p. 357.

thesised in the simple manner suggested by Dr. Pavy, namely, by the direct combination of a glucose molecule or molecules with a peptone or some similar molecule, requires far more rigid proof than is here attempted.

We should have liked to have seen a greater amount of criticism of some of the many important researches which have been lately published by so many workers; but throughout the whole work, Dr. Pavy bestows but little space in criticising conflicting evidence, much of which remains completely unnoticed.

Though it is thus easy to criticise and point out where errors may have crept in, we can but thoroughly admire the energy and careful thought which are in evidence throughout the work. There is much in it that is suggestive, much that is most valuable. The experimental work which is here set forth so plentifully, forms a field which must be studied and consulted by all future workers in this direction.

PTOLEMY AS A PHILOSOPHER AND ASTROLOGER.

Studien uber Claudius Ptolemäus; ein Beitrag zur Geschichte der griechischen Philosophie und Astrologie. Von Franz Boll, Dr.Phil. (Leipzig: Druck und Verlag von B. G. Teubner, 1894.)

IT is somewhat strange that in the article on Ptolemy in the "Penny Cyclopædia," he is spoken of only as a geographer. His fame is undoubtedly built upon his two great works on astronomy and geography. But the present publication treats of him rather as a philosopher, and discusses also the genuineness or otherwise of the less-known works of the great Alexandrian. A few lines are devoted to his life, of which scarcely anything is known. Dr. Boll sees no reason for calling in question the statement of Theodorus Meliteniota, that he was born at Ptolemais Hermii, in Upper Egypt. He lived to his seventy-eighth year, and died in the reign of Marcus Aurelius, who became emperor in A.D. 161; but it is somewhat doubtful whether the last observation referred to in the "Almagest" was made in 141, or ten years later. At any rate, it is clear that that work preceded the description of the earth's surface (written, Sir E. Bunbury remarks, much more in the spirit of an astronomer than of a geographer), which remained during more than twelve centuries the paramount authority in geographical questions where physical matters were not concerned.

However, as we have said, the present treatise is not occupied with any consideration of these great works. Astronomical and geographical questions do not form its subject-matter, which is rather concerned with the comparatively untrodden ground of Ptolemy as a philosopher, besides a discussion of the genuineness of his writings on astrology in the present acceptation of the term. His work, *Περὶ κριτηρίου καὶ ἡγεμονικοῦ*, has been generally overlooked, the first apparently to refer to it being Heinze, in his edition of Ueberweg's "Grundriss der Geschichte der Philosophie von Thales bis auf die Gegenwart.' But besides this professed treatise, Ptolemy touches upon philosophical questions in several places in his other writings.

Dr. Boll's "Studien" is distributed into three principal sections. The first gives, in three chapters, a discussion of his author's views on questions of this nature, as they may be derived from passages in his undoubtedly genuine works. The second is devoted to a critical examination of the genuineness of the *Τετράβιβλος Σύνταξις*, which is astrological, and generally considered as unworthy of the writer. An inquiry into the source of the so-called astrological geography in the second book of that treatise forms the third section of the present "Studien" of Dr. Boll.

Our space in this brief notice enables us only to indicate the general conclusions arrived at under these three heads. A detailed discussion of the views propounded by Ptolemy on psychological and other philosophical questions shows that he must be classed as an eclectic, but with distinctly peripatetic principles. This appears in the "Harmonics" as well as in the work first mentioned. But in his teaching a number of stoical propositions is also to be found, and it is not in these only that Aristotelian ideas are rejected or set aside, for a tendency is manifested to accept some Platonic doctrines on psychology, whilst Pythagorean speculations on numbers form the foundation of the third book of the "Harmonics."

A very careful and elaborate comparison of expressions used in the *Τετράβιβλος*, and in the smaller work *Καρπός* (which is in fact a collection of aphorisms), with Ptolemy's great astronomical and geographical works, proves that the former is genuine, but the latter is not, being evidently the production of some astrologer of later date.

Dr. Boll's conclusion with regard to the *Τετράβιβλος* agrees with that of previous writers; thus the author of the article "Astrology" in the "Penny Cyclopædia" says: "Though its genuineness has been doubted by some merely because it is astrological, there appears no sufficient reason to reject it." We would gladly do so if we could; but the present examination seems to confirm the Ptolemean authorship but too fully. The admiring English translator in the last century (John Whalley, Professor of Physic and Astrology) affirms that "there is nothing in Astrology but what is there comprehended, nothing there comprehended, but the Quintessence and Divinity of Astrology."

The second book of this treatise gives a system of what Dr. Boll calls astrological ethnography, *i.e.* the stellar influence on different parts of the world and their inhabitants according to the signs of the zodiac which are especially supposed to rule over each. The sources of this, by a comparison with earlier writers, are discussed by Dr. Boll (led so to do by a small treatise published at Berlin by Paul Wendland in 1892) in the third section of his work, which shows great industry and research, it being difficult to disentangle the subject from that of the effects of climate on the human race, so that matters of this kind require very careful handling. We may take an instance of this from our own Shakespeare. When Prospero says his zenith doth depend upon a most auspicious star, the allusion to astrology is patent. But when the melancholy Jaques, in *As You Like It*, is made to describe human life as divided into seven stages, it is somewhat straining a point (Dr. Boll refers to Steevens as having anticipated him in this, but he means Malone) to assume that reference is intended to the notion that each age was dominated by one of the seven planets. However, he shows a close correspondence between many expressions in the Τετράβιβλος and in Roman writers under the empire, Manilius, Vitruvius, and Pliny.

The work concludes with an *excursus* on the date of the ἀστρολογούμενα of Petosiris and Nechepso, which had been referred to the first century before, but Dr. Boll gives reasons for placing in the first century after, the Christian era. W. T. L.

LETTERS TO THE EDITOR.

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

Platinum Resistance-Thermometers.

AT the meeting of the British Association, just coming to an end, it was pointed out to the Committee of Section A, by Mr. E. H. Griffiths, that the general adoption of the method of thermometry, founded on the variation of the electric resistance of platinum with temperature, that has been worked out by Prof. Callendar and himself, is seriously hindered by the existence of a report presented to the Belfast meeting of the Association in 1874 (British Association Report, 1874, pp. 242–249), by a Committee "appointed for the purpose of testing the new pyrometer of Mr. Siemens." As I was secretary of this Committee and drafted the report, and as all the experiments were made either by myself or under my direction, I was desired by the Committee of Section A to ask you to allow me to state in the columns of NATURE (what is indeed obvious to anyone who refers to the 1874 report) that the tests carried out by the Committee of 1874, and the conclusions arrived at by them, had reference solely to the pyrometers supplied to them for examination by Messrs. Siemens Brothers, and that they have consequently no bearing on the question of the trustworthiness or accuracy of the platinum resistance-thermometers of the kind devised by Messrs. Griffiths and Callendar.

August 15. G. CAREY FOSTER.

International Courtesy.

I LEARN from a speech of Prof. Ludwig Boltzmann, in Section A to-day, and also from some Englishmen well acquainted with German Universities, that I have unintentionally offended the physical philosophers of Germany by one or perhaps two ill-considered and hasty expressions employed in the first edition of my "Modern Views of Electricity."

These remarks do not occur in the second edition, but mere silent withdrawal of them does not convey the information that I desire to convey to my illustrious leaders and *confrères* in the foreign scientific world. I therefore request you to permit me space to make the following *amende*.

When I said that the four great names in connection with our partial knowledge of the nature of electricity were (excluding living persons) Franklin, Cavendish, Faraday, and Maxwell, I ought to have interpolated the adjective *British* before the word "names," in order to avoid entering upon much larger questions than were at all appropriate to the expository course of lectures on which the book "Modern Views" was based.

The second remark was this:—When emphasising the great achievements of Hertz, in my lecture at the Royal Institution on "The Discharge of a Leyden Jar" (reprinted as appendix to same book), I spoke of him as "no ordinary German." Literally of course it is true, but it may easily be interpreted in a discourteous sense. It was, however, less widely known then than it is now that Hertz was a German savant of the highest type, and this fact I wanted to express; but if the proverbial odiousness of implied comparisons had only happened to strike me, I would certainly have altered the mode of expression before any reprints of my lecture were made.

Prof. Boltzmann seems to think that the context to this remark indicates that some rancour was felt in this country that the fruits of Maxwell's theory should have been reaped by a German. That, if true, would be a serious accusation, but I can assure him that it is conspicuously untrue. To an Englishman my words would not even convey the impression. I honestly think that at the present era no trace of international jealousy exists among English and Irish physicists.

August 14. OLIVER J. LODGE.

A Remarkable Meteor.

WHILE at Pasadena, eight miles north-east of Los Angeles, California, on July 27, a few minutes before half-past seven, the writer had his attention suddenly drawn towards the north-western horizon by a bright flash of light as of the bursting of a meteor; but on keeping his gaze fixed on the point where this flash appeared, he was surprised still more to see that instead of disappearing, as usually happens with meteors when they explode, there remained a very luminous figure, somewhat of the shape of the new moon but with more wavy outlines, and of an intense whiteness, something as of an electric light, in well-defined relief against the pale golden glow of the sky. The whole time during which this luminosity was visible was something over twenty minutes, and it had ceased to be visible at eight minutes before eight. The crescent shape was not maintained more than about three minutes, then it took the appearance of a luminous vapour or cloud rising vertically for a little distance and then bending off sharply to the left in almost an horizontal line, but not showing any tendency to dissipate or grow thinner at the end farthest from the point of origin. As time went on, the whole figure became more wavy in outline, but persistently remained fixed in the same part of the sky. The bottom, the point of origin, was slightly brighter than the rest of the figure, and a little reddish in colour, and the underside of the arm outstretched to the left was brighter than the upper side. It was clearly beyond, and in no wise connected with, the Sierra San Gabriel, which cut the sky with a dark, well-defined lune under the luminous figure. All who were watching it perceived that it was no common cloud; the north-western sky was cloudless and free from haze, and no cloud in the west at such an hour can shine with this sort of light, which indeed had more the lustre of white flame.

The cloud seemed unbroken so long as it was visible at all. It would be idle to speculate beforehand on the exact locality of this outburst, since no accurate estimate of its distance could be formed at the time; but the direction, as nearly as the writer could judge by reference to the pole star, was about north 35° to 40° west, which, projected on a map of the State, gives about the direction of Tehachipi Peak from Pasadena.

The direction in which the meteor was seen to explode, as stated by other observers all the way from the Needles in the south-eastern part of the State to Lodi and Oakland in the central counties, that is to say, from points five hundred miles apart, enables one, by projecting those bearings which are reported in most detail, viz., Fresno, whence it seemed a little north of west; Keeler, whence it also seemed a little north of west and directly beyond Mount Whitney; Tracy, whence it seemed to be in the south-east; and Pasadena, whence it seemed, as above stated, to limit the spot over which it exploded to some point in the north-western part of Fresno county or the south-western part of Merced county, both being in the San Joaquin Valley, and 250 to 300 miles from Pasadena. With much greater diffidence the writer would estimate its angular height above the true horizon at not to exceed 3°.

Los Angeles, July 29. EDWARD WESSON.

[From newspaper cuttings sent with the foregoing it appears that the meteor was seen at the Lick Observatory at 7h. 35m., and that the explosion was heard at 7h. 36½m. At Benicia the meteor was extremely brilliant for a moment, and then disappeared in a column of white vapour about two degrees long. This cloud remained visible for a quarter of an hour. At Fresno and at Redlands the luminous stream was visible for twenty minutes. An observer at Tracy says that a loud report, resembling a clap of thunder, was heard in the south-east, five minutes after the meteor disappeared. According to the news from Fresno, the meteor left a track of great beauty, consisting of an irregular spiral curve, the lower end of which was little more than a tangle of threads. The upper part of this track was pale red, and farther down blue. The lower part was almost yellow, and still farther down were two detached bright red spots, like the sun breaking through clouds.—Ed. Nature.]

Height of Barometer.

Mr. Pearson will find much information as to extreme readings of the barometer in two papers published in the *Quarterly Journal* of the Royal Meteorological Society; one by Mr. H. Sowerby Wallis, in vol. viii. p. 147, and the other by Mr. C. Harding, in vol. xiii. p. 201. The lowest known reading is stated, on the authority of Mr. Blanford (Nature, vol. xxxv. p. 344), to be 27·135 ins. observed on September 22, 1885, at False Point, on the coast of Orissa; this requires a subtractive correction of ·011 to bring it to English standards, reducing it to 27·124 ins. The highest known reading is given, on the authority of Prof. Loomis, as 31·72 ins. at Semipatalinsk, on December 16, 1877, giving an extreme range of 4·6 ins.

The lowest reading recorded in these Islands is 27·332 ins. at Ochtertyre, near Crieff, on January 26, 1884, while at Belfast the barometer fell to 27·38 ins. on December 8, 1886, and on the same day at Newton Reigny to 27·566 ins., which seems to be the lowest recorded in England. The highest pressures recorded in this country during recent years were on January 18, 1882, when 30·990 ins. was registered at St. Leonards, but on January 9, 1820, 31·056 was recorded at Kinfauns, Perth, and appears to be confirmed by other readings in Scotland.

Henry Mellish.

THE BRITISH ASSOCIATION.

By the kindness of the Secretary of the British Association we were able to give in our last issue a list of the grants awarded by the General Committee just as we were going to press. Upon referring to this, it will be seen that the grants amount to very nearly £1100, that is £400 more than those awarded at the previous meeting. The increase of funds available for research is due to the large number who attended the Oxford meeting, the receipts being as much as £2175. In this matter, and indeed from every point of view, the meeting was a most successful one. The membership reached a total of 2321—a number greatly in excess of the average. In moving a vote of thanks to the authorities of the city for the hospitable reception accorded to the Association, Sir John Evans remarked that the meeting had been notable both for the large attendance of members and associates, and for the great scientific interest and importance of the papers read. In fact, it was the opinion of all that rarely, if ever, has a more brilliant meeting of the Association been held. No less than seventy-seven foreign members, eminent in many branches of scientific knowledge, honoured it with their presence. The exchange of ideas, which results from the meeting of investigators from all parts of the world, must lead to real progress. "Science," as someone has said, "is cosmopolitan." She recognises no differences of nationality between workers devoted to extending her domains. Therefore men who live "for the promotion of natural knowledge" meet on common ground at the British Association, for they know that anything that will help on this object will be appreciated.

Several changes in the constitution of the sections were adopted by the General Committee. Section D will in future be called Zoology instead of Biology, and there will be a separate section for Botany. Section I, which met this year for the first time, is to consist of Physiology with Experimental Pathology and Experimental Psychology. As pointed out by Prof. Bayley Balfour in his address, Section D has had its constitution changed oftener than any other section of the Association. Experience will show whether the new arrangement is the one best calculated to bring together investigators with similar scientific interests.

The continual division of this section suggests that Astronomy should be removed from Section A (Mathematical and Physical Science), and have a section of its own. It may also be well to point out that there should be a sub-section of Section H (Anthropology) dealing with large questions of Archæology—that is to say, with Assyrian and Egyptian Archæology—and with the various points which, from an archæological point of view, are common to the earlier races.

Another matter worth the attention of the General Committee is the introduction of evening reunions of physicists and biologists, such as are provided in German meetings. Under the present conditions it is very difficult to meet and talk with fellow-workers, especially with foreign members, at each meeting.

The meeting will be held next year at Ipswich, under the presidency of Sir Douglas Galton, K.C.B., F.R.S. Liverpool will be the place of meeting in 1896. The Association was invited to meet in Toronto in 1897, but as arrangements are never made more than two years in advance, nothing definitely could be settled in the matter. There was a strong feeling, however, in favour of accepting the invitation when the proper time arrives for doing so.

The University testified to its interest in the welfare of science by conferring the degree of D.C.L. *honoris causâ* on the following eminent foreign investigators present at the meeting:—Prof. Edouard Van Beneden, Prof. Ludwig Boltzmann, Dr. E. Chauveau, Prof. Cornu, Prof. Theodor W. Engelmann, Prof. Wilhelm Förster, Prof. C. Friedel, Prof. L. Hermann, Prof. Gosta Mittag-Leffler, Prof. S. P. Langley, Prof. G. Quincke, Prof. E. Strasburger. The degrees were conferred by the Vice-Chancellor, and the Latin oration was delivered by Prof. Goudy. The following brief notes show the character of the recipients' chief researches:—

Edouard Van Beneden, Professor of Zoology and Comparative Anatomy, has not only contributed a long series of memoirs on the structure of various Invertebrata to the literature of zoological science, but has especially gained the highest recognition and esteem for his work on the microscopic details of the process of fertilisation in relation to karyokinesis and cell-structure. His investigations on this process in Ascaris megalocephala form the starting-point of recent theories and researches on the subject of the partition of the nuclear matter by the splitting of the chromosomes in spermatozoon and ovum and in the fertilised egg. In addition to these investigations, Prof. Van Beneden's researches on the formation of the blastoderm in the rabbit and the bat have been of the greatest importance, and are cited in all modern treatises as classical. Recently, Prof. Van Beneden has occupied himself largely with the study of Anthozoa (especially Cerianthus and its larva Arachnactis), and has arrived at most important conclusions as to the relationship of these forms to the Vertebrata.

Ludwig Boltzmann was born in Vienna in 1844, and is now Professor of Theoretical Physics in the University there. His first paper was on the distribution of electricity on a sphere and cylinder, and his second one on the mechanical significance of the second law of Thermodynamics. His subsequent papers are too numerous to mention in detail, and have been published principally by the Academy of Science at Vienna, and recently at Munich. The most important of these treat of the steady state of kinetic energy in gas molecules and its connection with the second law of Thermodynamics, of the specific inductive capacity of solids and gases, and other thermodynamic and electromagnetic subjects. Along with Clausius and Maxwell, he is a founder of the kinetic theory of gases, especially in its more com plicated aspects and in its connections with the second law of Thermodynamics. Recently he has devoted himself to popularising Maxwell's electromagnetic theory in Germany.

French physiologists are represented by Prof. Chauveau of Paris. Two only of his achievements need be mentioned—his investigations of the movement of the heart, conceived in the same spirit, and pursued with the same desire to search out the secrets of nature that animated our own Harvey; and secondly, his inquiries as to the nature of the process by which infectious diseases are communicated from one individual to another. It would be difficult to estimate which of these is most worthy of our admiration, for whereas the first were experiments of light, the others were experiments of fruit, and served, with those of Pasteur and our own Lister, as the foundations of a new science—that of Bacteriology—pregnant with promise for the future welfare of mankind.

M. Cornu, Professor of Physics at the École Polytechnique, Paris, is renowned for his numerous experimental researches. His investigations on the velocity of light earned for him a high place among experimenters twenty years ago, and his work on the ultra-violet part of the solar spectrum is still the standard of reference. The telluric spectrum also, and the spectrum of hydrogen, have engaged his attention, as well as various problems in astronomical physics. But his investigations have not been confined to optical physics, one of the most important of them being concerned with the determination of the density of the earth. He was elected a Foreign Member of the Royal Society in 1884, and received the Rumford medal in 1878.

The career of Prof. Engelmann of Utrecht as an investigator has been very fruitful. His work, like that of Hermann, has related to the very *principia* of physiology—to those vital endowments which are common to ourselves and to organisms of the simplest structure. These he has studied with a view to the eventual solution of the most elementary, yet the most difficult, problems which living nature presents to the investigator.

Prof. W. Forster, the Director of the Observatory of Berlin University, is well known for his great activity in furthering astronomical inquiry, both in the institution under his charge and elsewhere. Quite recently he succeeded in establishing an International Bureau for undertaking and conducting astronomical computations. He has also played an important part in the work of the Geodetic Union. Most of his earliest work belongs to geodesy, a number of carefully-made pendulum observations calling for special mention. By directing attention to luminous clouds, and pointing out the importance of photographing and accurately observing them, he has done a service which will lead to results interesting alike to astronomers and meteorologists. His astronomical works, though not numerous, are such as add to his renown, and, with his rare and active administrative faculty, they single him out as well deserving the honour done to him.

Prof. Friedel, the eminent occupier of the chair of Organic Chemistry at the Paris Sorbonne, and one of the six members of the Chemistry Section of the Paris Academy of Sciences, has carried out numerous investigations of the highest value. His first work was on the relations between thermo-electric properties and crystalline form, but his chief researches relate to organic compounds, in the synthesis of which he has been very successful. A few of his earlier papers refer to the artificial production of minerals, and he has made some important contributions to the inorganic side of chemistry.

The name of Prof. Hermann of Königsberg is familiar to students of physiology in all parts of the world, as the author of a general treatise on the subject which has been translated into every European language. He is also the author of several monographs on special subjects, and of innumerable smaller papers, in each of which some permanent additions to knowledge are recorded. His investigation of the chemical processes which are concerned in muscular contraction, published a quarter of a century ago, and his more recent inquiries as to the electrical concomitants of these processes, constitute the foundation of what Physiology is as yet able to teach on these difficult but fundamental questions.

It was at the Allegheny Observatory, Pennsylvania, that Prof. S. P. Langley began his investigations in solar physics, which have resulted in so great an extension of our knowledge in this direction. About 1878 he turned his attention to the question of solar radiation. Finding the thermopile quite inadequate for the work he had undertaken, he was led to invent his now well-known bolometer, with which instrument he has since carried out some very important investigations. After the death of Prof. Henry, he was offered the position of Assistant Secretary of the Smithsonian Institution by Prof. Baird. He removed to Washington, but for a time continued to carry on his work at Allegheny. A few years ago, however, he built a small astro-physical observatory on the grounds of the Smithsonian Institution, and he has there continued and extended his work on the infra-red spectrum of the sun.

All mathematicians are familiar with the name of Gosta Mittag-Leffler, Professor of Pure Mathematics in Stockholm University. He is the editor of the authoritative journal *Acta Mathematica*, devoted to the extension of mathematical knowledge. His work in pure mathematics has been of a very varied character, the most noteworthy, perhaps, being concerned with linear differential equations and their integration, and with the theory of the uniform functions of a variable.

The Royal Society elected Prof. Georg Quincke of Heidelberg as a Foreign Member in 1879, for his researches in physics. He is one of the veterans of science, his first paper having been published so long ago as 1856. All branches of physics have been benefited by his careful experimentation and acute reasoning. Few workers, indeed, can claim to have added so much as he to our knowledge of physical laws, or to have studied natural phenomena in a more comprehensive and profound manner. His researches on capillarity, carried on thirty-seven years ago, led up to the important work in which he showed that the movements of amœbæ and protoplasm can be fully explained by physical laws.

Prof. Strasburger is Professor of Botany in the University of Bonn, having previously been Professor in the University of Jena. He is a Foreign Member of the Royal Society. Having made his mark in Morphology by his monumental work on the Gymnosperms ("Die Coniferen und Gnetaceen," 1872), he has since chiefly devoted himself to the study and investigation of the nucleus of the cell, with special reference to the reproductive processes of plants in their connection with the phenomena of heredity. His researches fill several volumes, such as "Zellbildung und Zelltheilung," "Angiospermen und Gymnospermen," "Unters. ueb. d. Befruchtungsvorgang," and his recent "Histologische Beiträge." It is not too much to say that to Prof. Strasburger's researches is due nearly the whole of our present knowledge of the processes of cell-division in plants.

SECTION I.

PHYSIOLOGY.

Opening Address by Prof. E. A. Schäfer, F.R.S., President of the Section.

Before beginning the subject matter of my address I had conceived it to be necessary, appearing before you as we do as a new Section, to offer some sort of apology for our presence. But, on looking up the history of the Association, I find that my task is somewhat different. If I have any apology to offer at all it is that the Section of Physiology has ceased to appear for many years.

The British Association was founded at York in 1831; and at the subsequent meeting, which was held in this very city of Oxford, amongst other Sections which were established, was one for Anatomy and Physiology. Now, when we consult the records of this Section we are struck with the fact that Medicine early shows a marked preponderance. Thus, in 1833 a physician is selected as President for the Section, with two surgeons as secretaries: one of them, be it noted, being Mr. Paget. This preponderance soon came to be recognised in the designation of the Section, for in 1835 we find it entitled Section E, Anatomy and Medicine.

As time went on the interests of medical men became gradually more absorbed in the rapidly growing British Medical Association; and in 1841 the medical title was dropped, and the Section came to be called simply Physiology, which title it retained until 1847. Under that designation the Section has now been revived.

The fact that Physiology as a separate section in this Association was allowed to lapse for so long a period is not remarkable when we remember that during the first half of this period Physiology as a science was practically non-existent in this country. The teachers of Physiology were, almost without exception, practising physicians and surgeons, and even when a professor was expected to devote the whole of his time to the teaching of Physiology he was not expected to devote part of that time to the prosecution of physiological research. During all these years, from 1833 to 1847, we do not find amongst the officers of the Section any actual working physiologists. Most of the officers were distinguished medical men, with an anatomist here and there amongst them. Far be it from me to say that there was no actual work being done in Physiology at this time; for Charles Bell and Marshall Hall were engaged in elucidating the functions of the nervous system; whilst Bowman, Wharton Jones, and others were producing good and permanent work in various other departments of Physiology. Their labours, however, were isolated, and formed but oases in the Sahara of neglect into which the pursuit of Physiology had fallen in this country; and this during a period when it was being pursued with signal success and activity both in Germany and France.

After 1847 a revival of Physiology began to manifest itself even here; and this was followed by the establishment, from time to time, of a sub-section to Section D, which was devoted to Physiology, and had a special President. Whether, however, owing to their subordinate character, or from some other reason, these sub-sections had not usually any great measure of success, and for the last twelve years they have been wholly dropped. During that period Physiology has only twice been represented in the chair of Section D, and has usually had no secretarial representation. This decadence of Physiology in the British Association during the last eleven or twelve years is the more remarkable because it is obviously not due to any want of outside activity in regard to the subject; for during this period we find an extraordinary revival of interest in physiological research, a revival which in its most active stage dates from about twenty-five years ago, but still some twenty or thirty years later than the corresponding revival in France and Germany. I have taken the trouble to prepare a list of prominent physiological workers who flourished during the thirty years prior to 1870. My list comprises, in all, thirty. Of these four are English, five French, and twenty-one German or Dutch. Of the four English working physiologists not one is a teacher of Physiology. Of the five French and twenty-one German all are recognised teachers. It was not, in fact, until it came to be understood that teaching and work in Physiology, as in all branches of science, ought in the main, to be successful, to go hand in hand, that the science had any possibility of revival.

Let us glance for a moment at the history of the revival of Physiology in this country as compared with its revival in Germany. In each country the revival may be said to have been largely due to the influence of one teacher. In Germany the teacher was Johannes Müller; in this country, William Sharpey. Both of these remarkable men were pupils of Rudolphi, who was professor of Anatomy and Physiology in Berlin until 1833. It is stated regarding Rudolphi that "he was an enemy to subjective speculation in biological science: he looked on the so called philosophy as mistaken and futile in its application to the phenomena of the animal economy, and based his physiology chiefly, and perhaps rather exclusively, on the study of the animal structure." The influence of Rudolphi is apparent in both Müller and Sharpey.

Muller was born in 1801, Sharpey in 1802; they were therefore of about the same age. But Muller's scientific and intellectual development was more rapid than that of his contemporary. Thus we find that already in 1826, when he was but twenty-five years old, Muller attained so great a reputation as to be made Professor Extraordinary in the University of Bonn; and before very long he was promoted to the grade of Ordinary Professor there. In 1833, whilst still a young man, he was called to the chair of Anatomy and Physiology at Berlin, which had just become vacant by the death of his master and friend, Rudolphi. Sharpey, on the other hand, occupied himself until 1829 with perfecting both his general and his special anatomical education. It was not until 1830 that he published his first essay in anatomical and physiological research entitled "On a Peculiar Motion excited in Fluids by the Surfaces of Certain Animals"—observations which were preliminary to the discovery of the existence of cilia in vertebrates. And it was not until 1836 that he was called to the newly instituted professorship of Anatomy and Physiology in University College, London, which he filled for so many years with such signal success. Both of these distinguished men owed, there is no doubt, their success as teachers of Physiology to their early anatomical training. The general anatomical bent of Johannes Muller is evidenced by the fact of his scientific work being turned so much in the direction of comparative Anatomy and Physiology. And Sharpey, although great, and deservedly great, as a teacher of Physiology, remained to his dying day, above all, an anatomist. Physiologists of this school are rare at the present day; but it is probable that in some respects the progress of Physiology may suffer thereby. Helmholtz began his public career as professor of Anatomy; but it would be unfair to attach too much weight to this particular incident in the case of so many-sided a man as the great Berlin Professor of Physics. Nevertheless, the necessity of a close and careful training in Anatomy for those who are afterwards to work at or to teach Physiology is so important that I do not hesitate to say that the younger physiologists who neglect the study of Anatomy will find that before very long they must abandon the pursuit of many byways of Physiology which might otherwise be followed up with manifest advantage.

The influence of Johannes Müller upon the revival of the pursuit of scientific Physiology in Germany, and indeed generally, cannot be over-estimated. We have only to look at the names and eminence of his pupils in order to recognise the immense influence which his teaching has exerted upon the progress of Physiology ever since his time. Some of these pupils are still amongst us, others have joined the majority. But the pupils of these men, again, are now great names in many departments of our science, and through them we cannot fail to recognise the influence which was exerted by this truly great man.

We may say the same in almost identical words of William Sharpey. The practical pursuit of Physiology in this country has mainly radiated from the centre where Sharpey taught. Michael Foster was his pupil. The physiological investigations of Burdon-Sanderson were assisted and encouraged by him. From Sharpey, therefore, we may trace the rise of the great school of Physiology at Cambridge, and we have only to look at the magnificent laboratory which has been erected here to observe a monument of the influence of the same teacher. And there have emanated either directly from the physiological school established by Sharpey at University College, or indirectly from those at Cambridge and Oxford, many of the most active teachers and workers in Physiology in the kingdom.

In these respects there is much in common between the revival of Physiology in Germany and in this country. In other respects, however, the two cases have been entirely under different conditions. There its revival, in common with that of science generally, has been assisted and stimulated by the active and beneficent co-operation of every German State. Here, also, in common with science generally, it has had to make its way against every conceivable obstacle; and almost without assistance, either moral or material, from the Government or from public bodies. But not only has it not met with assistance, there have been actual obstacles placed in the way of teaching and work in Physiology. Some have been unintentional, others intentional. As an instance of the unintentional may be mentioned the practice which has obtained in medical schools and on examining boards—a practice which, I am happy to say, is gradually being discarded—of appointing as teachers and examiners in Physiology men who may have a good general knowledge of the science, yet with whom it is not the business of their lives; and who cannot, therefore, be expected to be as familiar with its details, and absorbed in its interests, as those who devote their entire time and attention to its pursuit.

The more virulent opposition, in some measure, to science generally, but in the greatest measure to Physiology, appeared almost simultaneously with the active revival of the subject. This opposition, which has come to be known as the Anti-vivisection Movement, but which might equally well be called the Anti-scientific Agitation, has hitherto met with no measure of success, except that it has to a certain extent hampered the full development of the science by diverting to its defence some of the energy which might be devoted to its pursuit. Indeed, the actual results of this unreasoning agitation furnish an illustration of the old-established principle that persecution of a good cause will in the long run tend towards its development and propagation. And in this case the chief results have been the following:—

(1) The most immediate effect of the anti-vivisectionist attack was the establishment of the Physiological Society, which in the first instance was only a small gathering of working physiologists, who met to discuss measures of defence in a drawing-room in Queen Anne Street. This society, which had such a small beginning, is now large and important. Its doors are besieged by applicants for admission, although it is a necessity for such admission that the applicant be either a teacher of Physiology or a worker at Physiology, or both. Its numerical strength has grown from ten to fifteen to more than 150; and its numbers are every year increasing. And, besides the work which it has done in this country in promoting the interests of Physiology, and co-operation between English physiologists, it has succeeded in establishing a succession of triennial International Congresses of Physiology, which are amongst the most successful of such gatherings, and which have been the means of bringing us into communication with the most prominent physiological workers and teachers on the continent.

(2) A second result of the agitation was the passing of the so-called Cruelty to Animals Act. This Act, which was intended to restrict the performance of experiments upon animals, was in no sense called for, since it had been found by a Royal Commission that there was no evidence to show that there had been unnecessary experimentation upon animals, or any desire on the part of physiologists to neglect the use of anæsthetics. On the other hand, it is of inestimable advantage in that it gives the public a definite guarantee that the excesses of which physiologists used to be freely accused are not possible. Such excesses never did actually occur; although, to believe all the publications which have been issued by Anti-vivisection Societies, one would come to the conclusion that a physiologist is a being who spends his whole time in torturing sensitive creatures, careless of the suffering which he may cause, or even of the scientific results which he may obtain. The fanatical supporters of the agitation would have you to believe that we are all neither more nor less than "fiends"; they cry with Ferdinand that "hell is empty and all the devils are here."

I am told there was even a feeling of this sort in this University at the time when it was proposed to establish the Wayneflete Professorship of Physiology, and that an agitation was set on foot having for its object, first, the prevention of the establishment of such professorship; and secondly, that being impossible, the prevention of the professor's practising physiology. The common-sense of the University stifled this agitation, and the more intimate acquaintance with physiologists, which has resulted from the establishment of the school, has been sufficient, I believe, to smother the little fire which was still left smouldering.

(3) A third result of the Anti-vivisection Agitation was the establishment of the Association for the Advancement of Medicine by Research. This immediately followed a unanimous resolution of the International Medical Congress of 1881, affirming the necessity of experiments upon animals. To the ignorant accusation that physiological experiments had been and were of no use or influence in the advancement of medicine, the leaders of the profession unanimously affirmed that it is upon Physiology hat Medicine and Surgery are based, and that there can be no real progress in those sciences without a corresponding progress in experimental Physiology and Pathology. The Association for the Advancement of Medicine by Research has been of the greatest possible value and assistance to Physiology in this country. It has shown physiologists that they have the great medical profession at their back, and it has acted as an impartial and independent medium of communication between physiologists and the successive Secretaries of State, whose business it has been to administer the Act.

(4) A fourth result of the attacks of the anti-vivisectionists has been, I may perhaps be permitted to believe, the re-establishment of this Section of Physiology of the British Association. Those who were present at the meeting of the Association in Nottingham may have remarked that the gutters of that town were strewn with papers which had been forced upon the members of the Association by the anti-vivisectors of the place. This literature, which in a double sense may be termed "gutter literature," teemed with flagrant misstatements, and with vicious calumnies, directed against physiologists, and especially called forth, I presume, by the fact that for the first time in the history of the British Association a physiologist was called upon to occupy the presidential chair. We may look upon the establishment of this Section as the reply of the Association to the false witness which was borne against us at Nottingham.

But although a special section for Physiology has been re-established, it may not be advantageous that there should be one at every meeting of the Association. Physiology is above all things a practical science. It requires laboratories and means of demonstration. Physiologists are rarely satisfied with the opportunity of hearing and reading papers, but require that, as much as possible, the actual methods of research employed should be capable of demonstration. By this I am not to be supposed to advocate the demonstration of experiments upon animals, for there are very many subjects in Physiology which can be both worked at and illustrated in a manner involving in no sense whatever the word vivisection. But in order that the methods should be shown, it is important to have the appliances of a laboratory at hand, and the Association frequently meets in towns which are not university towns, and have no laboratories, in which, therefore, it would be difficult or impossible to arrange for demonstrations of the sort that I am alluding to. On this account we may well imitate the practice of the British Medical Association, which establishes a Section of Physiology only when its meetings are held in such a centre as is likely by the applicances which are to be found in that centre to render the Section useful and efficient. Hence, in recommending the establishment of a Physiological Section, it is expressly reserved that the Section shall be held only at such future meetings as may seem to the council to be desirable.

I will now invite you to consider with me one or two of the more obscure subjects in the range of Physiology, subjects which are, however creating a great, almost an absorbing, interest at the present moment The first of these subjects relates to the structure and function of every cell in the body. All are aware that the body of every animal and of every plant is made up of minute corpuscles which are formed of protoplasm, and which contain in every case at least one nucleus. The protoplasm and the nucleus form the living substance of the cell. Other substances may be present, but they are, in a sense, outside the nucleus and protoplasm, not incorporated with their substance. Apart from a few details relating to the structure of the nucleus, this was, until quite lately, practically all that we knew regarding the parts composing either the animal or the vegetable cell. There appears, however, to be yet another something which, although in point of size is of very insignificant dimensions, yet in point of function may perhaps be looked upon as transcending in importance, in some respects, both the protoplasm and the nucleus. Not many years ago it was noticed by various observers that in certain specialised animal cells the protoplasm showed a tendency to radiate from or converge towards a particular point, and on further investigation it was found that at this point there was a minute particle. This observation, which began, as we have seen, upon specialised cells, was, after a little while, found to hold good for other and yet other cells, until, at the present time, we believe that in every cell of the animal or plant body such a particle exists Now, it may well be asked, why after all should so great importance be attached to this observation? To this it may be replied that, in the first place, it is of importance, because it shows conclusively that the whole cell is not of a uniform nature, since there is this one point within the cell that exerts a special attraction upon the rest of the cell-substance: and, indeed, on this account the particle has come to be termed the "attraction particle." And in the second place, because of the apparent universality of the occurrence of such a particle. And, thirdly, because of the fact that one of the most important phenomena exhibited by the cell hinges upon the behaviour of this particle; for it is found that before a cell or its nucleus divides this minute attraction particle begins by itself dividing, and is, in fact, more commonly met with double than single. Nor is it until the two particles thus produced have evolved, either from themselves or from the substance of the protoplasm or nucleus, a system of communicating fibres, the so-called *achromatic spindle*, that those changes in the nucleus and protoplasm take place which produce the division and multiplication of the cell. This *attraction particle*, which is also called the *central particle* or *centrosome*, has absorbed so great an interest that, short as is its history, many papers have already been devoted mainly to it, the latest of these being an elaborate treatise of some 300 pages by Martin Heidenhain. I shall not here attempt to follow out the details of all these researches, but will be satisfied with putting before you the conclusion which Heidenhain has come to regarding this particle, viz. "that it is morphologically, physiologically, and chemically a structure *sui generis;* not merely a separate portion of nucleus or of protoplasm, but an organ of the cell with definite functions, and having a definite existence of its own." Nevertheless, it is almost as minute an object as it is possible to conceive. In a cell which is magnified a thousand diameters the central particle appears merely the size of a pin-point. Yet this almost infinitely small object exerts an extraordinary influence over the whole cell, however large (and the cell may be many thousand times its size); for it initiates and directs those processes which result in the multiplication of the cell, and indirectly, therefore, it is concerned in directing the general growth of the individual, and ultimately the propagation of the species.

A former President of the Association took as the subject of his presidential address what he was pleased to call the "Next to Nothings." In considering this central particle, of the actual structure of which, and of its chemical constitution, we know at present hardly anything, we may surely regard it as a striking instance of the supreme importance of the "next to nothing" in Physiology.

The other subjects to which I desire to draw your special attention relate to the physiology of certain organs the functions of which have always been extremely obscure, and which, although they differ greatly from one another in almost every point of structure, and presumably also in function, it has been usual to group together under the name of ductless glands. The name "gland" is given to such organs of the body as take materials from the blood, and convey those materials in an altered or unaltered form, by a tube or duct, to a surface either internal or external. Such material is termed the secretion of the gland, and has for its object either the performing some function which is useful to the organism or the getting rid of material which would be detrimental if retained. In the case of the ductless glands there is no such possibility of pouring out material produced by the gland upon a surface, because these organs do not communicate with any surface by a duct; and whatever material they may furnish must therefore, if it is to reach the body generally, pass into the blood; that is to say, the blood on the one hand must furnish the materials for the secretion of the gland, and on the other hand it must take up those materials after they have been manufactured into something else, and carry them away to other parts of the body. Now, in the case of a certain number of the ductless glands there has not appeared to be any very great obscurity as to their function; for some of them seem very obviously to be devoted to the formation of corpuscles which are found within the blood itself. But with regard to others of these bodies it has not hitherto been possible to find any special material in the blood which they have furnished to it, and our knowledge of them is derived almost entirely from experiments. I will take the case of two of these to illustrate the vast influence which small and almost disregarded organs may exert upon the whole economy. But in the first place I may be permitted to point out what is indeed a self-evident statement, that there is no part of the body which does not exert some influence upon the rest. Every single portion of the body is continually taking materials from the blood, and furnishing to the blood other materials which are formed within it, whether we call that portion which performs such functions a gland or not; and it is quite certain that the removal of any portion of the body would be followed by some permanent alteration in the blood were it not that other similar parts may by increased activity compensate for the alterations which the blood would otherwise undergo from the loss of any one such part. Take the case of a limb. The changes which the blood undergoes in circulating through it affect the body generally through that fluid, for the composition of the blood becomes modified in traversing the limb. And not only is the body affected thus through the medium of the blood, but, by means of the nerves which pass to and from the limbs, the central nervous system is itself affected by the movements and alterations of various kinds which are proceeding in the muscles and other parts, and through the nervous system the whole organism must constantly be influenced from the limb. There is, however, no evidence that the removal of a limb or part of a limb permanently modifies either the condition of the blood or of the nervous system. Nor is such a result to be expected, for in this case there are other parts of the body possessing similar organs and performing similar functions, the increased activity of which may easily compensate for the loss which is sustained through removal of such a part.

But if we deal with an organ which is not multiple, but unique, and completely remove this from the body, it is easy to see that the case may be very different. This organ, like every other organ of the body, is continually taking from the blood some materials and giving up to it certain other materials. Now it is clear that its removal must make a permanent difference in the blood, and since the whole organism is remarkably sensitive to even slight changes in the composition of the circulating fluid, very marked results may well follow the removal of such organ. And this is in fact found experimentally to be the case.

It has long been known that extensive disease of the thyroid gland, a small reddish organ, weighing about one or two ounces, found at the front of the throat, is followed by extensive alterations in the nutrition of the body generally. The patient becomes swollen from the overloading of the connective tissues with a mucinous exudation; the nervous and muscular systems are seriously affected; the power of generating heat is greatly modified; and the final result is, in the first instance, the production of a condition of semi-idiocy, ultimately followed, if the disease be extensive, by death. Precisely similar results have been found in animals, and in fact in man as well, to follow the complete removal of this body. Yet the weight of this organ is not more than one sixteen-hundredth part of the whole weight of the body; and even this figure does not represent the enormous influence which a relatively small organ can exert upon the general nutrition of the body; for it is found that even if a minute part of the thyroid gland be left whilst the greater part is removed, the symptoms above enumerated do not supervene. Indeed, certain contradictory results which have been got by some observers after removal of the thyroid are explained by the fact that in some individuals there are minute detached particles of thyroid gland lying apart from the main organ; and that after the latter has been removed these detached particles may sufficiently carry on the function of the organ in relation to the blood and the nervous system to prevent the supervention of the deleterious symptoms which usually occur after its removal. Here is, then, a notable instance of the enormous influence exerted by a "next to nothing" upon the general organism.

Another illustration may be given from these ductless glands. It was noticed in 1849 by a celebrated physician, Dr. Addison of Guy's Hospital, that certain cases, accompanied by extreme debility, occurring in the human subject were associated with the appearance of peculiar bronzed patches on parts of the skin and mucous membranes; and on post-mortem examination of these cases, which always sooner or later have a fatal termination—and indeed sooner rather than later—he found the symptoms in question to be accompanied by disease and destruction of the supra-renal capsules—small bodies which are placed close to the kidneys, but which, so far as we know, have no physiological connection with them. Now when experiments came to be directed upon these bodies in order to elucidate their functions, and especially to observe whether their injury or removal was accompanied in animals also by symptoms similar to those occurring in man as the result of disease, it was found by Brown-Séquard that when these bodies are totally removed in any animal the removal is speedily followed by a fatal result. These experiments of Brown-Séquard's were made in 1858, and at the time attracted some attention. They were repeated by other experimenters with similar effects. But some of those who removed the supra-renal capsules obtained contrary results, and for many years the matter remained in an undecided condition. It was even supposed that the fatal results which were got by Brown-Séquard might be due to the shock of the operation or to the fact that the removal necessarily involves certain parts of the sympathetic nervous system, and were not necessarily due to the removal of the supra-renals. Recently, however, attention has been again directed to the subject, and the experiment of Brown-Séquard has been repeated by Tizzoni (1889) and by Abelous and Langlois (1891 to 1894) in various animals, viz. frogs, guinea-pigs, rabbits, and dogs. I have myself performed two confirmatory experiments in monkeys. The result of all these recent observations is to show that the complete removal of the supra-renal capsules is not compatible with prolonged existence of life, and Abelous and Langlois have shown that it is accompanied by an alteration in the blood, which renders that fluid poisonous to other animals. The contrary results which have been obtained by some investigators are apparently due to the fact that in certain cases there are, as with the thyroid body, small isolated portions of supra-renal substance ("accessory capsules," as they are sometimes called) which have not been noticed and removed at the time of the operation, and that these small portions of supra-renal substance have served to maintain that proper relation between the blood and the gland which is sufficient to prevent the supervention of the symptoms in question.

Now the weight of both supra-renal capsules taken together is not more than three drachms, and their weight, as compared with that of the whole body, is only as 1 to 6000 or less. The accessory supra-renal capsules which may be left after the removal of the main bodies probably do not originally weigh more than one-twentieth of the whole structure, and yet this minute proportion of material (a material, so far as we know, unique in the organism) is nevertheless sufficient to maintain the composition of the blood and the nutritive equilibrium of the body, and thus to prevent the necessarily fatal result of complete removal.

Now it has been found in the case of the thyroid gland that patients in which this structure has been so diseased that its function is seriously interfered with, and animals in which it has been removed entirely, may be greatly benefited, if not indeed cured, by the inception, either subcutaneously or with food, of the thyroid glands of animals, or of the juice of such glands. Even where no affection of the thyroid can actually be detected, the exhibition of thyroid juice is frequently beneficial in certain conditions of the system, and it was noticed by Dr. Oliver, of Harrogate, that this is especially the case where there is a too marked constriction of the blood-vessels, the juice of this body tending in such cases to reduce the extreme tone of the vascular walls, which is the cause of this condition. Encouraged by this result, Dr. Oliver was led to examine the effects of other animal extracts, and among them that of extract of supra-renal capsule. The effect of this was precisely the reverse of that which he had got with the thyroid body, for he obtained evidence tending to show that in certain cases in man extract of supra-renal capsule can produce an *increase* of vascular tone and a diminution in the size of the arteries. Beyond this point, however, Dr. Oliver was unable to proceed by clinical experiment, and he accordingly came to my laboratory with the object of determining the precise physiological effect of the active substance of the capsules. The results which were obtained show that there is present in both alcoholic and watery extracts of the gland a most potent physiological substance which when injected into the body of an animal produces, even in minute doses, a remarkable effect upon certain parts of the nervous system, upon the muscular system, upon the heart, and upon the blood-vessels. If only as much as a grain by weight of supra-renal capsule be extracted with alcohol, and if this alcoholic extract be allowed to dry, and then be redissolved in a little water or salt solution and injected into the blood of a dog, the results which are obtained, considering the minute amount of substance added to the blood, are certainly most extraordinary. The nervous centre which regulates the action of the heart is powerfully affected, so that the heart either beats very slowly and weakly, or the auricles may even for a time stop beating altogether. If, however, these inhibitory influences be cut off by division of the vagi nerves, the effect of the poison upon the heart is of an opposite character. There is great acceleration of the rate of the beat and a great increase of force. This is accompanied by a strongly marked influence upon the blood-vessels, and especially upon the arterioles. The walls of these are chiefly muscular, and the drug exerts so powerful an action upon this muscular tissue as to cause the calibre of the vessels to be almost obliterated. The heart being thus increased in force and accelerated, and the calibre of the vessels almost obliterated, the result is to raise the pressure of the blood within the arterial system to an enormous extent, so that from a blood-pressure which would be sufficient to balance a column of some four inches of mercury the pressure may rise so high as to be equal to a column of mercury of twelve or more inches.

This result is obtained, as we have seen, by a very minute dose. We have to do here with a substance which is as potent, although in a different direction, as strychnia. Whether it is a useful substance formed by the supra-renals from materials furnished by the blood, and subsequently gradually used in the economy for the virtue of its action upon the circulatory system, or whether it is to be regarded as a poison, formed by the tissues during their activity and carried by the blood to the supra-renals, there to be rendered innocuous, we do not as yet certainly know. These are important points which must form the subject of further investigation. But, however this may be, it is clear that in this gland also we again meet with an instance of the physiological importance of what Sir Frederick Bramwell called the "next to nothing."

I will give one more instance, taken this time from a gland which is provided with a duct. Until quite recently it might have been thought that there was nothing very obscure regarding the functions of the pancreas. The pancreas is a digestive gland which lies below and behind the stomach: it has a duct which carries its secretion into the beginning of the intestine, and that secretion acts powerfully upon all constituents of the food, digesting starch, meat, and fat. It was not supposed that the pancreas had any other function to perform. Animals can live without this secretion, and to a large extent can continue to digest and absorb their food much as before; for it has been possible to divert the secretion from the intestine and to collect it at the surface of the body; and it is found under these circumstances that, although the food is not quite so readily digested, nevertheless the animal does not materially suffer from the lack of the secretion. It was discovered, however, a few years ago (by v. Mering and Minkowski) that if, instead of merely diverting its secretion, the pancreas is bodily removed, the metabolic processes of the organism, and especially the metabolism of carbohydrates, are entirely deranged, the result being the production of permanent diabetes. But if even a very small part of the gland is left within the body, the carbohydrate metabolism remains unaltered, and there is no diabetes. The small portion of the organ which has been allowed to remain (and which need not even be left in its proper place, but may be transplanted under the skin or elsewhere) is sufficient, by the exchanges which go on between it and the blood generally, to prevent those serious consequences to the composition of the blood, and the general constitution of the body which result from the complete removal of this organ. Now, some years ago it was noticed by Kuhne and Sheridan Lea that, besides its proper secreting structure composed of tubular alveoli, lined by granule containing cells, there are highly vascular patches of peculiar epithelium-like cells scattered here and there in the substance of the pancreas, which are wholly unconnected with the ducts and, so far as one can judge, with the secretion of the gland. We do not know anything whatever about the function of these patches, although from their vascularity it is extremely probable that they are not without importance physiologically, and it is tempting to conjecture that it is these cells which are specially concerned in effecting that influence upon the metabolism of carbohydrates which experiment has shown to be peculiar to the pancreas.

The lesson to be drawn from these results is clear. There is no organ of the body, however small, however seemingly unimportant, which we can presume to neglect; for it may be, as with the supra-renal capsules, the thyroid gland, and the pancreas, that the balance of assimilation and nutrition, upon the proper maintenance of which the health of the whole organism immediately depends, hinges upon the integrity of such obscure structures; and it is the maintenance of this balance which constitutes health, its disturbance, disease. Nor, on the other hand, dare we, as the investigation of the attraction-particle has shown, afford to disregard the most minute detail of structure of the body.

> "All is concenter'd in a life intense,
> Where not a beam, nor air, nor leaf is lost,
> But hath a part of being."

PHYSICS AT THE BRITISH ASSOCIATION.

AFTER the President's address on Thursday morning, Lord Kelvin opened the proceedings in Section A with an account of some preliminary experiments made by himself and Mr. Maclean on the electrification of air by the subtraction of water from it. The subject is one in which Lord Kelvin has been for many years interested, and he commenced experimenting on it as far back as 1868. The nature of the results now obtained was illustrated by his insisting that the proper title of the paper was "Preliminary experiments *to find if* subtraction of water from air electrifies it" (and not as in the *Journal*—"Experiments *proving* the electrification of air"). In the present investigation a large U-tube was used. One branch of this was filled with pumice-stone soaked in sulphuric acid; the other was simply varnished inside and out. By means of a platinum wire touching the pumice, connection was made with a quadrant electrometer. A metal cylinder screened the tube from external influence. Air from an ordinary blow-pipe bellows was blown through the tube steadily for an hour; and the electrometer showed an electrification rising gradually to about nine volts positive. This shows that the passage of the air through the tube gave positive electricity to the acid, and therefore sent away the dried air electrified negatively. No such effect was observed when the pumice was moistened with water instead of sulphuric acid. The experiments are to be repeated with precautions to prevent any bubbling of the air through liquid in the tube; for it was observed that the strong positive electrification of the tube (when acid or calcium chloride was used) seemed to commence suddenly as soon as a gurgling sound, due to bubbling through free liquid, began to be heard. The authors have reversed the conditions, and have first dried air by passing it over sulphuric pumice, and then passed it through a tube containing moistened pumice. The tube became negatively electrified, but this may have been due to the negative electrification of the dry entering air. This experiment is to be repeated with dried and dis-electrified air. Lord Kelvin also described certain preliminary experiments made by himself and Mr. Galt with the object of comparing the discharge of a Leyden jar through different branches of a divided channel. The metallic part of the discharge channel was divided between two wires of conducting metal, each consisting in part of a test-wire. Each of the two test-wires consisted of 51 cm. of platinum wire of 0·006 cm. diameter and 12 ohms resistance stretched in a glass tube. One end was fixed to a solid brass mounting, and the other was attached to a fine spring carrying a light arm for multiplying the motion. The testing effect was the heat developed in the test-wire by the discharge, as shown by the elongation, the amount of which was measured by a tracing on sooted paper carried by a drum. The wires to be tested were generally of the same length. When they were of the same material but of different diameters, the testing elongation showed, as might be expected, that the test-wire in the branch containing the thicker wire was more heated than the other. With wires of various non-magnetic materials, of the same resistances but different lengths and diameters, the testing elongations were very nearly equal. In one experiment two equal copper wires were used, but one of them was coiled into a helix; the testing elongation in this branch was less than half of that in the straight branch. Lastly an iron wire was compared with a platinoid wire of equal resistance but greater diameter. The heating effect in the platinoid branch was nearly one-and-a half times as great as in the iron branch. This is interesting in relation to Lodge's experiments on alternative paths, which were not decisive in showing any general superiority of copper over iron of the same steady ohmic resistance, but even showed a seeming superiority of the iron for efficiency in the discharge of a Leyden jar.

Prof. Oliver Lodge followed with a communication on "photo-electric leakage." It is known that a negative charge on an electrified surface escapes much more rapidly when the surface is illuminated with ultra-violet light (Hallwach's experiment). Prof. Lodge has investigated the rate of discharge for a number of substances under positive as well as negative electrification, and in hydrogen as well as air. He finds that when the inside of an electrified pewter-pot is illuminated, it does not leak; but when the edge is illuminated, it leaks rapidly. Thus the leakage appears to be a matter of surface-tension, and not of potential. In the discussion which followed, Prof. S. P. Thompson stated that he had verified the statement made by Elster and Geitl, that when the light is polarised the effect depends upon the plane of polarisation, the leakage being most rapid when the Fresnellian vibrations are in such a direction as to "chop into" the surface. He has found an analogous difference in the action on selenium cells.

Mr. G. H. Bryan presented the second part of his report on the present state of knowledge in thermodynamics. In a lengthy and valuable paper he discusses the limitations to the law of distribution of energy in the kinetic theory. He deals primarily with the so-called Boltzmann-Maxwell law of distribution of energy among the molecules of a gas, which law forms the basis of the kinetic theory of gases. One of the main points kept in view has been to show, as far as possible, where to draw the line between dynamical systems which do, and dynamical systems which do not satisfy the law in question. A great advance in the subject is due to the extension of the use of generalised co-ordinates, by which greater generality has been given to results, and the analysis has been much simplified, as a comparison of Boltzmann's early papers with modern writings abundantly testifies. A further simplification has been effected by the extensive use of the Jacobian notation in this report. The report is divided into three sections. In Section I. the law is regarded in the aspect of a general dynamical theorem without reference to any particular applications, and without taking into account the effect of collisions. Section II. treats of its application to a system of bodies colliding with one another indiscriminately, and partaking of the nature of gas molecules. Section III. deals briefly with certain researches relating to the connection between the Boltzmann-Maxwell law and the Theory of Probability, the Virial Equation, and the Second Law of Thermodynamics. With regard to non-colliding systems (Section I.), it may be asserted that a large portion of our progress has been made in, firstly, showing that Maxwell's demonstrations are faulty and unsatisfactory, and by subsequently discovering fresh methods of proof, which, while leading to the same general conclusions, show more clearly the limitations and conditions under which these conclusions hold good. Test cases of Maxwell's law are given, and also an account of Mr. Culverwell's criticism of the "decisive" test case by which Lord Kelvin claims to have effectually disposed of the law. It is urged that uniformity of nomenclature is most desirable in this as in other branches of science, and hence that some definite understanding should be agreed on as to what precisely constitutes the Boltzmann-Maxwell law. The following statements are recommended:—(1) That the distribution of a large number of molecules or other dynamical systems of the same or different kinds in which the coordinates (q) and momenta (p) of each system are so arranged that the number of systems in the neighbourhood of any given state is proportional to

$$e^{-hE}dp_1 \ldots dp_m dq_1 \ldots dq_m$$

h being the same for all the kinds of molecules or systems, be called the Boltzmann-Maxwell distribution. (2) That the law which asserts the permanence of the Boltzmann-Maxwell distribution in any particular case be called the Boltzmann-Maxwell law. (3) That in future these names be not applied to any corollaries such as that which asserts the equality of the average value of the squares into which the kinetic energy can be split up. That corollary may be called Maxwell's law of partition of kinetic energy.

The proof of the Boltzmann-Maxwell law, and the assumptions involved in it, may now be regarded as fully satisfactory for gases whose molecules collide with one another to a certain extent at random, but in a medium in which the molecules can never escape from one another's influence the subject still presents very grave difficulties.

On Friday the Section held a joint meeting with Section G, at the headquarters of the latter in Keble Hall. The first subject of importance was a discussion on integrators, harmonic analysers and integraphs, and their application to physical and engineering problems. A number of these were exhibited, both models and working instruments, some of the latter being beautiful specimens of Swiss workmanship. For the discussion an hour and a half had been allowed: of this the opener, Prof. Henrici, occupied the greater part, but did so to the entire satisfaction of his audience. The subject had been discussed at previous meetings by Sir Frederick Bramwell at Brighton, and by the late Mr. Merrifield at Swansea; Prof. Hele Shaw had also read a paper on the subject before the Institute of Civil Engineers. The first planimeter was invented by a Bavarian engineer named Hermann. It was lost sight of, but was subsequently reinvented in 1825 and 1826, and from it our present planimeters are derived. Amsler invented his instrument in 1854, and first published an account of it in 1856. Planimeters may be classified in two ways. As Prof. Hele Shaw subsequently remarked, it is natural for an engineer to classify instruments with reference to their mechanical action, and thus planimeters may be divided into two classes, according as the wheel does or does not slip. Prof. Henrici prefers a classification depending upon the geometrical properties involved in the action of the instrument. A planimeter measures the area swept out by a line. The length of the line may either be fixed or variable. Again, a line in a plane may either move or turn. To obtain general areas we have a choice of two combinations (for only special areas could be traced, *e.g.* by a line moving parallel to itself). The first class of planimeters depends upon the motion of a line which can both turn and move parallel to itself, but which remains of fixed length. The line takes the form of a rod of fixed length, one end of which is jointed to another rod so as to move on a circle about a fixed point (the pole), while the other end is provided with a tracing-point to be moved around the figure whose area is to be evaluated. These planimeters can only be used to integrate around closed curves. It does not matter where the wheel is placed along the rod, but its axis must be parallel to the axis of the rod. This introduces one of the most serious difficulties with which the maker has to contend. In Amsler's planimeter the rod can only be used on one side, so that the error is always in the same direction; but an improved form was exhibited in which the rod can be used on both sides, so that this error is eliminated. Then there is the slipping error. Maxwell drew attention to this, and was the first to propose an instrument in which there was no slipping at all. There are a number of planimeters in which the wheel, instead of rolling on the paper, rolls on a prepared surface. There is always some resistance to the motion of the wheel and counters, and this increases the slipping. The error can be reduced to a minimum by diminishing as far as possible (1) the friction between the paper and the wheel (as by using a prepared surface); (2) the resistance to the motion of the wheel. In using the instrument we should also avoid getting the instrument in such a position that the wheel has to move much at right angles to its own plane, for then the friction and slipping error is greatest. Amsler, in his first paper (1856), foreshadowed many improvements which have since been carried out; and in his second paper (he only published two), he described a planimeter depending upon the action of a cylinder rolling on a sphere, in which there was no slipping. Maxwell suggested two forms of instrument in which slipping was altogether avoided; but they were never made. The second class of planimeters depends upon the motion of a line of variable length which moves without turning. They give the value of definite integrals between any fixed limits, and may be called integraphs. Instruments of this type have been devised by Lord Kelvin, Abdank-Abakanowitz, Vernon Boys, and Conradi. To engineers it is more important to be able to integrate a curve than an expression; and an integraph can give the integral of a curve as a curve. Lord Kelvin and Boys have shown how instruments may be made to integrate a differential equation. The idea of a harmonic analyser was given by Amsler in his first paper as early as 1856, but Lord Kelvin first actually constructed one. It has been of great service in analysing tidal motion; but it is bulky, and cannot be carried about. Prof. Henrici has devised two others, one of which will give five terms in the expansion according to Fourier's theorem of any curve. These analysers should prove of great use to engineers and electricians, *e.g.* in investigating the action of valve-gear and the behaviour of dynamos. In the discussion which followed, Prof. Hele Shaw drew attention to the Hatchet planimeter as a most simple and efficient workshop instrument. Prof. Boys explained why it was so much more difficult to construct an instrument for differentiating than for integrating. An automatic differentiator appeared at present to be an impossibility. A person can differentiate with a machine; but a machine cannot of itself well differentiate. It is of the very nature of an integraph to smooth over the irregularities of a curve; whereas a differentiator would exaggerate all the irregularities of a curve.

Mr. Arnulph Mallock followed with a note on the behaviour of a rotating cylinder in a steady current. Lord Kelvin was in his best British Association form when discussing the resistance experienced by solids moving through fluids. As the time approached for Mr. Hiram S. Maxim's paper on flight, the audience grew to dimensions most easily explained by supposing that an experimental demonstration in Keble Hall was expected.

After Friday, on account of the large number of papers, the Section had to split up into two or three departments sitting simultaneously (and continuously, without any luncheon interval). Only the more important physical papers can be noticed here. On Saturday, Prof. Osborne Reynolds described and illustrated experimentally the successive stages in the motion of water passing under gradually increasing pressure through a vertical tube constricted in the middle. At first the water leaves the constriction in the form of a narrow, steady jet. As the pressure increases it fills the lower part of the tube, and eddies appear below the constriction; but the motion is still steady. The third stage is that of turbulent motion. Finally, there is an appearance as of air-bubbles at the constriction, accompanied by a singing or hissing sound; the water is now boiling under diminished pressure. Prof. S. P. Langley gave an account of his recent researches on the infra-red spectrum to an audience most unwilling to allow him to stop, and rather impatient at the manner in which his lantern slides were exhibited. The President (Prof. Rücker) and Prof. Norman Lockyer heartily congratulated Prof. Langley on the magnificent success of his work, which will be fully described in a subsequent number of NATURE. Dr. E. Pringsheim followed with an account of his new determination of the ratio of the specific heats of certain gases.

The first paper on Monday was one by Dr. A. Schmidt, on a new analytical representation of terrestrial magnetism. Prof. Schuster followed with two papers: in one of these he examined a suggested explanation of the secular variation of terrestrial magnetism, and in the other he discussed the minimum current which could be observed in a galvanometer of given dimensions wound in various ways. Lord Rayleigh followed with three papers.

In the first of these he described experiments made by him to determine the minimum current audible in the telephone. The estimates previously put forward vary widely: Preece gives 6×10^{-13} ampere; Tait, 2×10^{-12}, and De la Rue 1×10^{-8} ampere. Ferraris is the only experimenter who has given satisfactory details of his experimental methods; he found that the current diminished when the frequency increased, and that a minimum current of 5×10^{-9} ampere was required at a frequency of 594. His experiments were made with a make-and-break apparatus, which would give higher harmonics in addition to the stated frequencies. In Lord Rayleigh's experiments electromotive forces of the harmonic type were produced by the revolution of a magnet in the neighbourhood of an inductor coil of known construction. The revolving magnet consisted of 2·5 cm. of clock-spring driven, windmill fashion, by air from an organ bellows. The magnetic moment of the magnet was deduced from observations with a magnetometer. The inductor coil was the one which had been used as the "suspended coil" in the determination of the electro-chemical equivalent of silver, and it was placed with its centre vertically below that of the magnet. From the known data the induced electromotive forces were calculated. The current was carried to a distant part of the house through leads, and was varied by introducing a resistance-box going up to 10,000 ohms; the adjustment of the sound could thus be made by the observer at the telephone. Theory shows that the minimum current required in a telephone should be inversely as the square root of the resistance. Two telephones of the Bell unipolar type were used: the data given below refer to one which had a resistance of 70 ohms. When the magnet was driven at full speed the frequency was 307, and the minimum current observed was $3 \cdot 0 \times 10^{[illegible]}$ amperes. In order to extend the determinations to higher frequencies, recourse was had to magnetised tuning-forks vibrating with known amplitudes. With a frequency of 512 the minimum current was $7 \cdot 0 \times 10^{-8}$, and with a frequency of 640 it was $4 \cdot 4 \times 10^{-8}$ amperes. Lord Rayleigh's second paper was on the quantitative theory of the telephone. About this so little is known that even an attempt to determine the order of magnitude of the physical quantities involved is of great value. The method adopted is to consider first the case of an infinitely long thin rod of iron, divided by a transverse gap, and encompassed by an infinite coaxial magnetising coil. He finds the force exerted across the gap by a periodic current, and then replaces one-half of the infinite rod by the plate of the telephone, and reduces the coil to the actual dimensions used in practice. The force in dynes exerted at the centre of the telephone plate is calculated to be equal to $1 \cdot 7 \times 10^{6}$ C., where C is the current in amperes. By actual experiment the force was found to be equal to 0·6 C. Experiment also showed that the displacement of the plate produced by a current C was C × 0·08 cm. The amplitude of the motion produced depends largely upon the relation between the frequency of the impressed vibration and those natural to the plate. For the telephone in question, assuming the plate to be clamped all round the edge, the frequency of the gravest symmetrical mode is calculated to be about 991. On making the plate speak on its own account, the frequency found was 896. As it is almost impossible to estimate the amplitude when the frequency of the force is near any of the free frequencies, the vibration number 256 is taken for calculation. At this pitch the minimum recorded current is $8 \cdot 3 \times 10^{-7}$ amperes; and the amplitude corresponding to this is $6 \cdot 8 \times 10^{-8}$ cm. Assuming the telephone to be applied closely to the ear, so as to include 20 c.c. of air, it is shown that the condensation (in atmospheres) produced is $1 \cdot 4 \times 10^{[illegible]}$. For higher frequencies than 512 the actual sensitiveness, in virtue of resonance, is greater than the value calculated by the above method.

Prof. J. A. Ewing exhibited an apparatus for measuring small strains. The measurement of Young's modulus for considerable lengths of wires, as carried out in physical laboratories, is an easy matter; but engineers have to investigate the behaviour of short bars, and require an instrument which should be convenient and expeditious in use. In the instrument described these ends are achieved without any sacrifice of accuracy. There is only a slight mechanical magnification of the extension, but by means of a microscope forming part of the instrument, readings are made to 1/100,000th of an inch, and the readings are calibrated by a simple device which forms part of the instrument. If the arms have the same coefficient of expansion as the material of bar, there is automatic compensation for change of temperature. Difference readings were given for the extensions produced in a half-inch steel bar by twelve successive loads increasing each time by half a ton: these only varied between 10·4 and 10·7. The instrument is attached to the bar under examination in such a way as to measure strictly the *axial* elongation. It is well adapted for the investigation of small strains in parts of structures (*e.g.* members of railway bridges).

Mr. F. G. Baily made an important and interesting communication on hysteresis in iron and steel in a rotating magnetic field. It has long been known that, up to the limits of experiment, the value of hysteresis in an alternating magnetic field increases continuously. But it is a deduction from Prof. Ewing's molecular theory of magnetism that in a rotating magnetic field the hysteresis should diminish at a high induction, or at least show a reduction in the rate of increase. The following experiment substantiates this deduction in a very complete manner.—An electromagnet is rotated on bearings concentric with the bore of its own pole-pieces, which were bored out cylindrically. In the polar cavity a finely-laminated armature is suspended between centres, and held by a spiral spring attached to the axle and to a fixed support. Movement of the armature is indicated by a beam of light reflected from a mirror on it. On rotating the magnet, the armature tends to rotate with it by reason of hysteresis. The motion is checked by the spring, and the consequent deflection is proportional to the instantaneous value of the hysteresis per revolution. The curve of hysteresis and induction obtained is somewhat like that in an alternating field, rising very slowly at first, then more rapidly, but finally reaching a maximum and bending over. The fall is very rapid so far as the experiments have been tried, shows no sign of becoming asymptotic, but runs straight towards the zero line. Soft iron and hard steel give the same results, the differences between them corresponding to their differences in the **B H** curve. The three states of molecular arrangement, which are the essential point of the molecular theory, are exactly reproduced in the hysteresis curve. This first stage of quasi-elastic movement gives a very small hysteresis value. The second stage of irregular molecular groups and magnetic combinations gives a value approximately proportional to the induction at a steep inclination; this extends to the knee of the **B/H** curve. The third stage of approaching saturation gives a rapidly diminishing hysteresis when the molecular magnets are ranged in regular order along lines of force, and new combinations and irregular movements are prevented. Since the non-appearance of a correspondence between the **B H** curve and the hysteresis curve in alternating fields has been urged as an argument against the molecular theory of magnetism, this complete accord and verification of the deduction previously made is important as giving powerful support to Prof. Ewing's theory.

Prof. S. P. Thompson briefly explained how he had verified the magnetic analogues of well-known propositions respecting optical images in plane mirrors. The experiments were made by placing a magnetic pole in front of a sheet of iron, and investigating the field by an exploring coil connected to a ballistic galvanometer. Prof. A. M. Mayer showed how beats and beat-tones could be produced by two vibrating bodies whose frequencies of vibration are so great as to surpass the limit of audibility. He has also employed the transverse vibration of bars at various temperatures to determine the variation of the modulus of elasticity with change of temperature.

On Tuesday morning there was a joint meeting with Section I, to discuss theories of vision. Prof. Oliver Lodge showed experiments to illustrate Maxwell's theory of light. Electromagnetic waves produced by a small vibrator were allowed to fall upon a detector placed inside a large copper "hat." The detector consisted of a glass tube containing iron borings forming part of a circuit with a galvanometer. On account of its mode of action, this detector is called by Prof. Lodge a "coherer." Under the action of the waves its resistance diminishes and the galvanometer current increases. The coherer was used to demonstrate the reflection, refraction, and polarisation of electromagnetic waves. The audience, which filled every part of the large museum lecture-room, repeatedly showed its warm appreciation of Prof. Lodge's beautiful experiments. His electrical theory of vision may be briefly described as a suggestion that light-waves do not directly produce the sensation of vision, but that their action (like that of the electromagnetic waves in these experiments) is a kind of "trigger" action.

In the subsequent Section-meeting, Principal Viriamu Jones gave the results of further determinations of resistance in absolute measure by the Lorenz method. The apparatus had previously been used to determine the absolute resistance of mercury, and has now (with modifications ensuring still greater accuracy) been employed to measure certain coils whose resistance in terms of the Cambridge Standards is known. He also exhibited a new form of standard coil of low resistance.

In the absence of Prof. J. J. Thomson, his paper on the velocity of the cathode rays was read by Prof. Fitzgerald. The phosphorescence shown by glass in the neighbourhood of the cathode was ascribed by Crookes to the impact of charged molecules driven off from the negative electrode. The remarkably interesting experiments of Hertz and Lenard, which show that thin films of metal interposed between the cathode and the walls of the tube do not entirely stop the phosphorescence, have led some physicists to doubt whether Crookes' explanation is the true one, and to regard the phosphorescence as being due to a kind of ultra-violet light. The view to which Lenard has been led by his experiments—that the cathode rays are ethereal waves—demands the most careful consideration; for if it is admitted, it follows that the ether must have a structure either in time or space. A magnet produces no effect upon ultra-violet light unless this is passing through a refracting substance. Now these cathode rays are deflected by a magnet, so that on the above view it must follow that in the ether in a magnetic field there must either be some length with which the wave-length of the cathode rays is comparable, or else some time comparable with the period of vibration of these rays. Prof.

Thomson first proved by experiment that a magnet acts on the cathode rays through the whole of their course, and does not merely affect the place on the cathode at which they have their origin. He then proceeded to investigate the velocity with which the cathode rays travel, for it seemed that a knowledge of this velocity would enable us to discriminate between two views as to their nature. If they are ethereal waves, we should expect them to have a velocity comparable with that of light; if they are caused by molecular streams, their velocity should be that of the molecules, which we should expect to be very much smaller than that of light. The value found for the velocity of the cathode rays was $1 \cdot 9 \times 10^7$ cm./sec., which is small compared with the velocity of the main discharge from the + to the − electrode. It is much greater than the velocity of mean square of the molecules; it agrees very nearly with the velocity which a negatively electrified atom of hydrogen would acquire under the influence of the potential fall which occurs at the cathode.

On Wednesday, M. Cornu exhibited some brilliant optical experiments illustrating Babinet's principle. Prof. W. Förster described the displacements of the rotational axis of the earth. His results had been deduced by investigating the results of 6000 determinations of latitude in various parts of the globe. The maximum amplitude amounts to nearly half a second, which corresponds to a motion of the pole amounting to 40 or 50 feet. It appears that we are now approaching a period of minimum amplitude.

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE meeting of Section B at Oxford will be remembered as one of quite exceptional interest. That portion of the President's address urging upon the University fuller recognition of the claims of science in their curriculum will doubtless have valuable results. Certain of the communications brought forward in the course of the meeting may be described as epoch-making. The presence of a large number of eminent foreign chemists served further to render the proceedings memorable and attractive.

The Committee for preparing an International Standard for the Analysis of Iron and Steel reported that their work was now completed, and that it is proposed to shortly deposit the standards with the Board of Trade, or with some other suitable authority where they will be at the public service.

Prof. Clowes gave an account of his experiments on the proportions of carbonic acid in air which are extinctive to flame, and which are irrespirable. He finds that the flames of candles, oil, paraffin and alcohol are extinguished by air containing from 13 to 16 per cent. of carbonic acid. The flame of coal-gas, however, required the presence of at least 33 per cent. of the extinctive gas, and the flame of hydrogen was not extinguished until the amount of carbonic acid in the air reached 58 per cent. Comparing his experiments with those of Mr. J. R. Wilson on the percentage of carbonic acid required to suffocate a rabbit, Prof. Clowes concludes that air, containing at least 10 per cent. of carbonic acid more than is required to extinguish a candle flame, can be breathed with impunity. By taking advatage of the extraordinary vitality of the hydrogen flame in presence of high proportions of carbonic acid, it is possible to maintain the flame of the composite safety-lamp (previously described by the author), after the oil flame has been extinguished.

Mr. Haldane concluded from some experiments he has made on the respirability of air containing carbonic acid, that the percentage of this gas, considered by Prof. Clowes to be respirable, is too high.

Much interest was shown in the successful experiments of Dr. Lobry de Bruyn, demonstrating the properties of free hydroxylamine. On heating a small amount in a test-tube, a sharp explosion took place. Left exposed to air, it was shown by its action on iodised starch-paper to have become converted into nitrous acid. In a series of test tubes its behaviour with various reagents was demonstrated. With potassium permanganate, and with chromic acid oxidation took place, accompanied by flame; potassium bichromate produced an explosion. The anhydrous sulphates of copper and cobalt were reduced by the substance. Free hydroxylamine was dissolved in anhydrous ether, and sodium added, hydrogen was evolved and the very explosive sodium compound of hydroxylamine produced. Chlorine and iodine were shown to act spontaneously on hydroxylamine, producing inflammation. It is of interest that hydroxylamine will dissolve many salts which are soluble in water, the order of solubility differing in the two solvents.

Dr. Bernthstein described a new bacterium which occurs in milk, whose chief property is that of peptonising the caseine, thus forming a soluble compound, and rendering the milk transparent, and more readily digested.

On Friday a discussion took place on the behaviour of gases with regard to their electrification, and the influence of moisture on their combination. It was opened by Prof. J. J. Thomson, who exhibited some brilliant experiments illustrating the connection between chemical change and electrical discharge through gases. The gases were confined, under a pressure of about 100 mm. in glass bulbs which were placed in the centre of a coil of wire connecting the exterior of two Leyden jars, the interior coatings of which were connected with the two poles of a Wimshurst machine. As each spark passes between the poles of the machine, a rapidly alternating current is set up in the coil, and hence by induction in the gas. In the case of oxygen it was found that the moist gas gives a vivid incandescence, followed by an afterglow or phosphorescence, on removing the bulb from the coil. With the dry gas, on the other hand, incandescence does not take place. The incandescence, can however, be started in the dry gas by a brush discharge, and if once started continues under the influence of the induced current. With air the phenomenon is reversed; damp air does not glow, dry air will. By making use of two coils in one of which was a beaker of fairly strong sulphuric acid, and in the other a bulb containing moist oxygen, the presence of the acid was shown to prevent the incandescence in the bulb, showing the conductivity of the gas to be much greater than that of the acid. As the glow is only given in gases forming polymeric modifications, it is suggested by Prof. Thomson that the drops of water present may act as conductors causing the original molecules to dissociate. In the case of dry gases this preliminary dissociation can only be brought about by expenditure of a large amount of energy. Alcohol vapour will behave similarly to water, and it becomes of interest to study other solvents.

Mr. Brereton Baker followed with some experiments on the influence of moisture on chemical substances. He showed that ammonia and hydrochloric acid when dry do not combine. He also exhibited tubes containing dry sulphur trioxide and cupric oxide, and dry sulphur trioxide and lime, side by side without action upon one another, a kind of "chemical happy family," as he expressed it. He concludes that the function of moisture is physical rather than chemical from the fact that on heating together a dry mixture of cupric oxide, carbon and oxygen, no action takes place. He has obtained analogous results to Prof. Thomson, by using semi-vacuous tubes, into one end of each of which a platinum wire is fused and which contain a small quantity of mercury. On shaking these tubes in a dark room incandescence takes place in those containing moist oxygen. This is less if nitrogen is present, and ceases if the gas is dry. It was resolved in committee that Prof. Thomson's and Mr. Baker's papers should be published in full.

Dr. Ewan read a paper on the rate of oxidation of phosphorus, sulphur and aldehyde, a portion of which has already appeared in NATURE. The results obtained with aldehyde are free from the uncertainty produced by the correction for the changing rate of evaporation. When proper precautions are taken this reaction goes perfectly regularly at 20°, and its velocity is proportional to the product of the pressure of the aldehyde and the square root of the pressure of the oxygen. These results are most simply explained by assuming (in accordance with Williamson's theory), that the oxygen first splits up to some small extent into atoms, and that these alone take part in the oxidation.

In the discussion which followed the reading of these papers, Prof. Schuster spoke of the difficulty experienced in passing a discharge through mercury vapour.

Prof. Pringsheim noted the importance of ascertaining the relation between the spectrum given by the discharge, and that of the after-glow in the gas.

Mr. Vernon Harcourt remarked that Mr. Baker's results show that the part played by water in these reactions is probably unique, and is not shared by many, if any, other substances.

With reference to the dissociation of molecules, Mr. Baker pointed out that the atoms of gases can change their mode of combination independently of water, *e.g.* in the decomposition of potassium chlorate, and in the combustion of carbon disulphide. He suggested that the residual glow is due to the reformation of the original molecules.

Prof. Fitzgerald drew attention to the high specific inductive capacity of water, and contended that Prof. Thomson's explanation of his results meant simply that in a large molecule the atoms can change places.

The President understood Prof. Thomson to hold that water was present in actual drops, and queried whether that could be so in the explosion of carbon monoxide, where a very high temperature is reached.

Prof. Thomson, in his reply, seemed of opinion that minute drops might be present even in the case mentioned by Prof. Dixon. In conclusion he urged the desirability of the preparation of pure compounds in the large laboratories of the country, which might be sent to the physicist for investigation.

Prof. Hartley then described some new methods of spectrum analysis and some Bessemer flame spectra. He has found that if a mixture containing alkalies and alkaline earths be fused with borax or silica, the alkalies are first volatilised and give their characteristic spectra very clearly. For obtaining spectra at high temperatures it has been found useful to heat the substance in the oxy-hydrogen flame on a rod of kainite, pipe-clay, or dried alumina. The elements can be classified according to the type of spectrum given under these conditions. On vapourising alloys, those constituents which, when free, give band spectra, are found to produce line spectra, *e.g.* silver, in an alloy of copper and silver. This is thought to be due to the difference between the vapour pressure of the element when alloyed, and when in the free state.

The spectrum of the Bessemer flame has been studied with special reference to the bands produced by manganese.

Mr. J. W. Thomas read a paper on the chemistry of coal formation, in which he endeavours to trace the connection between the properties of a coal and the character of the vegetation from which it probably originated.

On Monday a large audience assembled to hear the announcement by Lord Rayleigh and Prof. Ramsay of the existence of a new gas in the atmosphere. It appears that certain experiments of Cavendish pointed to the presence, in air, of some substance other than the gases with which we are familiar. Attention was recalled to this substance by the fact that the density of nitrogen obtained from atmospheric air differs by about ½ per cent. from the density of nitrogen obtained from other sources. It was found that if air (with excess of oxygen) be subjected to electric sparks, the resulting nitrous fumes absorbed by potash, and the excess of oxygen by alkaline pyrogallate, there remains a residue which is neither oxygen nor nitrogen, as can be seen from its spectrum. The same gas can be isolated by exposing nitrogen obtained from air to the action of magnesium. As the magnesium gradually absorbs the nitrogen, the density of the residual gas gradually rises to nearly 20. The newly discovered substance constitutes nearly 1 per cent. of the atmosphere, and gives a spectrum with a single blue line much more intense than a corresponding blue line in the nitrogen spectrum.

Sir H. E. Roscoe, in proposing a vote of congratulation on the discovery, spoke of the special interest which attached to it as being the outcome of a purely physical observation.

Prof. Emerson Reynolds noted the place which the new substance, if it proved to be an element, would occupy in Mendeleef's table among the platinum metals.

Prof. Roberts-Austen suggested that this gas might be the one which is frequently found as a residue among the gases extracted from steel.

The President, in putting the vote of congratulation to the meeting, drew attention to an observation made by Prof. Dewar, that while a mixture of pure liquefied oxygen and nitrogen forms a clear liquid, air in a similar state shows a turbidity. The President suggested that this turbidity might be due to the new gas.

The question is discussed by Prof. Dewar in a letter to the *Times* for August 16, in which he states that the substance causing turbidity does not amount to 1 per cent. of the whole liquid.

The next communication was by Prof. McLeod, on Schuler's yellow modification of arsenic. This is produced as a yellow sublimate when pure arsenic is heated in vacuo. The substance rapidly changes to the black modification.

Some very interesting experiments on the electrolysis of glass were described by Prof. Roberts-Austen. In conjunction with Mr. Stansfield he has found that if a bulb of soda-glass be filled with sodium amalgam and immersed in a vessel of mercury heated in a sand-bath to rather over 200°, on connecting the sodium amalgam and the mercury respectively with the terminals of a battery, sodium will pass from the amalgam through the glass into the mercury. At the end of the experiment the glass is unchanged. If lithium amalgam be substituted for the sodium amalgam, however, a certain percentage of lithium is found in the glass at the end of the experiment, sodium from the glass is driven into the mercury, and the glass is altered in appearance and frangibility. With potassium amalgam and soda-glass no change takes place. These phenomena are believed by Prof. Roberts-Austen to depend on the relative atomic weights and consequent atomic volumes of the elements concerned. Lithium, having a smaller atomic volume than sodium, is able to follow in the galleries left by the atoms of the latter metal; potassium, on the other hand, having an atomic volume greater than sodium, cannot force a passage. From the results he has obtained, using other amalgams, such as those of gold and copper and different kinds of glass, Prof. Roberts-Austen hopes to throw light on the formation of mineral veins in rocks which apparently have not undergone fusion.

Mr. J. W. Rodger gave an account of the experiments which have been conducted by Prof. Thorpe and himself on the relations between the viscosity of liquids and their chemical nature. The method adopted allowed a rapid succession of experiments to be made on the same liquid, at different temperatures. In the case of the fatty acids and alcohols examined, evidence has been found of the existence of molecular aggregates.

Dr. J. H. Gladstone described some experiments on the rate of progress of chemical change. The chief reaction investigated was that which takes place when platinum chloride and potassium iodide are mixed, resulting in the formation of the dark coloured iodide. This change begins rapidly, with no period of inertness or "reluctance." Its completion is much retarded, however, by the presence of potassium chloride. A change which does require time to attain a maximum rate is that which takes place when cuprous oxide is immersed in a solution of silver nitrate, the silver which is produced making its appearance only after some time.

A similar change to the latter was described by M. Paul Sabatier, in which litharge added to silver nitrate solution is converted into the puce-coloured oxide of lead, with simultaneous deposition of silver.

A paper was read by Mr. Vernon Harcourt, in the name of the late Mr. Percy B. Lewis, on a new and very delicate method for determining the freezing points of very dilute solutions.

Dr. M. Wildermann gave an account of experiments he had made with Mr. Lewis's apparatus, and said that they fully confirmed the predictions of the Van't Hoff Arrhenius theory.

Mr. W. W. Randall described his apparatus for measuring the colour-tint of dilute solutions. His experiments, instituted in order to determine whether dissociation takes place in dilute solutions, are of a qualitative character. At their commencement he was not aware of the careful spectrometric work of Dr. Ewan on the same subject.

Mr. Philip Hartog read a paper on the distinction between compounds and homogeneous mixtures, a portion of which recently appeared in a letter to NATURE. He showed that until lately there was no satisfactory experimental criterion for distinguishing easily between true compounds and such mixtures, but the recent work of Raoult showed that the freezing point of a pure compound was always lowered, and its boiling point raised, by any admixture.

Prof. J. A. Wanklyn's paper on new evidence as to the atomic weight of carbon was received with interest, though not with unanimous support, by the chemists present. By fractionating Russian petroleum the author has obtained hydrocarbons of constant boiling point, whose vapour densities point to their all containing carbon atoms of the weight 6.

Dr. J. B. Cohen described a simple form of apparatus for determining carbonic acid in the air, depending on the length of time required by the carbonic acid in a given volume of air to neutralise a known amount of standard lime solution insufficient to combine with all the carbonic acid present.

Mr. A. P. Laurie contributed a paper on "The Diffusion of very Dilute Solutions of Chlorine and Iodine." The interesting result has been obtained that these elements in solution follow the law of gaseous diffusion, the chlorine diffusing twice as fast as the iodine.

Prof. J. W. Brühl gave an account of his investigations on tautomerism. By determining the molecular dispersion of compounds, he has been able to obtain values which are independent of temperature, and thus he has arrived at a sure means of distinguishing between bodies containing the group HC—C=O, or "keto" bodies, and those containing the group C=C(OH), which he termed "enole" compounds. With simple ketones and di-ketones no tautomerism or change from the keto to the enole form was found to occur. Nor did it occur with the alkyl derivatives of ketonic acids; when, however, the alkyl was replaced by an acid radical in these cases, tautomerism occurred. The author had investigated derivatives of camphocarboxylic and of malonic and succinic acids, and found the above rule to hold good in these cases, although enolisation was found to depend not only on the number of negative groups present, but also on the position of these in the molecule, and on the simultaneous presence of alkyl groups, which latter sometimes rendered the molecule more stable. An interesting compound had been obtained, namely, mono-brom-formyl camphor, which was a true ketone, and which was the only compound known in which the keto form of the formyl radical was present. In conclusion the assumption of Lahr, that ketonic compounds possess a "labile" constitution, was shown to be untenable, no continuous internal atomic movement being probable. In the case of benzene derivatives, on the other hand, such changes probably occur, and are termed by the author "phasotropic."

Prof. E. Noelting read two papers entitled, respectively, "On Di-nitros Derivatives of the Aromatic Series," and "On the Formation of Indazoles from Diazo-compounds." Both papers dealt with compounds, which showed the dependence of stability on molecular grouping.

Dr. Caro described the method of obtaining a new rhodamine, or pink colouring matter, by the interaction of chloral hydrate and an alkyl derivative of metamidophenol. A salt of a leuco base is formed, which latter on oxidation by ferric chloride gave a blue colouring matter. It was shown by experiment that on heating a solution of this blue compound in water it turned to a fine pink, owing to an intra-molecular change.

A paper followed, by Drs. G. G. Henderson and A. R. Ewing, on "Tetrarsenites." The sodium salt, which was prepared by adding arsenious oxide to acid sodium tartrate, was easily soluble in water, and might be conveniently used for hypodermic injections of arsenic. Other salts had been prepared, and also a solution which probably contained the hypothetical tartrarsenious acid from which they were derived.

Dr. J. B. Cohen read a paper on "The Constitution of the Acid Amides," in which he showed that these might be divided into two classes—those which formed compounds with silver and crystallised in needles or prisms, and those which did not form silver compounds and crystallised in plates. To account for these differences he fell back on Hantzsch's theory of the stereo-isomerism of nitrogen compounds, and concluded that the amides contain a hydroxyl group.

A short discussion followed the paper, in which Prof. Dunstan quoted experiments which he had made on the action of trichloride of phosphorus on acetamide, which did not bear out Dr. Cohen's view of the constitution of the latter body.

Dr. Caro, however, did not consider Prof. Dunstan's experiment conclusive.

The report of the Committee on Isomeric Naphthalene Derivatives was read. Work had been done on chlor-sulphonic and brom sulphonic derivatives of naphthalene, and the results tended to confirm the previous conclusions of the investigators.

The report of the Committee on the Action of Light upon Dyed Colours was read by the secretary, Prof. Hummel. The colours experimented with this year were chiefly yellows. Of these by far the largest number, ranging from "moderately fast" to "very fast," were to be found among the azo colours. The azoxy colours give good fast tints upon silk and cotton. The fastness of alizarin orange is probably greater than that exhibited by most other colours of the alizarin group. Very few fast yellows are derived from the natural colouring matters. The cultivation of weld, which yields the only fast and, at the same time, bright, natural yellows, is being gradually given up. It is fortunate then that efficient substitutes can be obtained from coal-tar, which, contrary to popular opinion, is the source from which the greatest number of colours fast to light are derived at the present time.

Dr. W. Meyerhoffer read a paper on "Certain Phenomena of Equilibrium during the Evaporation of Salt Solutions." For a given mixture of salts in a saturated solution it was found that there existed a certain transition temperature above which double decomposition took place. Thus with a saturated solution containing ammonium chloride and sodium nitrate, sodium chloride was formed above 6° C., while below that temperature no change took place.

GEOLOGY AT THE BRITISH ASSOCIATION.

OF the forty-three papers presented to Section C this year, comparatively few are of lasting importance, geologists having apparently saved up their best work for presentation at Zurich, or else having exhausted themselves at the excellent and successful session of the previous year. The President's address, containing an excellent epitome of the recent progress of mineralogy, was rather fitted for quiet and thoughtful perusal than for reading to a mixed audience, but it will be looked back upon as one of the most valuable of the contributions to the forthcoming volume of *Proceedings*. It was followed up by only one paper dealing with pure mineralogy, that of Mr. H. A. Miers, on a new method of measuring crystals. The two fundamental laws of crystallography—namely, (1) the constancy of the angle in crystals of the same substance, and (2) the law of simple rational indices—seem to be violated by those crystals which are liable to irregular variations in their angles, or those which have the simple faces replaced by complicated "vicinal" planes. Both these anomalies are exhibited by potash- and ammonia-alum. Brilliant and apparently perfect octahedra of these salts show large variations in the octahedron angle; other crystals show low vicinal planes in place of the octahedron faces. If it be true, as is supposed, that the octahedron angle varies in different crystals, it would be interesting to ascertain whether progressive variations can be traced during the growth of a single crystal, and whether some or all of the octahedron faces change their direction in space if the crystal be held fixed during growth.

In order to solve this problem a new goniometer has been constructed, in which the crystal is fixed at the lower end of a vertical axis, so that it can be immersed in a liquid during measurement. This device is in reality an inversion of the ordinary goniometer with horizontal disc; the liquid is contained in a rectangular glass trough with parallel-plate sides; one side is placed rigidly perpendicular to the fixed collimator, and the other is perpendicular to the telescope, which is set at 90° to the collimator. The trough is supported on a table which can be raised and lowered, so that the crystal can be placed at any required depth in the liquid. If the liquid used be its own concentrated solution the crystal can be measured during growth, and the changes of angle, if any, can be observed at different stages. In order that it may be held rigidly, the crystal is mounted, when small, in a platinum clip, which it envelops as it grows larger.

The results derived from the measurement of a large number of alum crystals are as follows:—

(1) The faces of the regular octahedron are never developed upon alum growing from aqueous solution.

(2) The reflecting planes (which are often very perfect) are those of a very flat triangular pyramid (triakis octahedron) which overlies each octahedron face.

(3) The three faces of this triangular pyramid may be very unequal in size.

(4) The triakis octahedron which replaces one octahedron may be different from that which replaces another octahedron face upon the same crystal.

(5) During the growth of the crystal the reflecting planes change their mutual inclinations; the triakis octahedron becomes in general more acute, *i.e.* deviates further from the octahedron which it replaces, as the crystal grows.

(6) This change takes place not continuously, but *per saltum*, each reflecting plane becoming replaced by another which is inclined at a small angle (generally about three minutes) to it.

(7) During growth the faces are always those of triakis octahedra; if, owing to rise of temperature, re-solution begins to take place, faces of icositetrahedra are developed.

These observations prove that the growth of an alum crystal expresses an ever-changing condition of equilibrium between the crystal and the mother liquor. It does not take place by the deposition of parallel plane layers; new faces are constantly developed: since these succeed one another *per saltum* they doubtless obey the law of rational indices, though not that of *simple* rational indices. From the mutual inclinations of these vicinal faces it is possible to calculate with absolute accuracy the angle of the faces to which they symmetrically approximate. This angle is found to be that of the regular octahedron 70° 31¾'. The octahedron angle of alum is not, therefore, as appeared from the observations of Pfaff and Brauns, subject to any variation.

Mr. Howard Fox described a remarkable rock which occurs at Dinas Head in Cornwall, between a greenstone and a slate, and apparently intruded upon by the former. It has the composition of albite felspar, with as much as 10 per cent. of soda, and is like the keratophyres in composition as well as in the possession of concretionary and spherulitic structures. The nodules and spherulites stand out as the rock weathers, and the latter are shown by the microscope to consist of blades of albite radiating round centres of cryptocrystalline material. On the other hand, the rock might belong to the altered sediments called adinoles, of which some, in the Harz, yield 7.5 per cent. of soda, and with this the field evidence and the presence of idiomorphic crystals of ferriferous carbonate appear to agree. Mr. W. W. Watts exhibited photographs of a stack of Keuper sandstone at the Peakstones, near Alton, Staffordshire, which, he claimed to have proved, owed its resisting power to the existence of almost vertical planes in the rock cemented by the deposit of barium sulphate. These planes strike along a prominent ridge between two valleys, and at the end of it is the projection of the Peakstones rock. Other cases in which basement beds of the Keuper sandstone are similarly cemented were quoted by the author.

Amongst the papers dealing with Oxfordshire geology, that by Prof. Green demands attention first. In it he described the sections displayed at Fawler and Stonesfield, Shotover, Faringdon, Culham, and Swindon. The thinness of the Upper Lias at Fawler was remarked upon, and a curious case of contemporaneous erosion in the Forest Marble described; the peculiar character of the iron-sands was explained by their having been deposited in a long strait, in which Faringdon was a sheltered bay, suited for the growth of the organisms which here make up almost the whole deposit. In the section at Culham, which shows Gault resting directly on Kimmeridge or Portland limestone, the denudation of the iron-sand was described as a local phenomenon, it being found in full force at another section hard by. The excavations at Stonesfield, carried out by Mr. Walford, were the subject of a report by him, in which he showed that about 30 feet of limestone with clay seams, presenting on the whole the aspect of the great oolite, occurred beneath the "slate" bed. He intends to continue his excavations in order to determine the relationship of these deposits to the Chipping Norton limestone and the Clypeus grit of the Oxfordshire Inferior Oolite. In another paper the same author points out that the terraced hill slopes occur in one geological line in Oxfordshire, the outcrop of a band of micaceous marl in the Middle Lias just below the "red rock bed." The water penetrates from above where the Upper Lias has been stripped off by denudation and filters through to the top of the clay of the *margaritatus* zone, where it makes its escape. The saturated marls are continually creeping down hill, and, in doing so, give rise to the terraces.

Prof. W. Boyd Dawkins endeavoured to trace the submerged folds of palæozoic rocks under the mantle of newer formations in Oxfordshire, by means of the principle originally laid down by Godwin-Austen and elaborated by Bertrand in recent papers, that the great pre-carboniferous folds form lines of weakness, along which the upper skin of later rock wrinkles and cracks. The northern rim of the South Wales syncline, which contains the coal-basin, was traced eastwards through the Forest of Dean, the partially covered fields north of the Mendips, through Gloucester, Blenheim, Kirtlington, Quainton, Bishop's Stortford, Braintree, and Colchester. From this it is reasonable to infer that coalfields will be found in the area between this line and that from the Mendips to Hythe. One such the author claims to have been discovered at Burford, and he advises that further investigation should be carried on, there and in the neighbourhood, to set at rest the question whether workable coals occur in this syncline. Three other papers by the same author dealt with evidence from borings. The first drew attention to a seam of oolitic iron ore (grains of hydrated oxide embedded in calcium and iron carbonates) of Kimmeridgian age, met with at the Dover boring. The second dealt with the Permian strata of the north of the Isle of Man, consisting of 913 feet of red Roth-liegende sandstone, followed by 455 feet of calcareous conglomerates and breccias, which were correlated with the magnesian limestone; these rocks form a connecting link between those of Cumberland and North Ireland. The third communication described three borings in the north of the same island, one of which had penetrated 33 feet of salt-bearing marls apparently at a greater depth than 450 feet from the surfaces: the Triassic sandstones and saliferous marls again present another link between Carrickfergus and the English coast. A paper by Prof. Bonney instituted a comparison between the pebbles in the trias at Cannock and Budleigh Salterton, as a result of which he concluded that those of Budleigh must have come from the south-west, but that similar fragmental rocks fringed the ancient western land in localities far apart.

Sir Archibald Geikie corroborated Heddle's identification of the Pitchstone of Hysgeir, an island about eighteen miles west of Eigg, with that of the latter island. This lava, which flowed into a river channel sloping from east to west, is exactly like that of the Scuir of Eigg, but unfortunately its base cannot be seen. The old river channel would be at least 20 miles long, with a fall of perhaps as much as 35 feet in a mile. Gravels containing masses of volcanic rocks (some of them possibly thrown direct from volcanoes), with water-worn blocks of Torridon sandstone, grit, quartzite, and other rocks, rapidly thinning out or passing into fine tuff or volcanic mudstone, are to be found in the islands to the north of Hysgeir, intercalated at various horizons in the bedded basalts, and have doubtless been formed by the flooding and torrential action of contemporaneous rivers.

A joint discussion on the plateau implements of Kent, held by Sections C and H, was opened by Prof. Rupert Jones, who agreed with Prof. Prestwich that the implements were of human origin and dated back to an ancient time when the physical geography of the Weald was very different from its character to-day. Mr. Whitaker followed with a paper, in which he stated that he did not consider the plateau gravels so ancient as had been supposed by other authors, but that part of the deposit, at any rate, was a residuum which had grown where it stood, and is still growing, so that implements in it might be of almost any age. He further stated that he could find no evidence to connect men with preglacial or even glacial times. Amongst the other speakers were Mr. Montgomerie Bell, Sir John Evans, Dr. H. Hicks, Prof. Boyd Dawkins, General Pitt-Rivers, Sir Henry Howorth, Mr. Clement Reed, and Lieut.-Colonel Godwin-Austen.

The more important palæontological communications included Prof. Rupert Jones's eleventh report on Palæozoic Phyllopoda, Mr. Laurie's second report on the Eurypterids of the Pentlands; recording the obtaining of a large amount of material from which important results are to be expected; Dr. Traquair's preliminary notice of a new fossil fish from the upper Old Red Sandstone of Elginshire; Mr. Jeffs' descriptions of forms of Saurian footprints from the Cheshire Trias, some of which were new, while apparently none of them could be referred to any known species of Labyrinthodont; and Dr. Hicks's conclusion that the original home of the earliest forms of animal life was at some point in the Atlantic. Mr. Montagu Browne's third paper on Rhætic Vertebrata, in which teeth of "Saurichthyan" type were described in the same jaws as Labyrinthodont teeth, proving that the remains attributed to Saurichthys must be assigned to Labyrinthodonts, Plesiosaurus, Hybodus, and Gyrolepis, also called attention to remains of Rysosteus, Metoposaurus or Trematosaurus (?), and Dinosauria.

The consecration of Monday to pleistocene geology has almost become an institution, probably because, although new facts of consequence may not have been discovered within the year, at least one new interpretation of them, or a new theory founded on some of them, can always be relied upon. The day was opened by Mr. Bell's report on the well and borings at Chapelhall, near Airdrie, which completely proved that there was now no shelly clay to be found in the well or in borings in its immediate neighbourhood. Mr. Kendall followed with a report on the boulders examined and collected during the year.

Dr. Hicks next endeavoured to prove that the stratified gravels, sands, and clay of the plateaux of Hendon, Finchley, and Whetstone, which are covered by chalky boulder clay, had been formed in a lake dammed to the east and west by ice in a moraine, a view which elicited considerable comment and disagreement from a number of glacialists present. Prof. Blake described areas in the Harlech Mountains, some of which were floored by bare, ice-scratched rocks, side by side with others covered by thick drift deposits. Prof. Bonney, judging by the temperature at which glaciers now form in the Alps, came to the conclusion that a fall of 15° to 20° F. would be quite sufficient to cause all the known glaciation in the northern hemisphere. Mr. E. P. Culverwell read a paper entitled "An Examination of Croll's and Ball's Theory of Ice Ages and Genial Ages," in which he stated that an appeal to figures conclusively proved the inadequacy of the astronomical theory as at present formulated. By calculating the comparative solar heat of the high eccentricity winter of 199 days, and that of 199 coldest days of the present winter, he showed that the isochimenals would be about 4° of latitude further south, and the isotherals more than 4° further north, then than now. In the "genial age" the shifting would not be more than $2\frac{1}{2}$°. This cause he considers totally inadequate to account for glacial and genial ages, and therefore falls back on changes in physical geography for the former, and shift of the pole, or greater solar and terrestrial activity, for the latter. In the discussion Sir Robert Ball defended his position, but was further attacked by Prof. Fitzgerald and other speakers.

Prof. Blake endeavoured to show that by the lowering of its centre of gravity as a whole the further end of an ice-sheet might be raised and carry boulders and detritus up a slope. The Rev. E. Jones presented the final report on the Elbolton Cave, stating that no palæolithic remains had been found, and that the investigation was consequently abandoned. The preliminary work, however, in the Calf Hole Cave, near Skipton, was more hopeful, and already a hafted implement, made of a chisel-like tooth bedded in antler and mounted in wood, had been found. In a short paper on the palæolithic section at Wolvercote, near Oxford, Mr. Montgomerie Bell described the section as follows: (1) a "northern drift" and subangular gravel resting in eroded hollows of the Oxford clay. (2) A river gravel containing shell seams, and in whose lowest bed palæolithic implements associated with mammoth, *Cervus elaphus*, *Bison priscus*, &c., have been found. (3) A bed of peat containing the remains of local plants. (4) Sand, mud, and hail close the section. Two palæolithic implements were recorded by Mr. Bruce Foote from an old alluvium, through which the Sabarmati river in Guzerat had cut a channel, varying from 100 to 200 feet in depth.

Dealing with questions of physical geology, Mr. Lobley tried to show that the contraction theory would not explain volcanoes and earthquakes. Dr. Tempest Anderson described three types of subsidences occurring in connection with volcanic rocks in Iceland; the most common type was due to a falling crust where the inner lava stream escaped, others were due to earthquakes, and still others to faulting, probably caused by subsidence of a volcanic centre as a whole. Dr. Johnston-Lavis recorded his observations on the activity of Vesuvius during the year. Mr. De Rance reported in underground waters. Prof. Herdman drew attention to the geological results flowing from his investigation of the bed of the Irish Sea. Prof. Sollas announced that arrangements were in progress for commencing the boring of a coral island. Prof. Hennessy described the channels of streamlets in estuaries as possessing a section constructed of two catenary curves, the only shape which gives a constant velocity whatever the depth of the stream; and Sir H. Howorth passed a series of strictures on current geological nomenclature, with suggestions for its revision, which will doubtless receive the attention due to so high an authority in these matters.

Mr. C. Davison's report on earth tremors contained an account of the trial and modifications of Mr. H. Darwin's bifilar pendulum, and of the horizontal pendulum used at Nicolaiew; then followed an elaborate analysis of the pulsations of the Greek earthquake of this year, showing how they spread to one observatory after another, and were felt at Rome, Siena, Nicolaiew, Potsdam, Kew, and Birmingham. In his report on geological photographs, Mr. Jeffs stated that the collection now amounted to 1055, and that the time seemed to have arrived when it should be housed in some convenient and central position, although it was still necessary to add to the collection, so as to make it thoroughly representative of the whole country. A number of photographs were exhibited and slides from some of them displayed at the second conversazione.

NOTES.

M. GUSTAVE COTTEAU, a Correspondent of the Paris Academy, in the Section d'Anatomie et Zoologie, died at Paris on the 10th inst.

MR. M. A. RYERSON has presented to the University of Chicago the Ryerson Physical Laboratory, built at a cost of 250,000 dollars.

THE International Congress of Applied Chemistry, which has just finished a session at Brussels, will hold its next meeting at Paris in 1896.

DR. D. F. OLTMANNS has been appointed Extraordinary Professor of Botany at the University of Freiburg-i. B.

THE Imperial Acclimatisation Society of Moscow has founded a botanical section for the purpose of collecting materials for a Flora of Russia. The co-operation is invited of all who are able to assist in this work. Communications should be addressed to the Director of the Polytechnic Museum, Moscow.

MR. H. W. UNTHANK informs us that while shore-hunting at Brightlingsea on August 4, he came upon a stranded Aurelia which exhibited a pentamerous instead of the usual tetramerous symmetry. The specimen is at present in the Brightlingsea Marine Laboratory of the Essex County Council.

MR. FRED N. SCOTT, Assistant Professor of Rhetoric in the University of Michigan, has issued, in the form of a leaflet, a series of questions on the psychology of usage. He wishes to ascertain the origin of dislikes, especially of arbitrary, unreasoning dislikes, for certain words and phrases. He will be glad to send a copy to anyone who is interested in the subject and who will take the trouble to answer the questions.

THE annual general meeting of the Federated Institution of Mining Engineers will be held in Newcastle-upon-Tyne, on Wednesday, September 5, in the Wood Memorial Hall of the North of England Institute of Mining and Mechanical Engineers. The papers down for reading are:—"The Stetefeldt Furnace," by Mr. C. A. Stetefeldt; "Walling and Sinking simultaneously with the Galloway Scaffold," by Mr. John Morison; "Timber Bridges and Viaducts," by Mr. Morgan W. Davies; "Explosions in Nova Scotian Coal-mines," by Mr. Edwin Gilpin, jun.; and "The Shaw Gas-tester for detecting the Presence and Percentages of Fire-damp and Choke-damp in Coal-mines, &c.," by Mr. Joseph R. Wilson. There will also be discussions on other papers, and various excursions.

THE cholera epidemic is slowly spreading, especially in European Russia. Since the end of June, fifteen new districts in Russia have been declared to be infected, making a total of about forty. In Austria-Hungary, in many towns situate on the Vistula, and in Belgium, the disease has extended, and a number of fatal cases have occurred in places in Northern Holland. The Local Government Board is keeping a close watch on the progress of the epidemic, and every precaution is being taken to prevent it from obtaining a foothold in this country. Some anxiety will be felt for a month or so, for during this period the risk of infection is greatest. The dismal weather we have been experiencing this summer, though hardly conducive to pleasant holidays, has one redeeming feature, for it is decidedly unfavourable to the development of a cholera epidemic.

BY the death of Dr. C. R. Alder Wright, at the end of last month, science lost a tireless and enthusiastic worker. He was educated at the Owens College, Manchester, and early showed an aptitude for scientific research. His work extended over a large part of the domain of chemistry. It comprises, says the *Chemical News*, "investigations of simple substances, like hydriodic acid, and some of the most complex substances, like the vegeto-alkaloids, upon which he laboured for many years—sometimes alone, and sometimes in conjunction with Matthiessen and others. These researches deserve to be classical if any researches do, and they occupy an entire department of organic chemistry." Another subject to which Dr. Wright devoted great attention was the determination of chemical affinity in terms of electromotive force. The versatility of his genius is shown by the different subjects of his numerous papers. Isomeric terpenes, the smelting of iron in blast-furnaces, some points in chemical dynamics, and certain voltaic combinations, are a few of the subjects taken up by him. In 1889 he commenced a series of valuable communications to the Royal Society, on "Ternary Alloys," and the seventh part of the series was read before the Society at the beginning of last year. Thorough and conscientious in everything he undertook, Dr. Wright will always be regarded with esteem throughout the world of science.

THE Paris Société d'Encouragement pour l'Industrie Nationale is constantly giving evidence of its usefulness. The latest proof of this is to be found in the publication of a circular on the "Unification des Filetages et des Jauges de Tréfilerie." The Society has had the question of a standard screw-pitch and wire-gauge in hand since the end of 1891. It was, however, only three months ago that a meeting was held for the purpose of discussing the various systems suggested, and at that meeting the scales expounded in the pamphlet before us were accepted. To secure uniformity in the manufacture of screw-threads, the Society proposes a system, to be known as the "Système Français," in which the pitch increases in steps of half a millimetre, from a screw having a diameter of six millimetres and a pitch of one millimetre (No. 0) to one having a diameter of 148 millimetres and a pitch of 10·5 millimetres (No. 19). The formula which, in this system, allows the diameter (D) corresponding to any pitch to be deduced is $D = p(p + 8) - 1{\cdot}5 \div 1{\cdot}3$, where p is any pitch expressed on the adopted scale. By means of this, it is possible to extend the new system to screws of any diameter, and the number of the screw of which the diameter had been thus determined would be equal to the number of half-millimetres expressing the pitch, *minus* two. For screws less than six millimetres in diameter the standard drawn up by M. Thury for the Société des Arts of Geneva is adopted. In addition to promulgating these standards of screw construction, the Société d'Encouragement has developed a decimal system of gauging wires. In this system, the numbers of the wires express their diameters in tenths of millimetres; thus, a No. 7 wire has a diameter of 0·7 mm. Such a method of designating wires is as simple as it is scientific. In France and other countries using metric standards, the introduction of the new system will be comparatively easy; but we regret to say that in this land of complicated weights and measures, there is little hope of its adoption.

THE general sitting of the German and Austrian Alpenverein was held this year in Munich from August 8 to 11. At the end of the Congress several tours were conducted into the Bavarian and Austrian highlands. The Congress was attended by more than 6000 members, by delegates representing Alpine clubs in other countries, by Bavarian State delegates, and others. Business matters were smoothly arranged, the Central Committee showing an annual income of £9850, and in addition £5000 in hand. There are now 214 local sections of the Alpenverein, each of which pays a certain portion of the fees of membership to the Central Committee and retains the rest for independent income and outlay. Out of an unostentatious beginning, twenty-five years ago, has grown a club with a membership of over 31,000, and a many-sided activity and vigour of life promising a still greater future. The object of the Verein is to improve travelling in the Alps, and to increase our knowledge of them. Again, the management of the guides is entirely conducted by the Verein; the guides being occasionally placed for a short course of training in some central town. The Munich section is the largest of the Alpenverein sections, and was therefore well able to entertain the members generously. The halls in which the great festival of the Congress was held on Thursday, the 9th inst., were decorated on a magnificent scale. An exhibition of maps and models was held in the Academy of Sciences. The relief of the Jungfrau Group, by Simon, modelled to a scale of 1:10,000, attracted great attention. The surest proof of the success of the Alpenverein in its efforts for Alpine travelling is its popularity among the mountain inhabitants. They honour it for the good it has done their wild country and for the intercourse it has opened up. Meanwhile the Alpenverein plays its part worthily in the wider arena of science as journalist, cartographer, meteorologist, geologist, botanist, and all in no small measure.

DR. P. MIQUEL contributes to the *Diatomiste* an important paper on the re-establishment of the size of diatoms. This takes place, according to this observer, mainly by the activity of the nucleus. The protoplasm within a micro-frustule clothes itself with a thick extensible membrane, frees itself from the valves which imprison it, attains the normal size, and then secretes a siliceous envelope. No process analogous to conjugation could be detected by Dr. Miquel in a vast number of observations on many different species. He proposes the abolition of the terms auxospore and sporangial frustule, as not expressing accurately any process which actually takes place in the multiplication of diatoms.

THE Department of Science and Art has issued the following list of successful candidates for National Scholarships, Royal Exhibitions, and Free Studentships, awarded upon the results of the May Examinations this year. National Scholarships for Mechanics—Arthur H. Barker, 23, fitter, Pontefract; Edward R. Amor, 18, engineer apprentice, Devonport; John T. Rieley, 25, science teacher, Birmingham; Charles B. Brodigan, 24, draughtsman, London. National Scholarships for Chemistry and Physics—Charles A. West, 24, teacher, Tottenham, Middlesex; William H. White, 15, student, Ipswich; Harry Dean, 17, student, Manchester; William C. Reynolds, 24, pharmacist, London; John Lister, 18, student, Stockport. National Scholarships for Biological subjects—Ernest Smith, 25, assistant teacher, Huddersfield; Frank H. Probert, 17, student, London. National Scholarships—George M. Russell, 22, shipwright apprentice, Portsmouth; Samuel Stansfield, 21, engineering student, Todmorden; Gilbert T. Morgan, 23, chemist, Huddersfield; William G. Hall, 18, student, Nottingham; Arthur S. Cox, 17, student, Southampton; Frederick T. Munton, 25, joiner, Derby; George Wilson, 22, mechanical engineer, Sheffield; George E. Ashforth, 16, student, Manchester; George L. Overton, 19, watchmaker, Bradford, Yorks; Norton Baron, 21, engineering student, Ulceby, Lincs.; Ernest E. L. Dixon, 18, student, London. Royal Exhibitions—Frank Fisher, 19, engineer, Brighton; Clarence Smith, 18, student, Brighton; William H. Eccles, 18, apprentice druggist, Barrow-in-Furness; Frank G. Edmed, 17, student, Brighton; Henry T. Hildage, 19, fitter, Altrincham; Robert H. Watson, 24, student, Dublin; Harold Hibbert, 16, student, Manchester. Free Studentships—John W. Button, 23, tool fitter, Oldham; George H. Stanley, 17, student, London; Walter Eraut, 19, mechanical engineer's apprentice, London; I. William Chubb, 23, draughtsman, London; Robert H. H. Duncan, 15, student, Sunderland; George George, 18, student, Bristol. Percy

Nicholls, 23, engineer, of Pontefract, obtained the third place in order of merit in the competition for National Scholarships, &c., but withdrew before the awards were actually made.

The separation of minerals of high specific gravity has recently been greatly facilitated by the introduction of the fused double nitrate of silver and thallium, originally due to Dr. J. W. Retgers. When these nitrates are brought together in the molecular proportion of 1 : 1, they yield a double salt, which fuses at 75° C. to a clear, mobile liquid, having a specific gravity of about 5 and miscible with water in all proportions at temperatures between its melting point and 100° C. The melting point also diminishes rapidly as water is added, going down to 50° or 60° C., and fusion and solubility pass uninterruptedly into one another. We have thus at our command for the separation of mineral particles a liquid far exceeding in specific gravity any of the previously described heavy solutions, and which has the advantage of being practically colourless, neutral, soluble in water, and of being readily recovered from the aqueous solution by simple evaporation on the water bath. Some further hints upon the use of this convenient medium are given in the current number of the *American Journal of Science*, by Messrs. Penfield and Kreider. Separations may be made in test tubes heated in a water bath. After a separation is completed and the fusion cooled, the test tube is broken and the solid cake divided, when the heavier and lighter portion may be obtained by dissolving the double salt. If fractional separations are required, the fused salt may be placed in a tube with a narrow neck at the bottom, into which is ground a glass rod to serve as a stopcock. This apparatus slips inside of a test tube to within a few millimetres of the bottom. The whole is heated in a beaker of hot water, and the liquid is stirred by means of a glass rod bent into a semicircle at the bottom. Heavy particles are drawn off by raising the ground glass rod. Small particles getting caught in the stopper can usually be ground out by twisting the rod, but in no case will such an accident cause great inconvenience.

The annual report for 1893, just received from the Department of Mines and Agriculture, New South Wales, states that the Government metallurgical works will probably be started this year. These works in conjunction with the School of Mines which has been established at the Sydney University, enables the colony to offer as complete and effective a course of training in mining and metallurgy as can be obtained in Great Britain. The report consists largely of statistics relating to the output, value, &c., of various minerals. A boring made at Cremorne Point is of interest. Prof. T. W. E. David made some determinations of the temperature of this bore. The hole was 2929 feet deep, but the bottom 29 feet (about) was silted up with the powdered rock produced by the cutting action of the diamond drill used in the boring. From 2900 feet to within 300 feet of the surface, the bore was filled with water, the column being, therefore, 2600 feet high, and giving a maximum pressure of, approximately, a trifle over half a ton per square inch. The thermometers used were hermetically sealed in wrought-iron tubes and surrounded with brass filings and brass turnings. The readings obtained showed that the rock temperature at a depth of 2730 feet was 97°·5 F. The mean surface temperature at Sydney is about 63° F., so the rate of increase was 1° F. for about every 78 feet 10 inches.

The *Bulletin* of the Royal Gardens, Kew, No. 92, for August 1894, is entirely occupied by a summary of information relating to Bananas and Plantains, with descriptions of the species and principal varieties of *Musa* grown for use and ornament.

From thirty to forty volumes are issued yearly in the comprehensive "Encyclopédie Scientifique des Aide-Mémoire" series published jointly by MM. Gauthier-Villars and M. Masson. The whole collection, when completed, will number three hundred volumes. The latest addition to the series is "Les Machines Thermiques," by Prof. Aimé Witz. The theory of steam, hot air, and gas engines is well described by the author, and the relations between different heat engines are set forth in a manner which brings out clearly the special characters of their respective cycles.

The third volume of the *Seismological Journal of Japan*, corresponding to the *Transactions* of the Seismological Society, has reached us. Prof. John Milne, F.R.S., contributes to it a paper on "Seismic, Magnetic, and Electric Phenomena," in which he discusses the evidence as to the connection between those phenomena. Observations are adduced which seem to show that there may be a connection between earthquakes and magnetic and electric manifestations. But, concludes Prof. Milne, though "a variety of experiments and investigations have been made to test whether earthquakes were preceded, accompanied, or followed by magnetic or electric phenomena, the results obtained do not guarantee the existence of such connections. It does not seem likely that earthquakes can result from electric discharges, and it has not yet been proved that they give rise to electric phenomena. When they have resulted in the displacement of large masses of rocky strata, as happened in 1891 in Central Japan, slight local changes in magnetic curves have resulted, but beyond this and effects due to the mechanical shaking of earth-plates, our certain knowledge is exceedingly small."

The "Geological Sketch-Map of Western Australia," by Mr. H. P. Woodward, the Government geologist, shows in a very clear manner the geology of the explored districts; but it also shows of how large an area the geology is quite unknown. The scale is 1 : 3,000,000 (1 inch to 47·3 miles). The rock-divisions coloured are: Recent and Tertiary, Mesozoic, Palæozoic, Metamorphic, Crystalline (schists and granite), Volcanic, and Plutonic (basalt and granite). The distribution is shown of gold, copper, lead, tin, and coal; gold and copper are indicated by solid colour, which somewhat interferes with the general effect of the map, as the colours appear to represent special formations; the other minerals are shown by coloured lines. The chief gold-fields are situated on metamorphic rocks; a few are in the crystalline areas. The geology of the Coolgardie and Dundas gold-fields is not indicated. The map is clearly printed, both in its topography and colouring. It is published, for the Government of Western Australia, by G. Philip and Son, Fleet Street, London.

The *Monist* for July contains an interesting article by Mr. Wm. R. Thayer, on Leonardo de Vinci as a pioneer in science. Of the thousands of MS. pages which this indefatigable experimenter left, one volume alone has been edited. At first no one could decipher them, for Leonardo wrote backwards from right to left. The pioneer work in science, astronomy, physics, geology, botany—in fact, the whole circle of the sciences—contained in this one volume is briefly but clearly sketched, and some of his pithy and epigrammatic notes are quoted. "His curiosity was insatiable; his methods were observation and experiment; his advance was from the known to the unknown. . . . To search out all things, to experiment and verify, to let his eyes test, and reason be the judge. This was Leonardo's method." Prof. Hermann Schubert's article on "Monism in Arithmetic" is a lucid statement of fundamental principles in continuation of a previous paper on "The Notion and Definition of Number."

Experimental psychology is represented in *Mind* by an article on "Mediate Association," by Mr. W. G. Smith, the results of which do not appear to be very conclusive. In the *Psychological Review*, Prof. Ladd describes the results of experimental work on the "direct control of the retinal field." A class of sixteen students were asked to close the eyes, allow after-images to die away, and then to cause, by attentively willing, a cross, circle, or some other simple figure, to appear in the retinal field. In two cases, where the results were successful, a coloured figure was distinctly visualised, and when the eyes were opened after these voluntary crosses were obtained, and were immediately focussed on a sheet of white paper, a cross was found to appear on the paper in the complementary colour. It is clear that these experiments open up interesting psychological problems. Prof. Jastrow, in the same journal, describes experiments on Helen Kellar, a blind and deaf girl. The sensibility of her finger-tips and the palm of her hand were found to be decidedly more acute than in the average individual; her verbal memory is decidedly above the normal; and she shows that sensitiveness to vibration and jars which has frequently been noted in the deaf.

Mr. Thomas R. Sim, Curator of the Botanic Garden, King William's Town, South Africa, has done good service by collecting and systematically arranging the records of Kaffrarian plants, in a pamphlet recently published at Cape Town. As a botanical district, Kaffraria is described as an oblong tract of country two hundred miles long by about one hundred miles wide, bounded at one end by the Karoo, and at the other end by Natal. Mr. Sim finds that the flora includes 2449 species, of which 1690 are dicotyledons, 656 monocotyledons, and 103 vascular cryptogams. The richness in species is shown by a comparison with Great Britain—an area much greater than that of Kaffraria, but containing only about 1700 species. The opinion is expressed that were the Kaffrarian plants as well known as our own, they would number more than three thousand species. Though Mr. Sim's list is incomplete, it is an excellent groundwork upon which a detailed description of the flora of the district surveyed may be built.

For some years past Lieut.-General Pitt-Rivers has supplied the means for physical and mental recreation near his country seat at Rushmore. He has had the Larmer Grounds laid out as pleasure grounds, and opened them free to the public every day. In 1887 the number of persons who availed themselves of this privilege was 15,351, and last year the number was 24,143. To those interested in breeding and acclimatisation, some of the animals in the grounds at Rushmore will be found of interest. But the museum at Farnham, established and supported by General Pitt-Rivers, is most attractive to us. It consists of eight rooms and galleries devoted mainly to antiquities, and containing models of the excavations carried on by the generous donor in the neighbourhood. During last year, more than seven thousand persons visited the museum. Another building open is King John's House at Tollard Royal. This building contains a series of pictures illustrating the history of painting from the earliest times, commencing with Egyptian paintings of mummy heads of the twentieth and twenty-sixth dynasties, B.C. 1200–528. Descriptions of all these places are given in a short guide, recently received, together with illustrations of some of the most interesting features.

Statistics relating to the distribution of rain over the British Isles have been collated by Mr. G. J. Symons, F.R.S., in "British Rainfall," for thirty-four consecutive years. The volume for 1893 resembles former issues so far as the tabular matter is concerned; but the great drought rendered the year an exceptional one in several respects. At twenty-five stations, only about an inch of rain fell from the end of February to the end of June, that is, during a period of four months. A curious point mentioned in connection with the discussion of this remarkably low rainfall is that among the stations recording droughts exceeding 120 days, two of the three which head the list were situated on promontories or projecting parts of the coast. These were Dungeness, with a period of 127 days, during which only 1·27 inches of rain were measured, and East Dean (near Beachy Head), where 1·18 inches fell in 126 days. Several remarkably heavy falls in short periods occurred during the year. At Preston, 1·25 inches is estimated to have fallen in five minutes on August 10; but this record is hardly trustworthy. A fall of 0·62 inch in five minutes was measured at Shirenewton Hall on June 14. This is at the rate of 7·44 inches per hour. An extraordinary fall of rain occurred at Eastbourne in July, and a waterspout (or cloud burst) caused great damage on the Cheviots in the same month. Various other remarkable falls of rain are recorded in the notes which the observers send to Mr. Symons with the results of their rain-gauge observations. A discussion of the relation of the total fall of rain in 1893 to the average shows that, taking the whole of the British Isles, the deficiency was 14 per cent.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. H. P. Nicholls; an Ocelot (*Felis pardalis*) from South America, presented by Miss Edith Zambra; two Ring Ouzels (*Turdus torquatus*) from Hungary, presented by Mr. John Young; a Herring Gull (*Larus argentatus*), British, presented by Mr. George Hayes; a Common Viper (*Vipera berus*) from Gloucestershire, presented by Mr. Barry Burge.

OUR ASTRONOMICAL COLUMN.

Solar Electrical Energy.—According to Dr. M. A. Veeder (*Proceedings* of the Rochester Academy of Sciences, vol. ii., July 1894), there is conclusive evidence that magnetic perturbations are not of thermo-electric origin, and are not connected with heat and light radiations. He holds, in short, that there is no correspondence whatever between the behaviour of magnetic storms and the manner in which thermal and luminous radiations are originated and propagated from the sun to the earth. His idea is that electrical disturbances upon the sun are transmitted to the earth not by radiation but by conduction through the impalpable dust and debris with which interplanetary space is filled. Such meteoritic particles are composed of good conducting material, and an examination of a large number of meteorites has shown Dr. Veeder that they all possess magnetic properties which might have been produced by long-continued induction. Therefore he thinks that the origin of magnetic storms is as follows:—"Particular portions of the sun's surface and cooler immediate surroundings are electrified by what has every mark of being volcanic action. The motion of rotation of the sun carrying forward these charged portions of its surface, develops currents dynamically which act inductively along lines of force wherever there is conducting material within their scope. There is no conveyance by radiation or in a manner similar to that in which heat and light are conveyed from the sun. The laws governing the process are entirely different from those of radiation, and have reference to the principles of conduction as they appear under the conditions existing in interplanetary space. It is a mode of solar action that is distinct, and that must be considered by itself."

Tempel's Periodic Comet.—This comet, rediscovered by Mr. Finlay at the Cape, on May 8, is still visible, and promises to be within the grasp of moderately large instruments for some time. M. Schulhof points out in the *Astronomische Nachrichten* that it is desirable that the comet should be followed as long as possible. The object is becoming more favourably situated for observation, and there will be very little diminution in its light during the next three or four months. Using recent observations of the position of the comet, M. Schulhof has computed a new orbit. The following positions are extracted from the ephemeris based upon the new elements:—

Ephemeris for Paris Midnight.

1894.		R.A. h. m. s.		Decl. ° ′ ″
Aug. 27	...	3 53 39·6	...	+3 32 39
29	...	3 55 24·5	...	3 24 13
31	...	3 57 1·2	...	3 15 16
Sept. 2	...	3 58 29·6	...	3 5 51
4	...	3 59 49·6	...	2 55 59
6	...	4 1 1·1	...	2 45 41
8	...	4 2 3·9	...	2 35 0
10	...	4 2 58·1	...	2 23 56
12	...	4 3 43·3	..	2 12 31

A NEW VARIABLE STAR.—The Rev. T. E. Espin informs us, through a Wolsingham Observatory *Circular*, that the star DM + 50°·2251, the position of which is R.A. 16h. 1·5m., Decl. + 50° 47′, is variable.

ON THE NEWTONIAN CONSTANT OF GRAVITATION.[1]

III.

FIG. 8 is a view of the apparatus with the optical compass in position, and with the microscopes focussed upon the wires. They are then ready to be withdrawn by the focussing slide, so as to transfer the distances directly to the small glass scale, as already described.

When this is completed the proper windows are put in position, the screen tubes, the octagon house, and the felt screens are all placed ready for operation 10, in which the deflections are measured, and the period with the balls is determined. As this is the operation in which variations of temperature produce so serious an effect, I prefer to leave everything undisturbed for three days, to quiet down. A few hours are quite useless for the purpose.

In operation 11 the period with the counter-weight in the place of the gold balls is measured; also the deflection, if any, due to the lid and lead balls upon the mirror alone. This is only 1/10 division, but its existence is certain. In the later operations the deflections, if any, due to the lid alone on the mirror alone, and to the lid alone on the mirror and gold balls, are separately determined. Neither of these can be detected. The actual elongation of the fibre may also be observed at this stage, but this is of interest only as bearing on the elastic properties of quartz fibres under longitudinal strain.

Before I come to the treatment of the observations, I should like to refer shortly to the kind of perfection of conditions which by the employment of every practicable refinement that I could devise, I have succeeded in obtaining. Taking experiment 8 as an example, favourable in that the conditions were good, *i.e.* I was not badly disturbed by trains, wind, or earth tremors, I give the worst and the best sets of four points of rest obtained from six elongations. They were:—

Worst set + position	Best set position
24491	20795·4
24493	20795·7
24493·5	20795·5
24492	20795·5
(24491·7)[2]	
	20795·5 mean.
24492·4 mean.	

Taking all the mean points of rest, as determined above, in groups of three to eliminate slow shifting, if any, of the points of rest, the series of deflections were:—

3696·0
3696·3
3696·0
3696·8

(Interval of one hour, in which oscillations of large amplitude were observed for period.)

(3697·7)
3696·0

Immediately after the oscillations of large amplitude, which in this case at the end were rather badly disturbed by trains or otherwise, a rather different deflection was observed, but not seriously different. As examination of the figures shows only one anomalous point of rest immediately after the large amplitude disturbance, I feel justified in rejecting the only discordant figure, and in taking the mean of the rest as the true deflection. The unit in this case is 1/10 division. It corresponds to an angular movement of 1/280000, *i.e.* about three-quarters of a second of arc. Now a calculation of the angular twist due to a rotation of the air based upon the period, the moment of inertia, and the logarithmic decrement, shows that if the air in the tube were made to whirl round at the rate of one turn in six weeks, so that the air would blow past the gold balls at the rate of one inch in a fortnight, the deflection produced would be 1/10 division, an amount which is greater than the uncertainty of the deflection on this particular night. Again, an examination of the points of rest through the night in the positive and in the negative positions shows a very small steady creep, the same in each case. Creepage of this sort has been, I believe, mentioned as a defect of quartz fibres. When it gives trouble it is due to draughts, as already explained, or to imperfect attachment of the fibres.[1] In the present instance the creepage observed corresponds to a surface rate of movement on the fibre of a millionth of an inch a month.

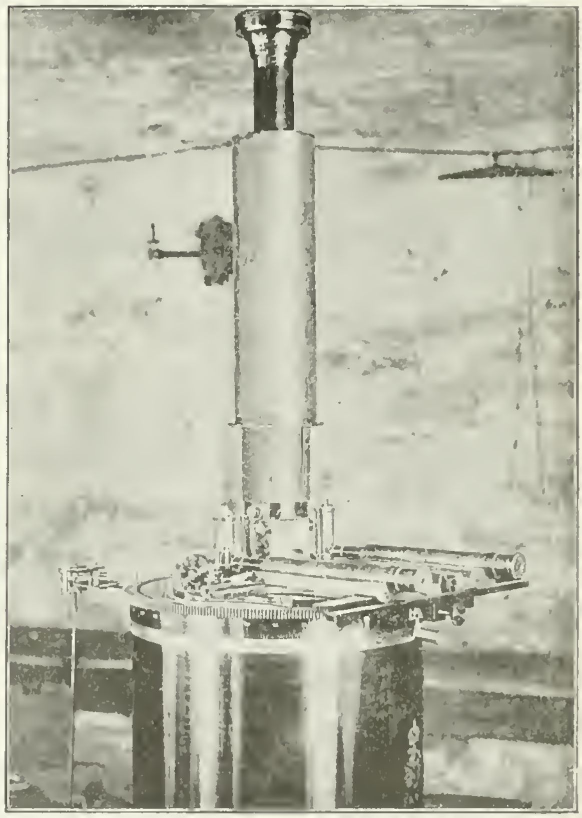

FIG. 8.

An examination of the mobile system of the beam and suspended gold balls, of which I exhibit a greatly enlarged and working model, at once shows that all the parts are capable of independent movement to an apparently perplexing degree. This in the theory of the instrument I have

[1] Continued from p. 363.

[2] Disturbed by trains.

[1] See my paper on "Attachment of Quartz Fibres," *Phil. Mag.*, May [illegible].

treated provisionally as a rigid system moving all as one piece, which it certainly does not seem to be. For instance, the lead balls, by their attraction of the gold balls, pull them out of the perpendicular, so that their distance from the axis is greater than that given by measurement by the optical compass. The error amounts, in the case of the lower ball, when the lead is at its nearest point, to 1/10,000,000 inch, and I have not taken any notice of it. When the beam is oscillating through so great an angle as 100,000 units the centrifugal force only makes the gold ball move out four times as much, and I have taken no notice of that. Again, when the mirror is under acceleration by the fibre, the gold balls, hanging 5 and 11 inches below, do not follow absolutely; they must lag behind, and so affect the period. Now in this case the gold balls are suspended in a manner which is dynamically equivalent to being at the end of a pendulum 5¾ miles long, the shortest equivalent pendulum that has ever been employed in work of this kind; but short as it is, I have not thought it worth while to be perturbed by an uncertainty of a few inches. There is one point which in some of the experiments only has amounted to a quantity which I do not like to ignore. It is due to the torsional mobility of the separate fibres, about which each gold ball hangs, allowing them in their rotation to slightly lag behind the mirror. As I did not see how to allow for it, I applied to Prof. Greenhill, who immediately told me what to do, and who, with Prof. Minchin, spent a day or two in the country, covering many sheets of paper with logarithms, in finding and solving for me the resulting cubic equation. The correction on this account is 1/7850 on the stiffness of the torsion fibre.

There are four remaining corrections depending on the fact that besides the gravitating spheres there are the ball-holders and supporting wires and fibres, all of which produce small but definite disturbances in the gravitation. These are all calculated and allowed for. They are:—

Disturbances due to brass-holders of lead balls ... 1/7320
,, ,, copper ,, gold ,, ... 1/265,000
Attraction of lead balls for quartz fibres .... + 1/200,000
,, gold ,, phosphor-bronze wires − 1/115,000

Then in experiment 9 gold cylinders were employed. Mr. Edser, of the Royal College of Science, calculated for me the correction to be applied if they were treated as spheres; this amounted to 1/3300.

I have already mentioned that experiment 8 was made under more than usually quiet conditions. Such extreme quiet is desirable, that I manage to reserve Sunday nights, from midnight to six or eight in the morning, for observations of deflection and period. All the other operations can be carried on in the daytime. Sunday is the only night that is suitable, as the railway companies spend every other night shunting and making up trains about a mile away, and this causes such a continuous clatter and vibration, that hours of work may be lost. A passing train does not seem so injurious; but, fortunately for me, most of the observations were made during the coal strike, and fewer trains than usual were running. However, though I may escape from the rattling traffic of St. Giles by working at night, and on Sunday nights am not so badly affected by the trains, I am still not sure of quiet even when there is no wind. For instance, at a quarter to four on Monday morning, Sept. 10, 1893, I was recording chronographically the passage of every ten divisions. Everything was quite quiet, and at the particular moment the marks on the drum recurred at intervals of about three seconds. Suddenly there was a violent non-vibrating lurch of fifteen divisions, or 150 units, which is enormously greater than anything that either trains or traffic could produce; of course, I could make no further record. The time of the last mark was, allowing for the known error of the clock, 15h. 44m. 14·3s. This was entered the same day in my note-book as an earthquake, and in Tuesday's *Standard* I read an account of a violent earthquake in Roumania at about the same time. I have not yet particulars from Vienna, for which Mr. Horace Darwin has written; but though the shock recorded in the newspaper seem to have been too late, preliminary shocks are by no means unknown, and I cannot help thinking that what I observed was the dying out and distant effect of one of these. Of this, however, I am sure, that it was an earthquake that I observed, and not any disturbance due to human origin.

Owing to the viscosity of the air, which limits the time during which an observation for period can be made to about 40 minutes, on account of the resistance that the slowly moving mirror and gold balls experience in their passage through it, I made one experiment, with the view of reducing this difficulty, by the use of an atmosphere of pure dry hydrogen gas, which possesses a viscosity only half that of air. I did find that on this account a great advantage could be gained; but this was more than counterbalanced by the difficulty of getting up a sufficient swing in the gas, and of efficiently controlling the mirror. At the same time, I think that if I had had time to provide means for feeding the gas into the tube without entering the corner, and at the same time were to prevent diffusion at the lower screw, that a little trouble in this direction would be well rewarded. Meantime I found within the limits of error, which were greater than without the hydrogen, that the deflection and the period corrected for the diminished damping were the same. The chief interest of this experiment lies in the fact that it revealed an action unknown to me, and I believe to others, that a thin plane glass mirror, silvered and lacquered on one side, definitely bends to a small extent, becoming slightly convex on the glass side when in hydrogen, and instantly recovers its form when surrounded by air again. This happened many times, producing a change of focus in the telescope of about five-eighths of an inch. I do not offer any explanation of the fact.

There is an observation which should be of interest to elasticians. In experiments 4 to 8 the torsion fibre carried the beam mirror and the ·25 inch gold balls, weighing, with their hooks and fibres, 5·312 grammes. In experiment 9, gold cylinders were substituted, weighing, with their hooks and fibres, 7·976 grammes. The weight of the mirror was ·844 gramme. In consequence of the small increase of load the torsional rigidity of the fibre fell more than 4 per cent., an amount far too great to be accounted for by the change of dimensions, even if Poisson's ratio were as great as ½. There is no doubt about the great reduction in stiffness, for this figure is one of the factors in the final expression for G, which does not show a change of more than 1 part in 1570.

It will not be possible at this late hour to explain how the observations are treated so as to obtain the value of G. It is sufficient to state that in one of these clips all the observed deflections and corrected periods are collected. In the second all the geometrical observations are collected and reduced, so as to obtain what I call the geometrical factor, *i.e.* a number which, when multiplied by the unknown G, gives the torsion on the fibre. In the third, the moments of inertia and periods are made use of to find the actual stiffeness of the fibre in the several experiments, and in the fourth these are combined so as to find G. From G the density of the earth Δ immediately follows.

The annexed table contains the important particulars of each experiment. From this it will be seen that the lead balls were twisted and interchanged in every way, so as to show any want of gravitational symmetry if it should exist. For instance, after experiment 7 the ball that was high was made low, the side that was outwards was turned inwards, and their distance apart was reduced by 1/50 inch, but the change in the result was only 1 part in 2764. The experiments 7, 8, 9, 10 were made under widely different circumstances. After experiment 8 the gold balls were changed for heavier gold cylinders, which, as has already been stated, reduced the torsion of the fibre by 4 per cent., but the result is practically the same as that of experiment 7. I then broke the end of the torsion fibre. After keeping it in London three months, I broke the other end. I then resoldered each end and put the fibre back in its place, and after making every observation afresh, found with the new shorter and stiffer fibre a result differing from that of experiment 8 by only 1 part in 27,635. These four experiments were all made under favourable circumstances, and on this account I feel more able to rely upon them than on the earlier ones, which were subject to greater uncertainty. The last experiment was made under most unfavourable conditions. The periods and deflections were taken in the first four hours after midnight, then, after a few hours' sleep, and far too soon for the temperature to have quieted down, I took the period with the counterweight, but was only able to give ten minutes, as I had to catch a train in order to be able to give my midday lecture at South Kensington. It is not surprising that under such conditions a difference of 1 part in 600 should arise. There is a difference of about the same order of magnitude between the earlier experiments and the favourable four. There is one point about the figures that I should like to mention. No results were calculated till long after the completion of the last experiment. Had I known how the figures were coming out, it would have been impossible to have been biassed in taking the periods and deflections. Even the calculating boys could not have discovered whether the observed elongations were such as would give a definite point of rest. I made my observations, and the figures were copied at once in ink into the books, where afterwards they left my hands and were ground out by the calculating machine. The agreement, such as it is, between my results is therefore in no way the effect of bias, for I had no notion till last May what they would be.

No. of Exp.	Lead balls: Arch side	Lead balls: Wall side	Lead balls: Shellac spots	Gold balls: Arch side	Gold balls: Wall side	Neutral lid reading	Date	Deflection	Geometrical factor	Stiffness of fibre.	Result: G	Result: Δ
				1·3 grammes each		°	1892			·00	·0000000	
3	2 low	1 high	Inwards	4 low	3 high	267	Oct. 1–30,	5637·3	6089·89	245483	66645	5·5213
				Gold balls of double weight			1893					
4	2 low	1 high	Inwards	4 low	3 high	267	Aug. 15–Sept. 3				66702	5·5167
5	1 high	2 low	Inwards	3 high	4 low	86·5	Sept. 4–11	3667·6	12423·8	772200	66711	5·5159
6	2 low	1 high	Inwards	4 low	3 high	265·9	Sept. 12–14	3667·7	12422·3	Same as No. 8	66675	5·5189
7	2 low	1 high	Outwards	4 low	3 high	265·9	Sept. 15	3664·0	12432·8	Same as No. 8	66551	5·5291
8	1 low	2 high	Inwards	4 low	3 high	265·9	Sept. 16–18	3695·2	12534·2	771664	66575	5·5271
				Gold cylinders								
9	1 low	2 high	Inwards	3 low	1 high	86	Sept. 27–Oct. 3	5775·5	18800·5	739988	66533	5·5306
							1894					
10	1 low	2 high	Inwards	4 low	3 high	85·25	Jan. 1–13	3515·4	12531·8	811011	66578	5·5269
11	1 low	2 high	Inwards	4 low	3 high	85·25	Jan. 14		Hydrogen experiment			
12	2 high	1 low	Inwards	3 high	4 low	265·2	Jan. 17–21	3520·5	12533·7	811385	66695	5·5172
									Adopted result ...		66576	5·5270

My conclusion is that the force with which two spheres weighing a gramme each, with their centres 1 centimetre apart, attract one another, is $6·6576 \times 10^{-8}$ dynes, and that the mean density of the earth is 5·5270 times that of water.

It is evident, from what I have already said, that this work is of more than one-man power. Of necessity I am under obligations in many quarters. In the first place, the Department of Science and Art have made it possible for me to carry out the experiment by enabling me to make use of apparatus of my own design. This belongs to the Science Museum, where I hope in time to set it up so that visitors who are interested may observe for themselves the gravitational attraction between small masses. Prof. Clifton, as I have already stated, has given me undisturbed possession of his best observing room, his only good underground room, for the last four years. The late Prof. Pritchard lent me an astronomical clock. Prof. Viriamu Jones enabled me to calibrate the small glass scale on his Whitworth measuring machine; and Mr. Chaney did the same for my weights. I would especially refer to the pains that were taken by Mr. Pye, of the Cambridge Scientific Instrument Company, to carry out every detail as I wished it, and to the highly skilled work of Mr. Colebrook, to which I have already referred. Finally, I am under great obligations to Mr. Starling, of the Royal College of Science, who performed the necessarily tedious calculations.

In conclusion, I have only to say that while I have during the last five years steadily and persistently pursued this one object with the fixed determination to carry it through at any cost, in spite of any opposition of circumstance, knowing that by my discovery of the value of the quartz fibre, and my development of the design of this apparatus, I had, for the first time, made it possible to obtain the value of Newton's Constant with a degree of accuracy as great as that with which electrical and magnetic units are known, though I have up to the present succeeded to an extent which is greater, I believe, than was expected of me, I am not yet entirely satisfied. I hope to make one more effort this autumn, but the conditions under which I have to work are too difficult; I cannot make the prolonged series of experiments in a spot remote from railways or human disturbance; I cannot escape from that perpetual command to come back to my work in London; so I must then leave it, feeling sure that the next step can only be made by my methods, but by some one more blest in this world than myself.

SCIENCE IN THE MAGAZINES.

IN the August magazines received by us, science is but poorly represented. A brief mention of the more important articles will therefore be sufficient this month.

Mr. Benjamin Kidd's work on "Social Evolution" has furnished material for much criticism. In the *National Review* Mr. Francis Galton, F.R.S., discusses the part of religion in human evolution as set down in the book; and Mr. Kidd adds a short note on the opinions expressed in the article. The same magazine contains a paper on "Sleeplessness" by Mr. A. Symons Eccles, and one on "Colliery Explosions and Coal Dust," by Mr. W. N. Atkinson. An experience of fifteen years in investigating explosions in coal-mines has led him to believe that "coal dust has been the chief, or only, agent in all recent widespread colliery explosions." It is regretted that "no experiments have been made on a scale large enough to yield visual demonstration of the effect of an explosion of coal-dust, under conditions approximating as closely as possible to those existing in mines. The nearest approach to such experiments in this country were those recently made by Mr. H. Hall, H.M. Inspector of Mines, in an old pit shaft fifty yards deep. The length of such a shaft is insufficient to develop the whole force of a coal-dust explosion, and the conditions under which the explosions or ignitions took place were necessarily different from those obtaining in the practical working of mines. These experiments, however, are valuable, as demonstrating that the dust ordinarily existing in a great number of mines (not particular exceptional coal-dusts) are capable of propagating flame to the full limits admitted by the conditions of the experiments."

A psychological paper, entitled "How We Think of Tones and Music," is contributed to the *Contemporary* by Mr. R. Wallaschek. Mr. Andrew Lang tilts at Prof. Huxley's treatment of the Bible story of Saul and the Witch of Endor "as a piece of evidence bearing on an important anthropological problem," and treats the matter from a less scientific point of view.

Eight recent books on Iceland furnish the subject of an interesting account of the island in the *Quarterly Review* (No. 357). The same publication contains a long article on "Forestry," in the course of which the author says that the three great faults noticeable in the treatment of woods in Great Britain are: (1) Discrimination has seldom been shown with regard to the choice of the kinds of trees for given soils and situations. (2) Plantations have not usually been formed of the best degree of density for the given kinds of trees selected for planting. (3) A sufficient density of crop has not always been maintained during the subsequent periods of the natural development of the trees. It is finally concluded that—"Better results than can at present be reasonably expected would probably be obtained if State aid were freely granted towards the dissemination of sound instruction concerning sylviculture; and the only proper places for bringing this within the reach of the future landowners, and of young men of good education, are undoubtedly the great Universities."

Messrs. T. G. Allen and W. L. Sachtleben continue, in the *Century*, the description of their journey "Across Asia on a Bicycle," from Constantinople to Pekin. Dr. W. T. G. Morton's claims to the discovery of anæsthesia are championed by Mr. E. L. Snell. It will be remembered by readers of this monthly summary that the January number of the *Century* contained an article in which Miss E. B. Simpson told the story of her distinguished father's discovery of the anæsthetic properties of chloroform in 1847. It is now shown that, in the preceding year, Dr. Morton publicly demonstrated the use of sulphuric ether in producing anæsthesia, at the Massachusetts General Hospital.

A passing mention will suffice for the remaining articles of scientific interest in the current magazines. Mr. A. H. Savage-Landor describes a visit to Corea, in the *Fortnightly*. Some of the possibilities of the phonograph are foreshadowed in *Scribner*, by Octave Usanne. *Longman's Magazine* contains "White Sea Letters, 1893," by Mr. A. Trevor-Battye. Naturalists will find the letters interesting. Under the title "Land Crabs," Mr. E. Step contributes to *Good Words* a popular description of such terrestrial crustaceans as *Gecarcinus ruricola* and various members of the genus *Gelasimus*. Finally, the vivisection controversy is continued in the *Humanitarian*, and the man-like apes in the Gardens of the Zoological Society are described in the *English Illustrated*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 21.—"Researches on the Structure, Organisation, and Classification of the Fossil Reptilia. Part IX. Section 4. On the Gomphodontia." By H. G. Seeley, F.R.S.

"On an Instrument for Indicating and Measuring Difference of Phase between E.M.F. and Current in any Alternating Current System." By Major P. Cardew, R.E.

"On the Difference of Potential that may be established at the Surface of the Ground immediately above and at various Distances from a Buried Mass of Metal Charge from a High Pressure Electric Light Supply." By Major Cardew, R.E., and Major Bagnold, R.E.

PARIS.

Academy of Sciences, August 13.—M. Lœwy in the chair.—The death of M. Gustave Cotteau (August 10) was announced; the deceased correspondent was an authority on sea-urchins.—Note on the long-period meteorograph to be placed in Mont Blanc Observatory, by M. J. Janssen. A description is given of the arrangements for automatically registering during eight months the indications of the barometer, thermometer, and hygrometer, and the speed and direction of the wind.—New researches on the infra-red region of the solar spectrum, by M. Langley. The author shows that a perfected arrangement of the bolometer is able, by means of automatically photographing the movements of the galvanometer needle, to furnish a complete record in an hour of the infra-red region of the solar spectrum with very great accuracy. The accuracy obtained is illustrated by the case of the D lines in the visible part of the spectrum; the method indicates very clearly the Ni line occurring between D_1 and D_2. Crystals collect at the upper part of a less dense solution, by M. Lecoq de Boisbaudran. If a saturated solution of carbonate and thiosulphate of sodium be saturated with sodium sulphide ($Na_2S.9H_2O$) and a quantity of the latter placed at the bottom of the solution and a small fragment supported near the surface, in the course of a few days or weeks the additional sodium sulphide is found collected round the fragment on the support. By the solution of the crystallised sulphide the bulk of the solution increases in a greater ratio than the weight, and hence its specific gravity is lowered.—A new use of Plucker's conoid, by M. A. Mannheim.—New arithmetical theorems, by Père Pepin.—Remarks on the electrochemical graphic method of studying alternating currents, by M. A. Blondel.—Application of auto-collimation to the measurement of indices of refraction, by M. Féry.—On the specific heat of liquid sulphurous anhydride, by M. E. Mathias. A general method is described. The true specific heat of liquid sulphur dioxide is always positive and increases constantly and indefinitely with the temperature. A table is given showing the value of m between $-20°$ and $+155·5°$. Between $-20°$ and $+130°$, $m = 0·31712 + 0·0003507t + 0·000006762t^2$. At $155·5°$, $m = 2·980$.—On benzoylquinine, by M. A. Wunsch. The base has been obtained in clear, colourless prisms, insoluble in water. It dissolves easily in alcohol, benzene, chloroform, petroleum ether, carbon bisulphide, and ether. It has the composition $C_{20}H_{23}(C_6H_5CO)N_2O_2$, and melts at 139° without decomposition. The following salts have been examined: the basic and normal hydrochlorides, and the basic salicylate, tartrate, and succinate.—On the heart in some orthoptera, by M. A. Kowalevsky.—On the peritheca of the vine mildew (*Uncinula spiralis*), by M. Pierre Viala. The abundance of peritheca found in 1893 fully confirms the identity of *Erysiphe Tuckeri* with *Uncinula spiralis*. The parasite noted by Bary on the conidiophores of mildew, *Cicinnobolus Cesatii*, was abundantly developed in 1893 in the peritheca of *Uncinula spiralis*. The author also describes a peculiar parasitic bacterium.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Alembic Club Reprints, No. 7—The Discovery of Oxygen, Part 1: Dr. J. Priestley (Edinburgh, Clay).—Annual Report of the Department of Mines and Agriculture, New South Wales, 1893 (Sydney, Potter).—Hygiene: Dr. J. L. Notter and R. H. Firth (Longmans).

PAMPHLETS.—Ueber den Osmotischen Druck von Lösungen von endlicher Konzentration: T. Ewan (Leipzig).—The Glaciation of the West of Scotland: D. Bell (Glasgow).—On the Selection of suitable Instruments for Photographing the Solar Corona during Total Solar Eclipses: A. Taylor (Dublin).—Les Grands Instruments de L'Avenir par M. Alvan Clark et la Fabrication des Grands Objectifs d'Astronomie par M. Mantois (Paris).

SERIALS.—Journal of the Franklin Institute, August (Philadelphia).—Michigan State Agricultural College Experiment Station, Horticultural Department, Bulletin 3 (Michigan).—Journal of the College of Science, Imperial University, Japan, Vol. 6, Part 4, and Vol. 7, Part 1 (Tōkyō).—Mittheilungen der Deutschen Gesellschaft für Natur und Völkerkunde Ostasiens in Tokio, Supplement, Heft 1, zu Band 6 (Tokio).—Royal Natural History, Part 10 (Warne).—Journal de Physique, August (Paris).—L'Anthropologie, tome 5, No. 4 (Paris).

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THURSDAY, AUGUST 30, 1894.

A THEORY OF THE GLACIAL DEPOSITS.

Papers and Notes on the Glacial Geology of Great Britain and Ireland. By the late Henry Carvill Lewis, M.A., F.G.S. (London: Longmans, Green, and Co., 1894.)

THEY are wrong who think that little is left in England for a geologist to discover or do. Not only are there gaps to be filled up, and doubtful points to be made certain, but even whole fields remain where if labourers have been at work they have as yet reaped little fruit. Especially may an Alexander, sighing for a fresh world, be invited to turn his attention to what are called the glacial deposits. In area they extend over the greater part of the British Isles; in variety they far exceed the Archæans; in difference of opinion about them they would also exceed Archæans, if such an excess be possible. They have difficulties peculiarly their own. It is well said by the editor of this volume that in glacial geology not merely the interpretation of facts is debated, but there is dispute as to what the facts are themselves. Geologists of repute go to the same section, see the same phenomena, and describe them in contradictory terms. Mr. Clement Reid surveys the Cromer cliffs, and figures chalk masses ploughed up by glaciers. Mr. Mellard Reade examines the same cliffs, and sketches chalk masses dropped down by ice-floes. The questions connected with these deposits have been raised on the hills of Nicaragua and the banks of the Amazon. As their range of space, so their range of time: glacial phenomena have been described from the Permian epoch, and the Carboniferous. They seem to claim all time and all space as their province.

To conquer such a world is needed an Alexander in truth. Such an one some friends hoped they saw risen in the student whose remains are now given to the world. Those who knew Carvill Lewis, who knew his ability, energy, enthusiasm, perseverance, with his equipment of knowledge, travel, and means, when they saw him devote all these to his study of glacial deposits, thought that now at last order would emerge out of chaos; that what Sedgwick and Murchison did for the Grauwacke he might do for the Drift. His early death destroyed these hopes, quenching a kindled light. We have, however, in this volume a not unworthy memorial; no mean contribution to science. It is a record of the ideas he had formed or was forming, in some respects more valuable than a completed treatise would have been. For here we discover his plans, ideas, observations; his opinions, formed, corrected, abandoned; together with an immense mass of materials, collected out of previous writers, abstracted, arranged, and criticised. Dr. Crosskey has performed his most difficult task of editing with extreme tact and judgment. "I venture," he says in his introduction, "to set aside the injunction laid upon me to 'criticise' as well as to arrange and edit." A high proof this of fitness for such a task; it makes of correspondingly high value the two or three criticisms which he does pronounce. Sad that we should be presented with a volume doubly posthumous; that science must mourn the loss of editor as well as of author. But science should be grateful for what she has gained. The gain is great. Here we have presented a theory of the glacial deposits which, whether the truth or no, is certainly clear, consistent, rational, and moderate in its demands. Probably it will not ultimately be accepted as complete; assuredly it will not at once convince every sceptic, or even create an orthodox belief; but it may do much to destroy some current absurdities, it does bring out clearly some neglected truths, and it should form a very convenient working hypothesis to direct our reflection and research.

The volume consists of introductions by Dr. Crosskey and Mrs. Lewis, five entire papers, a mass of extracts from note-books, some memoranda and brief essays, with two appendices. One of these might, perhaps, be spared. We are keen to know what Carvill Lewis thought, but not so much what another thinks he would have thought on sections which he did not see. The other appendix, "Field Notes from Switzerland," though introduced with an apology, is inseparably connected with the rest of the notes, an essential part of the book. If dates could have been added to the extracts from note-books, it would have helped a reader to perceive which of the writer's varying views was his latest.

Prof. Lewis concerned himself little with the causes of the glacial epoch, though one or two shrewd remarks will be found. He devoted his research and thought to the interpretation of the effects which that epoch produced, of what occurred during the period, of what its phenomena represent. His fundamental idea pictures many separate glaciers originating from separate centres of high ground, spreading from these centres till they meet, then still retaining their separate individualities in the motions of the continuous ice-cap into which they have joined. His guiding principles are that such separate individualities can be traced by the peculiarities of the stones transported; still more, that the furthest advance of such glaciers must be marked by a moraine, or by some visible boundary of like nature. The tracing of these boundaries he made an especial work, and he believed himself to have followed them across England, through Yorkshire wolds and Welsh mountains, from the Humber to the Bristol Channel. As a consequence of prime importance, he lays down that such advancing glaciers would frequently dam the courses of rivers, and that the lakes formed by the ponded-up waters would produce deposits of their own. Such deposits he continually recognises and describes. Especially he maintains that the Scandinavian ice met the British, and damming the waters of the Humber and the Wash, created an enormous lake, which drowned all England east of the Pennines and north of the Thames. This vast sheet of fresh water he regards as the manufactory and manufacturer of all those deposits in East Anglia and the Midlands which are commonly called by us glacial. And whatever difficulties may lie in the way of this hypothesis, it is certainly remarkable that the highest level of such deposits at Flamborough Head (according to Lamplugh), on the Lincolnshire Wolds (according to Jukes-Browne), in East Anglia (according to Survey Memoirs), together with the lowest level of passes across the central watershed (as I infer from a map of

Stanford's), should all deviate little from the 400-feet contour line.

The volume is full of minute observations and acute remarks. Readers will find many cherished beliefs rudely handled; perhaps may feel some of them shaken. What a heresy is his denial of the three-fold division of the Drift. In disbelief of interglacial periods he has had predecessors. Herr Penck will find the assertion that frequent and finely striated stones in a clay are an argument against that clay being ground-moraine. Neither contortions nor groovings are here invariably ascribed to a glacier; on the contrary, he explains most such when they occur as products of his lakes or his moraines. He has seen no evidence (in Switzerland) for glacier excavation of lakes). He expresses opinions freely and forcibly: it is refreshing to read that "much rubbish has been written on the Cromer cliffs." The doctrine of a post-pliocene great marine submergence he believes "the most pernicious one ever propounded in geology." Amusing is his description of the "remarkable properties of this sea, wholly unlike any known sea. It made till and eroded till: it filled some regions with drift, while others it cleared utterly of all drift: its icebergs made striæ, while its waters washed them away." It is true that like language might be applied to the effects of glaciers, as described by some of their admirers. Probably it did not occur to him that with regard to them any expression of opinion was needed.

The author's own views offer points for an opponent's attack. While he cannot induce himself to believe in a thousand feet of submergence, it seems to him simple for Scotch ice to have climbed a thousand feet up a Welsh hill, and easy for it to have pushed portions of the sea-bottom to the top. He repeatedly distinguishes between clay formed under a glacier (till) and clay formed in a glacier lake (boulder-clay). But when he sees only till at Filey, and only boulder-clay in East Anglia, it is not easy to make out which of their points of difference are the critical ones. He makes several references to striæ as indicating direction of ice-motion. Yet his ultimate conclusion appears to be that the shape of the striæ depends only on the slope of the rock, and, except on level ground, gives no guide to the direction of motion. He frequently insists on the effects of great floods and débâcles which would result from his glacier-dam lakes, but he does not indicate the way in which these catastrophes would be brought about. "I believe," he says, "that the Scandinavian ice-sheet would temporarily dam up the Humber and form a great inland lake, which would pour over the country to the south in débâcles, making gravels. . . . ." The water would rise steadily to a level of overflow, but how would a débâcle be thereby produced? Such floods seem no necessary part of his theory; however, his belief in them is firm.

To decipher field notes intended only for the writer's own eye, must have been a most difficult task. It has been performed with remarkable success: of course, mistakes have not entirely been avoided, but probably each will be obvious to and easily corrected by any reader who is concerned with the case. In the illustrations on page [illegible] some clays are marked "Permian." There [illegible] clay in that neighbourhood; the word should evidently be Pennine, a designation for a division of the Midland boulder-clay.

Prof. Carvill Lewis began his studies in Pennsylvania, and there obtained his conceptions of moraines as "high-tide marks" for glaciers. He came to the British Isles for explanations of phenomena which perplexed him in America. In Ireland he sought and thought he found a solution of Transatlantic problems. He extended his researches over England and Scotland, and visited the Alps to see existing glaciers. The ideal order of study would be to begin by learning all about ice, and then applying the acquired knowledge to these questions. But practically all, even Carvill Lewis, begin upon deposits said to be glacial, though all do not go on to examine actual ice; and very few can study its grandest manifestations. It is much to be wished that such a geologist as he could spend some summers and winters round Greenland and Hudson's Bay. If to this he could add an acquaintance with Antarctic ice, he would have an equipment of appropriate knowledge such as no one has yet brought to bear on the question. Yet even so there is, perhaps, no spot on the earth where we can now see a glacier advancing across unglaciated lands: a cause whose effect is freely invoked by various writers on this question. However, we must use as best we can such means as we possess. Two characteristics of Carvill Lewis seem especially worthy of our imitation, viz., his untiring assiduity—we are told that he traversed the country between Cork and Mallow six separate times; and his readiness to acknowledge mistake and correct it—he completely retracts more than one opinion at first freely expressed. If any critic had condemned this as "a complete change of front," he would probably have answered, "I am ready to front any way where I see a road to truth."

An estimate of the advance which this book will have made towards a full and true theory is only possible to an infallible critic. His idea, that there ought to be a definite mark of the furthest extension of a glacier, seems to me a correct one: if so, such marks should be sought for. His clear conception of the power and action of floating ice deserves to be studied and developed. His distinctions between the products beneath an ice-sheet (till), adjacent to an ice-sheet (moraine), beyond the ice-sheet, but in waters washing it (boulder clay), are real distinctions of the highest importance. Surely there must be criteria of difference, whether the author has arrived at them or not. Surely when such criteria are ascertained, we shall be very near the solution of one side of the glacial problem. Still would remain for study another side: What brought that problem into existence; what was really the cause of the Ice Age?

E. Hill.

UNIVERSITY EXTENSION.

Aspects of Modern Study. Pp. 187. (London: Macmillan and Co., 1894.)

THIS volume consists of addresses delivered by Lord Playfair, Sir James Paget, Prof. Max Muller, the Duke of Argyll, and Canon Browne, among others, to students of the London Society for the Extension of University Teaching, at annual meetings held at the

Mansion House since 1886. In most of the addresses, special aspects of study are considered, but those by Lord Playfair and Canon Browne deal with the Extension movement itself.

Men of science, as a rule, look askance at University Extension lectures. They know that there is no royal road to scientific knowledge, and believe that popular lectures of a "peep-show" kind have no place in a properly organised educational system. This is true to some extent. Popular lectures of any sort, whether delivered at the Royal Institution or in a village club, are of little use to the practical student of science. They are useful, however, in bringing people into touch with current opinions, and in creating an interest in scientific things.

The subject of Lord Playfair's address is the evolution of University Extension as a part of popular education. After people have heard lectures, they desire to found institutions in which instruction is regularly given. Out of the single and unconnected penny readings in the early part of this century grew the Mechanics' Institutes that, in the Midlands and the North, have helped on the cause of education. It was, of course, inevitable that the committees of these institutes should sometimes have had queer ideas as to the kind of programme which should be offered to the community. Lord Playfair says that one of the most prosperous of them asked him to give a single lecture on chemistry in 1846, and sent him the programme for the preceding year as an inducement to accept the invitation. It was as follows:—"Wit and Humour, with Comic Songs—Women Treated in a Novel Manner—Legerdemain and Spirit-rapping—The Devil (with illustrations)—The Heavenly Bodies and the Stellar System—Palestine and the Holy Land—Speeches by Eminent Friends of Education, interspersed with Music, to be followed by a Ball. Price to the whole 2s. 6d. Refreshments in an Anteroom." Even now, programmes of this motley character can be found at many of the large workmen's clubs in the East End, and though most educationists consider them to be "awful examples," the fact that the science lectures are usually very largely attended testifies to a desire for knowledge, which often leads to systematic study. The University Extension scheme has certainly done something to mould this demand for popular instruction. When interest has been awakened by a pioneer lecture, it becomes a comparatively easy matter to run a successful course of six or twelve lectures. And if such courses are linked together in proper sequence, it cannot be denied that advantage must accrue from them. For, to use a simile of Lord Playfair's, not only does the lecturer scatter information broadcast among his audience, trusting that some of it will fall on fertile soil, but, in the class after each Extension lecture, he acts as a tutor and is able to treat the students individually, giving each mind the attention conducive to the production of good results. The great difficulty, however, is with regard to practical work. Every man of science feels that, so far as serious study is concerned, lectures should take a secondary place in a scheme of instruction. Observations in the field, laboratory, or observatory, are absolutely necessary for a proper appreciation of the facts and phenomena of nature; and, until some provision is made for this kind of work, the science lectures will be considered little more than a form of recreation.

Sir James Paget's address is concerned with the study of science. He points out that a scientific mind should be educated in four ways, viz. (1) in the power of observing, (2) in accuracy, (3) in the difficulty of ascertaining truth, (4) in proceeding from the knowledge of what is proved to the thinking of what is probable. The subject of Prof. Max Müller's address is "Some Lessons of Antiquity," and that of the Duke of Argyll, "The Application of the Historical Method to Economic Science." The addresses are interesting from many points of view, and they help to define the *rôle* of courses of University Extension lectures in our educational system. R. A. Gregory.

SOME RECENT WORKS ON ELECTRICITY.

(1) *Electric Traction on Railways and Tramways.* By Anthony Reckenzann, C.E. (London: Biggs and Co.)

(2) *Portative Electricity.* By J. T. Niblett. (London: Biggs and Co.)

(3) *First Principles of Electrical Engineering.* By C. H. W. Biggs. New edition, partly rewritten and extended. (London: Biggs and Co.)

(4) *Electrical Distribution, its Theory and Practice.* Part i., by Martin Hamilton Kilgour. Part ii., by H. Swan and C. H. W. Biggs. (London: Biggs and Co.)

(5) *Town Councillors' Handbook to Electric Lighting.* By N. Scott Russell, M.Inst.C.E. (London: Biggs and Co.)

(1) The present state of electric traction is precisely given, and the various methods and constructive details at present in use described. The best modern examples of traction are explained, with many excellent illustrations. In particular may be mentioned the proposed St. Louis and Chicago high-speed electric railway, designed to convey passengers 250 miles in two and a half hours. Much useful information has been collected from the various electrical journals and *Transactions*, and a handbook formed, which is sure to be of great service to practical men. We notice that the words "energy," "power," and "work" are used in the popular rather than in the exact scientific sense; but this circumstance detracts little from the value of the work.

(2) This little work is described as being "A Treatise on the Application, Methods of Construction, and the Management of Portable Secondary Batteries." It has been written mainly for the benefit of those who find this form of stored energy of service for economic, artistic, or scientific purposes. Part i. deals with applications to mining operations, domestic use, medical and other scientific purposes, the Army and Navy, carriage lighting, and traction and decoration. In a popular form we are presented with much information that will be very useful to anyone contemplating some of these special uses of electricity. Many of these are recent and novel, and not to be found in any other work with which we are acquainted.

Part ii. is occupied with the description and management of primary and secondary batteries and their adjuncts. It is an excellent small book, suitably illustrated.

(3) This is described as an "attempt to provide an elementary book for those who are intending to enter the profession of electrical engineering." In a very entertaining and humorous preface the author at once enlists the sympathy of the ordinary reader in general, and of the reviewer in particular. After its perusal the latter feels prepared to find much that is novel in treatment and revolutionary in substance in the work itself, but he finds that his anticipations are only realised to a moderate degree. The so-called "Inductive Circuit" is easily recognised as an old friend under a new name. The equation of the condenser, usually written

Quantity = Capacity × Potential-Difference,

is given by the autbor in the form

Accumulation × Resistance = Electrical Pressure,

wherein he regards inductive resistance as bearing the same relation to capacity that electrical resistance does to electrical conductivity. The only advantage we can see in this notion is that it brings out clearly the fact that condenser capacities combine according to the same law as electrical conductivities. Again, the author imagines the "sapient critic" to laugh at his views of "loops" and "unlooping" in connection with the lines of force of a magnetic field, and puts a question to him which he evidently regards as a poser of the first water. He says: "Your teaching involves cutting here, there, and everywhere—first in this direction, then in that; but though you tell us what happens when you cut 'lines of force,' you say nothing of what happens when your conductor leaves those lines of force. You bring your conductor to be acted upon by lines of force, but although you also take your conductor from those lines of force, you recognise no reverse action. All your cry is 'Cut,' 'cut,' 'cut,' &c., &c."

This is of course veritable moonshine. Every electrician is aware that every line of force forms a closed loop, and that "cutting" necessarily involves looping or unlooping, as the case may be, and *vice versa*, whenever the conductor forms a closed circuit.

The first principles of the dynamo are clearly and accurately given, though a worse illustration than that of a gramme ring on p. 152 is not often to be seen. However, it is good to see a clear distinction between "energy" and the "rate of its production," all the more noticeable by reason of its rarity in recent electrical books.

Notwithstanding its eccentricity, the book will be useful to a certain class of student.

(4) Mr. Kilgour considers scientifically the design of systems of distribution which shall give maximum economy with satisfactory working results. This subject was initiated by the valuable papers of Lord Kelvin and of Profs. Ayrton and Perry. In 1881 the former considered the problem of finding the cross-sectional area of copper required for a conductor to transmit a given current in order that the total annual expenditure for the energy wasted in the conductor, and for interest, depreciation, and repairs on the conductor should be a minimum. This problem is now historical. It was on this occasion, the meeting of the British Association in the year mentioned, that Lord Kelvin first brought before engineers the fact that the relation between the size of the conductor and the current strength should be governed by economical considerations. As stated by Mr. Kilgour, six quantities are involved in an important manner, viz.:—V, the pressure in volts at end of feeder near to generators; v, the pressure in volts at end of feeder remote from generators; C, the current strength in ampères flowing through the feeder; P, the watts delivered to feeder; p, the watts delivered by feeder; and x, the cross-sectional area in square inches of the copper of feeder. These six quantities are obviously connected by three relations; we may further assume two other relations between them, and then a sixth relation deduced from economical considerations suffices to determine the whole of the six quantities. The two assumed relations may take the form of two of the quantities being given. This is what usually happens, and is always the case in the author's discussion. Of the fifteen possible cases Lord Kelvin investigated, that in which v and C are given; Prof. Ayrton, that in which V and C, and also that in which V and x are given; while Prof. Ayrton and Perry, in conjunction, before the Society of Telegraph Engineers and Electricians in 1886, considered V and p to be given quantities. The remaining eleven cases are completely examined by Mr. Kilgour, and in doing so, as well as by giving a clear exposition of the whole subject, he has rendered valuable service. To all those who are concerned with the design of systems of distribution, this part of the work will be found to be of high interest and usefulness. In Part ii. will be found a collection of descriptions of the systems which practical men have gradually evolved by knowledge and experience. The best mains and culverts, and also the means of maintaining them in a state of efficiency, in use in England and on the continent, are described in detail with a large number of excellent illustrations. The compilers have shown good judgment in the selections they have made from the many systems that have been adopted.

(5) This work is intended to afford to County Councillors and others similarly placed some information likely to be of use to them in dealing with questions of central station lighting. It is a small and unpretending work of some forty pages, and seems to have accomplished the object in view.

OUR BOOK SHELF.

The First Technical College. By A. Humboldt Sexton. Pp. 188. 1894. (London: Chapman and Hall.)

When John Anderson became Professor of Natural Philosophy in the University of Glasgow, in 1786, he began to give instruction in science to persons engaged in industries. This was the beginning of technical education, and the future of the new line of study was to some extent provided for in Glasgow by its founder bequeathing the whole of his property "to the public for the good of mankind and the improvement of science in an institution to be denominated Anderson's University." The total value of the property, however, was only about £1000, and this, as Prof. Sexton remarks, was a small sum wherewith to start a new university which was to revolutionise the education of the country. But the gift formed a nucleus which attracted other benefactions, and, after a short time, sufficient funds were raised to appoint a Professor of Natural Philosophy and Chemistry. Dr. Thomas Garnett was nominated for this post in May, 1796. Three years later Count Rumford founded the Royal Institution, and Garnett accepted the first professorship in it. He was succeeded at the Anderson's Institution by Dr. George Birkbeck, who afterwards assisted in founding the well-known Birkbeck Institution in London. Dr. Ure next occupied the chair, and when he retired it was decided to appoint two professors—one of Natural Philosophy and one of Chemistry. Among the men who occupied the former chair at different times were Dr. William Heron, Dr. John Taylor, Prof. Carey Foster, and Prof. A. S. Herschel. The chair of chemistry was successively filled by Thomas Graham, Dr. William Gregory, Dr. Penny, Dr. T. E. Thorpe, and Prof. Dittmar. About 1830 Graham established a public laboratory for experimental work in chemistry, the first of its kind in Great Britain, and among the students who worked in it were Dr. James Young, Lord Playfair, and Dr. Walter Crum. Into the various changes which the institution has undergone we do not propose to enter. Suffice it to say that Anderson's College, the Mechanics' Institute, and the Allan Glen's School were united in 1882 to form the Glasgow and West of Scotland Technical College. The Mechanics' Institution, or College of Science and Arts, mentioned in this connection, was founded in 1823 as the result of the secession of some members of the Anderson's Institution. Lord Kelvin and his brother, the late Prof. James Thomson, studied for some time at the former institution.

The present Technical College, and the institutions from which it was formed, has had many distinguished men among its teachers and students. Prof. Sexton's history of the whole organisation is not merely of local interest, but appeals to all interested in the growth of technical education. The illustrations in his book are numerous, but mostly very bad, and the descriptive text might have been far more brightly written.

Practical Work in General Physics. By W. G. Woollcombe, M.A., B.Sc. Pp. 83. (Oxford: Clarendon Press, 1894.)

INSTRUCTION in practical physics is steadily, though very slowly, gaining ground in our schools and colleges. The tardy recognition of the great importance of this kind of work is doubtless due to the fact that practical physics does not bear directly on industrial and commercial pursuits. But, for training the mind, there is no better means than a course of physical laboratory practice. The hand is exercised in delicacy of manipulation; the eye is led to perceive instead of seeing things vacantly; and the mind is trained to make scientific deductions from observed facts. Whether a boy is designed to be a politician or a preacher, whether it is intended that he should follow the law or be sacrificed to science, in fact, no matter what the calling or profession in which he has to work his way through life, by far the best mode of obtaining the accuracy of observation and deduction desirable in everyone, is through instruction in practical physics. It is because we believe this, that we welcome any indication of the extension of such knowledge. Mr. Woollcombe is the author of a little book on practical work in heat, which we were able to commend when it appeared. The present volume deserves the same praise that we gave the previous one. It begins with descriptions of such instruments as the linear vernier, sliding callipers, micrometer screw gauge, and balance, and passes on to the measurement of length, area, and volume. The experiments performed under these heads lead naturally to the determination of the densities of solids, liquids, and gases, and then to Boyle's Law, the barometer, and capillarity. This order is practically the same as that followed in "A First Course of Physical Laboratory Practice," by Prof. A. M. Worthington, F.R.S., published eight years ago. Indeed, Mr. Woollcombe's book reminds us of Prof. Worthington's in more than one respect; but a similarity of gradation and general treatment almost inevitably exists between books covering the same ground.

The author is among those who take every opportunity of correcting the sense in which the word *weight* is generally understood. An aphorism of his worth quoting is: "We can no more lock up forces in a box than Pandora could imprison Hope in a casket, so that it is incorrect to talk of a *box of weights*—the correct term being a *box of masses*." We hope that a time will come when books similar to the one under notice will be required in all our public schools and colleges.

Manual of Practical Logarithms. By W. N. Wilson, M.A. (London: Rivington, Percival, and Co., 1894.)

THE great importance of a sound knowledge of the use of logarithms, and the frequency of their application in the majority of sciences, is sufficient to account for the appearance of such books as that under review, entirely devoted to their exposition. The subject is treated to a small extent in many of the larger text-books on algebra and trigonometry, but their insertion there is more to acquaint the student with the principles than to give him a good working knowledge, which can only be obtained by constant solving of problems.

In the book which we have under notice, the author assumes that the reader has had such a smattering of the subject as above suggested, since he purposely omits the propositions and formulæ found in most of the text-books, and devotes his whole attention to the treatment of various methods of solving problems with their aid. The examples dealt with, illustrate those branches of arithmetic, algebra, plane trigonometry, and mensuration, and those that are worked out are given in the forms that the student himself is advised to adopt.

The author deviates here from the usual method of writing the characteristic before the mantissa, by placing it afterwards. His reason for doing so is that he thus avoids the necessity of using the old and clumsy notation, as he calls it, for denoting the combination of a negative characteristic with a positive mantissa. The method here adopted has, no doubt, its advantages, and might facilitate matters for beginners, who nearly always find this a difficult point to surmount.

The reader is supplied with plenty of examples to practise his ingenuity upon, many of them being selected from various examination papers for the Army, Navy Oxford, and Cambridge, &c.

In the absence of any external assistance, close attention to the methods of solution employed in the book should give the reader a good insight not only in the right way of handling and becoming familiar with tables, but in the art of successfully attacking problems by their aid.

W. J. L.

LETTERS TO THE EDITOR.

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

Towards the Efficiency of Sails, Windmills, Screw-Propellers, in Water and Air, and Aeroplanes.

THE discussion of this day week, on flying machines, in the British Association was not, for want of time, carried so far as to prove from the numerical results of observation put before the meeting by Mr. Maxim, that the resistance of the air against a thin stiff plane caused to move at sixty miles an hour through it, in a direction inclined to the plane at a slope of about one in eight, was found to be about fifty-three times as great as the estimate given by the old "theoretical" (!) formula, and something like five or ten times that calculated from a formula written on the black-board by Lord Rayleigh, as from a previous communication to the British Association at its Glasgow meeting in 1876.

I had always felt that there was no validity, even for rough or probable estimates, in any of the "theoretical" investigations hitherto published: but how wildly they all fall short of the truth I did not know until I have had opportunity in the last few days, *procul negotiis*, to examine some of the observational results which Maxim gave us in the introduction to his paper. On the other hand, I have never doubted but that the true theory was to be found in what I was taught conversationally by William Froude twenty years ago, and which, though I do not know of its having been anywhere published hitherto, is clearly and tersely expressed in the following sentence which I quote from a type-written copy, kindly given me by Mr. Maxim, of his paper of last week:—

"The advantages arising from driving the aeroplanes on to new air, the inertia of which has not been disturbed, is clearly shown in these experiments."

Founding on this principle, I have at last, I believe, succeeded in calculating, with some approach to accuracy, the force required to keep a long, narrow, rectangular plane moving through the air with a given constant velocity, V, in a direction perpendicular to its length, l, and inclined at any small angle, i, to its breadth, a. In a paper, which I hope to be able to communicate to the *Philosophical Magazine* in time for publication in its next October number, I intend to give the investigation, including consideration of "skin-resistance" and proof that it is of comparatively small importance when i is not much less than 1/10, or 1/20, of a radian, and the "plane" is of some practicably smooth, real, solid material. In the meantime, here is the result, with skin-resistance neglected:—The resultant force (perpendicular, therefore, to the plane) is $2\pi V^2 \sin\theta \cos\theta\, la$; which is $\frac{4\pi \cos\theta}{\sin\theta}$ times (or for the case of $\sin\theta = \cdot 8$, one hundred times), the old miscalled "theoretical" result. KELVIN.

Eastern Telegraph Company's Cable Steamer *Electra*; crossing the mouth of the Adriatic, August 17.

Geological Maps of Baden.

IT may interest some of your readers likely to visit the Black Forest, that Herr Winter, of Heidelberg, has begun the issue of an official series of geological maps, each 19½ × 17½ inches, with memoir. Two are already out, one east of Heidelberg, the other giving the Mooswald district, north-east of Gengenbach. The scale is 1 : 25000; *i.e.* 10 cm. to 2½ km., or practically two and a half inches to the mile. Three sections are given on the sheet; the memoir has about 100 pages. The price for the map and memoir is only two marks; if the map is mounted, three marks. I had intended to comment on the contrast between this marvellous cheapness and our own Survey issues, as our inch ordnance cannot approach this for detail; for instance, the contour lines are given for every ten metres. But a paragraph read to-day in the New York *Nation* of August 9, in a letter signed "W. M. D." will speak for me:—". . . unfortunately the publications of the British Surveys are rarely found complete at home outside of the Governmental bureaus in Washington. Very few copies of the British geological reports and maps are presented to libraries in foreign countries, and the prices at which they are sold practically forbids their purchase. The maps are, moreover, coloured by hand, so every copy is expensive; while ours are lithographed, and 'additional copies' are of only nominal cost, perhaps three or four cents apiece. . . . The British practice almost seals up the costly results of the geological surveys. . . . It was a satisfaction to learn that this opinion, formed at home, was shared and emphatically expressed over here" (at Edinburgh).

The Baden State geology maps are also, of course, lithographed, and so are the equally cheap Imperial maps of all Germany, another series, now being published by Justus Perthes, and of which also the first two are just issued and cover the same region, South-west Germany. That the policy pays seems certain. Three other purchases, for instance, were the immediate result of my own, whereas my friends have always been content to *borrow* my English maps, when I could see my way to lend them. J. EDMUND CLARK.

York, August 21.

Variation of "Aurelia."

I SEE that you note (p. 413) the occurrence of an *Aurelia* with pentamerous symmetry. In an expedition of the Liverpool Biological Society to Hilbre Island, a few weeks ago, we found several such specimens, and remarked upon the frequency of the variation. I think the number was either four or five pentamerous forms out of twelve examined.

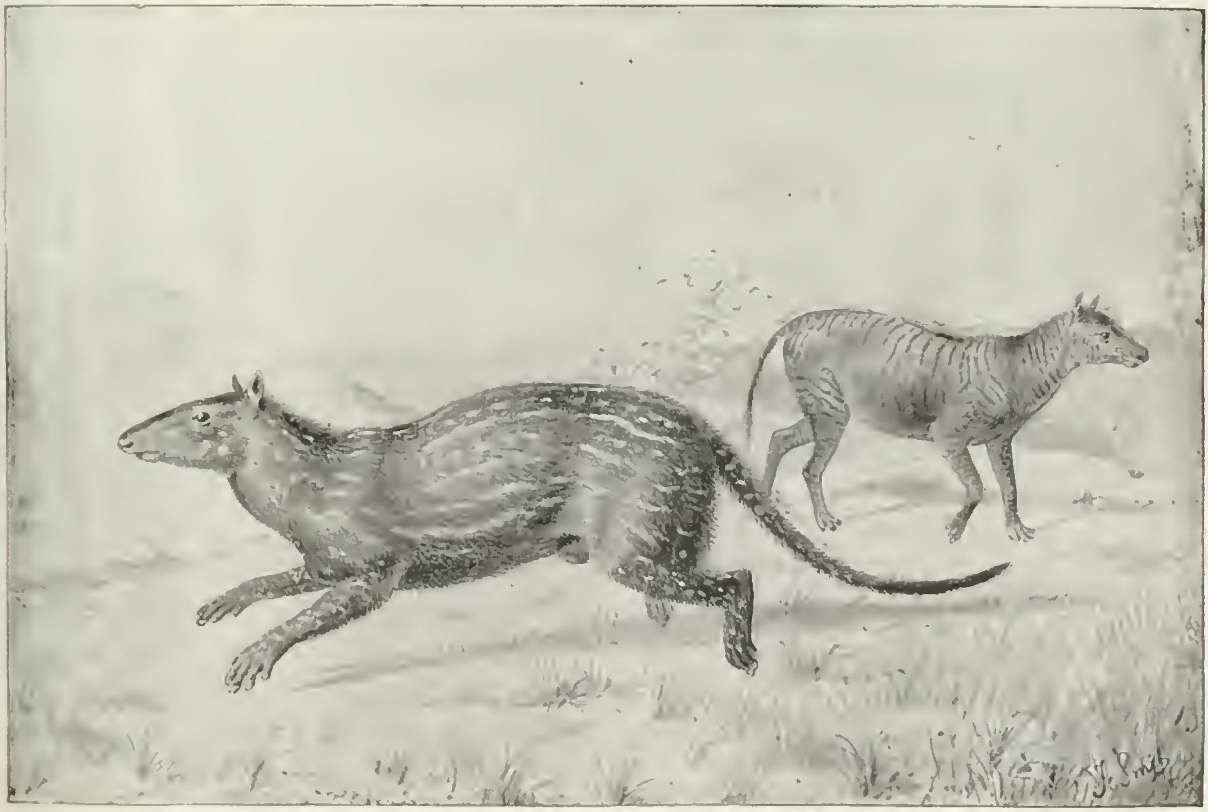
Port Erin, August 25. W. A. HERDMAN.

CREATURES OF OTHER DAYS.[1]

"CREATURES of Other Days" is a work of literature rather than science, and is yet so full of reference to scientific facts and discoveries that it appears like a work of learning. It narrates the history of extinct animals laboriously discovered, and in many cases still undergoing laborious interpretation by palæontologists, in language which is free from technicality. There is no reference to the anatomical structure of the skeleton which necessitates technical language. There is no critical digest of the facts enumerated, or of the nomenclature under which the fossils are described. No attempt is made to state the osteological characters which distinguish these fossils from each other. Materials which any author has supplied are accepted impartially, and the same animal type is illustrated by dissimilar restorations. Thus Mr. Hulke made a quadrupedal restoration of *Hypsilophodon Foxi*, an animal which once was termed a young *Iguanodon*, out of which Mr. Smit has restored a vigorous-looking lizard. If these interpretations are correct, it is improbable that the vertical bipedal restoration of *Anchisaurus*, given by Prof. Marsh, and restored by Mr. Smit, can also be satisfactory. Many of the original restorations endeavour to convey an idea to the unlearned of the skin and aspect of the living animals. And as these are based upon published figures, or restorations, the author has no doubt gone to the best material which was available, even when the result is unsatisfactory. Sir William Flower, in his preface, fairly states the claim of the restorations to consideration. He says: "In the restoration of the external appearance of extinct animals, known only by bones and teeth, there is much of imagination, much indeed of mere guess-work, and I should therefore be sorry to guarantee the accuracy of any of the representations of animals in this book, the majority of which were never seen in the flesh by the eyes of mortal man. I think, however, I may safely say that Mr. Hutchinson and his accomplished artist, Mr. Smit, have done their work carefully and conscientiously, and given us, in most cases, a fair idea of the appearance of the creatures they have endeavoured to depict according to the best evidence at present available." Sir William commends the figures because they give a better idea of the animals than most persons who only saw their fossil remains would be able to carry away. This unscientific attitude of the book is its chief merit. It is only when the author becomes an expositor of science that scientific men are likely to disagree with him. More care was needed in some of the restorations. The old red sandstone fishes, for example, are drawn without any regard to their relative sizes, those of the upper and lower beds swimming together as though they were of the same geological age, while at the bottom of the water are Trilobites, Brachiopods, and Cephalopods, which no one ever saw in the old red sandstone.

[1] By Rev. H. N. Hutchinson, B.A., F.G.S., author of "Extinct Monsters." With numerous illustrations by J. Smit and others. (London: Chapman and Hall, Limited, 1894.)

FIG. 1.—A restoration of Hypsilophodon.



(Phenacodus).[1] (Hyracotherium).

FIG. 2 —Ancestors of the Horse. Eocene Period.

Protorosaurus is classed under the Rhynchocephalia, apparently on the author's judgment, though the proposition might be hard to sustain. There are chapters given to Anomodonts, Crocodiles, newly-discovered Dinosaurs, and ancient birds; in which curious illustrations appear, some of the funniest being reproductions of the animals created by Mr. Waterhouse Hawkins for the Central Park, New York. The concluding chapters describe and illustrate mammals. *Palæotherium* and *Coryphodon*, *Dinotherium* and *Mastodon*, are fairly well illustrated. Horses and their ancestors give illustrations of *Phenacodus* and *Hyracotherium*. There is some account of the extinct marsupials of Australia, and of the extinct mammals of South America, such as *Toxodon*, *Macrauchenia*, and *Machærodus*.

The *Bos urus* of Cæsar, which probably became extinct in Britain before the Roman occupation, is represented by a spirited drawing. Appendices give a table of strata, an enumeration of the orders of animals, and a list of books for reference. H. G. S.

ERNEST MALLARD.

THE following paragraphs are extracted from an obituary notice of this distinguished mineralogist, contributed to the *Mineralogical Magazine* by M. G. Wyrouboff:—

In the history of scientific mineralogy the name of M. Mallard will undoubtedly occupy a place beside that of Hauy, to whom is universally conceded the honour of originating this branch of human knowledge. It may be asserted without exaggeration that M. Mallard created anew the science of crystallised bodies by bringing that science into close and intimate union with general physics. Only a few years ago mineralogy was regarded as a purely descriptive science, and crystallography was no more than a special chapter of abstract geometry.

He was a close follower of Bravais, whose beautiful theory he, to his great credit, adopted, developed, and popularised. Bravais, however, viewed the problem of crystalline structure as a geometrician, and saw only one side of the question. His conception of the lattice is based upon the homogeneity of the crystal; now, experience had long ago shown that crystals are far from being always homogeneous. To M. Mallard is due the honour of explaining this apparent contradiction by demonstrating, theoretically and experimentally, that crystals frequently consist of several lattices distributed in a certain regular manner about an axis which does not belong to any one of them.

M. Mallard did more than this, and hereon rests his claim to imperishable fame: he deduced from the theory of lattices and of reticular assemblages all the physical phenomena observed in crystallised bodies, including what were called the optical anomalies. Owing to his labours crystallography became a completely rational science to the same extent as any other branch of physics.

The crowning work of M. Mallard was his "Traité de Cristallographie," which was intended to comprise three volumes. Two only of these have been published; the third was to have dealt with crystalline assemblages, polymorphism and isomorphism, the most complex problems in crystallography, and those in which his most original work was done. The materials from which this volume was to be constructed are to be found in the memoirs published by M. Mallard since 1879. Some of these are real masterpieces, and have become classical; such are the papers on optical anomalies, on the quasi-cubic form of all crystallised bodies, on the transformations of polymorphous substances, and on isomorphous mixtures.

When we add to these the many detailed researches which he published in the *Bulletin* of the French Mineralogical Society, some relating to improved instruments of precision, and some to particular mineral species such as boleite, lussatite, tridymite, and melanophlogite, we cannot but feel that since the time of Haüy no one has done so much to advance that section of physical science which is concerned with crystallised bodies.

NOTES.

M. Cotteau, whose death we announced last week, has bequeathed his fine collection of living Echinoderms to the Paris Muséum d'Histoire Naturelle.

Reuter reports that an earthquake shock of short duration was felt at Athens at a quarter to eight on the morning of the 26th inst., and also at Corinth, Vastizza, Zante, Thebes, Chalcis, and Atalanti.

It is announced that a laboratory for the manufacture of tuberculin, mallein, anthrax, vaccine, &c., will shortly be established in Rome in connection with the laboratories of Hygiene of the Ministry of the Interior.

We learn that Prof. Pettenkofer has resigned the chair of hygiene and the directorship of the Hygienic Institute in the University of Munich, on account of his advanced age. He is succeeded by Prof. Hans Buchner.

The *British Medical Journal* says that the President of Queen's College, Belfast, has received information that the Government will grant the sum of £2,500 for the erection and equipment of a physiological and pathological laboratory. Plans are being prepared, and the buildings will be at once proceeded with.

Mr. H. C. Russell, of Sydney Observatory, writing to us with reference to an aurora observed on July 20, says that he noticed that while the display lasted there was a fog or haze over the southern sky bright enough to hide 5th magnitude stars, and when these began to reappear the auroral light vanished, as if the fog or haze had been necessary for its manifestation.

Mr. Richard Langdon, station-master at the Silverton Station of the Great Western Railway, Devon, died on July 18. Nearly thirty years ago he began to study astronomy, in which he took an absorbing interest to the end of his life. Being a skilful mechanician, and having acquired a knowledge of optics, he employed his spare time in constructing an eight-inch silver-on-glass equatorial reflector, grinding the mirror with a machine which he made for the purpose. He was a keen and accurate observer, and in 1872 he read a paper "On certain Markings on the Planet Venus" before the Royal Astronomical Society.

For just a year the Birahi Ganga River has been dammed back by the great landslip at Gohna. We noted this event shortly after its occurrence, and on July 5 gave an abstract of Mr. T. H. Holland's report upon it. In this report Mr. Holland estimated that the lake would overflow the barrier about the middle of August. The news has now come that the water reached the top of the dam early on Sunday morning, and cut through the temporary dam which had been constructed to prevent its escaping during the night. Combined percolation and overflow caused the water to fall rapidly, until its length was reduced from five miles to about two and a half miles. Telegraphing on Monday, Reuter's correspondent at Simla says that the water thus released has swept away all the Government buildings on the banks of the river. At Hardwar a torrent of water 6ft. in depth rushed through the town, but there was no loss of life, owing to the precautions taken. All the buildings, however, between Gohna and Hurdwar have been destroyed. The lake formed by the landslip is now empty. Though considerable damage has been done to property by the escape of the water, no loss of human life is reported. The Indian Government is to be commended for the ample precautions taken to avert disaster at the time of overflow, and for the scientific manner in which the formation of the lake has been investigated.

THE journey to Greenland, modestly referred to by Prof. G. F. Wright in our correspondence columns on July 12, promises to lead to results of scientific value. We understand that the excursion was organised by Dr. Frederick A. Cook, anthropologist of Peary's first expedition, and consists of fifty persons, of whom a good part are students of science. Among the scientific members are Prof. W. H. Brewer, of Yale College, Prof. B. C. Jillson, of Pittsburg, Pa., who with Prof. G. F. Wright and his son, of Oberlin, Ohio, and a party of six, will disembark in Umenak Fiord about latitude 71°, to study the border of the ice-sheet, the neighbouring glacial deposits, the glaciers entering the fiord, the Tertiary deposits of the vicinity, and make a collection of the plants and animals. Prof. L. L. Dyche, at the head of the department of zoology and taxidermy at the State University of Kansas, is the official naturalist of the expedition. He will make a point of collecting birds and mammals. With him are Mr. S. P. Orth and Mr. B. F. Stanton (both of Oberlin), as assistant naturalists, to make general collections. Mr. E. A. McIlhenney, of Louisiana, accompanies the expedition as an ornithologist. Prof. C. E. Hite, of Philadelphia, with three assistants, goes to Labrador for general exploration. Prof. E. P. Lyon, of Chicago, goes for the general study of biology. The expedition expects to return about September 20.

PROF. H. B. DIXON's report on the explosion that occurred at the Albion Colliery, near Pontypridd, South Wales, at the end of last June, has been published as a Parliamentary paper. Although it was not possible to examine all the workings, the evidence obtained justifies the opinion that the explosion throughout its main extent was purely a dust explosion. Prof. Dixon thinks it would have been practically impossible for fire-damp to have accumulated in the main intake air-roads, or to have been introduced suddenly into them in sufficient quantity to feed an explosion throughout the extent of road actually traversed by the flame. On the other hand, sufficient dust was found lying in a dry and fine state along the main roads to feed the flame throughout the parts penetrated by the explosion. As to the origin of the explosion, the belief is expressed that a dynamite shot raised a cloud of inflammable particles and set them on fire. If precautions were taken always to water the dust near the spot where a cartridge is going to be fired, such explosions as that at the Albion Colliery would be less frequent.

THE twenty-third meeting of the French Association for the Advancement of Science was held at Caen, from August 9 to 15, under the presidency of M. Mascart. In his opening address, the president paid homage to the many men of light and leading who were born and nurtured in the little province of Normandy, in which the meeting was held. Pierre Varignon, the celebrated geometer, was born at Caen in 1654. The two chemists, Ronelle and Vauquelin, and the intrepid traveller Dumont-Durville, were born in the same neighbourhood. Other names associated with the province are the great astronomer Laplace; Elie de Beaumont, one of the founders of French geology; Augustin Fresnel, whose work in physical optics has become classical; and that intellectual giant, Le Verrier. The second section of M. Mascart's address was devoted to brief descriptions of some of the institutions designed for scientific study in the United States. Praise was especially given to the generous donors whose lavish benefactions had helped on the cause of science in America. If M. Mascart had followed the traditions attached to a president's office, he would have given his audience his reflections upon the progress accomplished in the branch of knowledge to which he has paid most attention, that is, meteorology. This, however, he did not do, but passed in review some points in the history of electricity. The meeting was not favoured with fine weather, nevertheless the number of members was about the same as in previous years. The total receipts amounted to 91,182 francs, of which, however, only 55,551 francs came from annual subscriptions. The sum of 15,624 francs was disbursed in grants for scientific research. The Association will meet next year at Bordeaux, and in 1896 the place of meeting will be Tunis.

THE *London Gazette* for Friday last contains the following new denominations of standards for electrical measurement, adopted by the Privy Council on the previous day: (1) *Standard of Electrical Resistance*. The standard of electrical resistance, denominated one ohm, being the resistance between the copper terminals of the instrument marked "Board of Trade Ohm Standard Verified 1894" to the passage of an unvarying electrical current, when the coil of insulated wire forming part of the aforesaid instrument, and connected to the aforesaid terminals, is in all parts at a temperature of 15°·4 C. (2) *Standard of Electrical Current*. A standard of electrical current, denominated one ampere, being the current which is passing in and through the coils of wire forming part of the instrument marked "Board of Trade Ampere Standard Verified 1894," when, on reversing the current in the fixed coils, the change in the forces acting upon the suspended coil in its sighted position, is exactly balanced by the force exerted by gravity in Westminster upon the iridio-platinum weight, marked A, and forming part of the said instrument. (3) *Standard of Electrical Pressure*. A standard of electrical pressure, denominated one volt, being one-hundredth part of the pressure which, when applied between the terminals forming part of the instrument marked "Board of Trade Volt Standard Verified 1894," causes that rotation of the suspended portion of the instrument which is exactly measured by the coincidence of the sighting wire with the image of the fiducial mark A, before and after application of the pressure, and with that of the fiducial mark B during the application of the pressure, these images being produced by the suspended mirror, and observed by means of the eye-piece. In the use of the above standards the limits of accuracy attainable are as follows:—For the ohm, within one-hundredth part of one per cent.; for the ampere, within one-tenth part of one per cent.; for the volt, within one-tenth part of one per cent. The coils and instruments referred to are deposited at the Board of Trade Standardising Laboratory, 8 Richmond-terrace, Whitehall, London.

THE Department of Science and Art has issued the following list of candidates successful in this year's competition for the Whitworth Scholarships and Exhibitions. Scholarships of the value of £125 per annum (tenable for three years)—John Ball, 22, engineer, Derby; James H. Smith, 23, student, Manchester; Harry Verney, 24, fitter, Bristol; Charles F. Smith, 21, mechanical engineer, Bristol. Exhibitions of the value of £50 (tenable for one year)—Frank Fisher, 19, engineer, Brighton; William M. Thornton, 24, student, Liverpool; John W. Hinchley, 23, student, Lincoln; William D. Young, 23, engineer, Westfield (N.B.); Alexander L. Mellanby, 22, engineer, West Hartlepool; William T. F. Trunchion, 22, fitter, Bedford; Henry Deanesly, 25, draughtsman, Wincanton;

William T. Swinger, 19, engineer apprentice, Plumstead, Kent; Arthur W. Ashton, 21, fitter, Plumstead, Kent; Arthur E. Mascall, 18, engineer, Woolwich; William Rosbotham, 25, student Belfast; Joseph J. Kirwin, 20, engine fitter apprentice, Devonport; Charlie W. Cairns, 21, apprentice engineer, Newcastle-on-Tyne; John W. Button, 23, fitter, Oldham; Sydney Eraut, 22, mechanical engineer, London; Charles E. Pickles, 18, student, Bradford; Richard G. Allen, 21, fitter apprentice, Southsea; Alexander Craig, 22, engineer, Crewe; Thomas S. Usherwood, 20, engineer apprentice, London; Walter Eraut, 19, mechanical engineer apprentice, London; Lewis E. Limming, 21, shipwright apprentice, Southsea; Sidney E. Lamb, 20, fitter apprentice, Devonport; Francis J. Russell, 20, fitter apprentice, Portsmouth; Edgar R. Sutcliffe, 19, draughtsman, Leeds; George F. Hambly, 20, engineer apprentice, London; William Gore, 23, engineer, King's Lynn; Thomas S. Cockrill, 25, marine engineer, London; William H. James, 21, engineering student, Cardiff; Harry J. Peachey, 18, engineer apprentice, Stratford (London); James N. Boot, 25, engineer, London.

During a severe hailstorm at Vicksburg, in May last, a remarkably large hailstone was found to have a solid nucleus, consisting of a piece of alabaster from one-half to three-quarters of an inch. During the same storm at Bovina, eight miles east of Vicksburg, a gopher turtle, six by eight inches, and entirely encased in ice, fell with the hail. Commenting upon this, in the *Monthly Weather Review*, Prof. Cleveland Abbe says that apparently some special local whirls or gusts carried the enclosed objects from the earth's surface up to the cloud region, where they were encased by successive layers of snow and ice, until they fell as hailstones. He points out that the fact that hailstones, as well as drops of water and flakes of snow, often contain nuclei that must have been carried up from the earth's surface, is entirely in accord with the general principle that ascending currents precede the formation of cloud and rain, and that solid nuclei are needed to initiate the ordinary precipitation of moisture.

Dr. Hergesell has sent us the results of the meteorological observations made in Alsace and Lorraine during the year 1892, containing hourly values for Strassburg, and monthly and yearly summaries at various other stations. The results obtained from two anemometers at the central station are very interesting; one of the instruments is erected at about 170 feet, and the other at about 470 feet above the ground. The wind velocity at the higher level has a daily range corresponding exactly with that of mountain stations, the minimum occurring in the morning, and the maximum during the night. The results show that the indications of an anemometer fixed more than 150 feet above the ground are much more comparable than those at a lower level, where the indications are affected by local conditions. We look forward to the promised publication in the next volume of a chart showing the distribution of rainfall for a long series of years.

We have received from M. E. Durand-Gréville two pamphlets entitled "Les grains et les orages," in which the author has endeavoured to show the connection between certain squalls, which accompany large barometric depressions, and thunderstorms. It is generally admitted that important thunderstorms occur at the same time on different points of an isochronous line moving towards east-north-east. Before the storm there is a gradual fall of the barometer, a rapid rise during the storm, and a sudden change in the direction of wind. But opinions differ considerably as to the conditions under which the thunderstorms occur. The author has investigated certain special cases, and has endeavoured, with some success, to co-ordinate the various views. He shows that several of them, while contradictory, at least in appearance, are capable of reconciliation, and are founded upon facts, which have been diversely interpreted. The papers are accompanied by several explanatory diagrams showing the line taken by the squalls, and the various forms of the isobaric curves which accompany them.

In an interesting report issued by the United States Department of Agriculture, Mr. Alexander McAdie gives an account of the statistics concerning the position, &c., of buildings struck by lightning, and also of the best methods to be employed to protect buildings, &c., from being damaged by lightning. One interesting point which is very prominently brought out by the statistics is the decreased liability to accident from lightning strokes in thickly populated districts. In fact, it may be said that, in general, the risk in the country is five times as great as in a city. The report concludes with a number of rules which ought to be observed with reference to lightning, from which we may select the following:—If the conductor, at any part of its path, goes near water or gas mains, it is best to connect them to it. Independent grounds are better than connection to water or gas-pipes. Clusters of points or groups of two or three along the ridge of the roof are recommended. The top of the rod should be plated, or in some way protected from rust, and chain or linked conductors are of little or no use. Finally, if you should be in the vicinity of a person who has just been struck by lightning, no matter if the person struck appears to be dead, go to work at once and try to restore consciousness. There are many cases on record proving the wisdom of this course, and there is reason for believing that lightning often brings about suspended animation rather than somatic death. Try to stimulate the respiration and circulation, and do not cease in the effort to restore animation for less than an hour's time.

At a recent meeting of the Vienna Academy of Science, Herr Bruno Piesch gave an account of his recent work on the change in the electrical resistance of aqueous solutions, and of the electric polarisation with change of pressure. The author has examined a large number of liquids, both acids and salt solutions. The apparatus was so arranged that the resistance and polarisation would be simultaneously measured. The high pressures used were obtained by means of a Cailletet's compression apparatus, and experiments were carried on up to a pressure of 600 atmospheres. The vessel in which the liquid to be experimented upon was placed was enclosed in the iron receptacle of the pump, being insulated by means of an ebonite plug. The following results have been obtained:—A change in pressure is always accompanied by a change in the electrical resistance, the resistance decreasing with increase of pressure. No definite connection is observable between the amount of the pressure change and the concentrate of the solution, but in the case of most of the substances investigated the change was greater in the case of very dilute solutions than in more concentrated ones. The magnitude of the change in resistance with change in pressure is very small, as is also the case with the change in the polarisation. In most cases an increase of the polarisation with increase of pressure was observed, but the irregularities were in this case greater than those observed in the resistance measurements. In conclusion the author examined a solution of ammonium nitrate in alcohol, when he obtained changes in the same sense as in the case of aqueous solutions.

At the same meeting, Herr J. Liznar read a paper on the 26-day period of the earth's magnetism. In a previous communication the author had compared the diurnal variation in stations in middle and high latitudes. In the present paper the magnitude of the 26-day period variation for declination and inclination at the stations of Pulowsk and Jan Mayen are compared and it is shown that the amplitude of the variation at the northern station is four times as great as at the southern. The author also considers that the small variations which constitute the 26-day period variation are not due to a direct magnetic action of the sun, but that they must have their origin in some secondary action of the same.

IN cases where it is desired to investigate a ray of light reflected perpendicularly from a surface, it is usual to employ a transparent plate of glass which transmits the incident ray before it falls upon the surface, and partially reflects it aside on its return. Such an arrangement, best known in Gauss's eye-piece, may be called a Gauss's plate. The best position of such a plate is, as pointed out by Herr B. Walter in the current number of *Wiedemann's Annalen*, not the commonly accepted one of 45°, but another depending upon the refractive index of the material of the plate, and upon whether the light is polarised and in what manner. From theoretical considerations, he concludes that for light polarised either in or at right angles to the plane of incidence the greatest possible intensity of the reflected light is 15 per cent. of the original intensity, whatever may be the refractive index. If the light is polarised in the plane of incidence, the plate must be placed at a lesser angle to the ray the smaller the index of refraction. For light polarised at right angles to this plane the reverse holds good. But for refractive indices about 1·4 this angle reaches the common value of 7° 46′ 16″. The best position for ordinary light may be determined by regarding it as composed of the two species of polarised light. For crown glass the inclination should be 10½°, at which position the intensity of the reflected light is 2·84 times that obtained with the usual inclination of 45°.

A NEW automatic sounding instrument has lately been brought into use by Captain G. Rung, the director of the Copenhagen Meteorological Institute, under the name of the universal bathometer. Unlike the instruments hitherto constructed, which register the depth attained by the compression undergone by a column of air, Captain Rung's bathometer, as described in *Hansa*, measures the density of a small volume of the compressed air cut off at the bottom of the sea. This density is directly proportional to the depth attained, and is measured by allowing the compressed air to expand until it is under atmospheric pressure only. Its volume will then be proportional to the density it had reached during compression. The whole apparatus is very neat and compact. A metallic tube contains two other tubes side by side, both communicating with a small chamber at the top. A valve shuts off the communication with the one or the other of the tubes, accordingly as the sounder is being lowered or raised. When the bathometer is being let down, water enters the "air tube" from the bottom, and compresses the air in the tube and in the small chamber. The whole is enclosed in another heavy tube, in which it can slide a little up and down. When the bathometer touches the bottom, the inner tube slides down, thereby turning the valve so as to close the communication with the air tube and open to the "measuring tube." At the same time, a couple of spring catches prevent the inner tube sliding up again. The bathometer is then drawn up to the surface, and the reading on the measuring tube at once indicates the depth. This tube is made of glass, and is graduated in fathoms or other units of length at equal intervals. This constitutes the chief advantage of this over previous types. In instruments measuring the depth by the volume of the compressed air the graduations had to be at smaller and smaller intervals as the depth increased, since the amount of compression decreases at high pressures. Captain Rung's instrument, on the other hand, can be graduated directly up to any limit of depth which it is likely to attain.

MR. W. J. MOENKHAUS has lately studied a species of American freshwater Percidæ—*Etheostoma caprodes*, Rafinesque—with a view to ascertain the extent of its variation, the relation of its variation to its geographical distribution, the extent of variation in each locality, and the variation with age. He gives an account of his investigation in the *American Naturalist* for August, and from it we learn, among other points, that the difference between specimens from the same locality is very slight. The greatest variation was found to be in the colour-patterns of the fish, but the most complicated colour-pattern can be connected with the simplest by means of intermediate stages. These variations, however, could not be connected with the latitudes inhabited by the different varieties. Slight variations were found in proportions and number of fin rays.

THE Plankton Expedition has yielded some very interesting results with regard to the bacteriology of the ocean, which are now published by Dr. B. Fischer in "Die Bakterien des Meeres nach den Untersuchungen der Plankton-Expedition." Except at very great depths, germs capable of germination were found everywhere. The number in the Canary, Florida, and Labrador currents was larger than in the south equatorial, north equatorial, and Guinea currents. None could be detected with certainty in the bed of the ocean; but bacteria abound at a depth of 400 m., and are certainly present at depths between 800 m. and 1100 m. The prevailing form of microbe is the spiral; but bacterium forms are also frequent; micrococci are rare. Forms more or less resembling the cholera-vibrio, both in their form and in their mode of motion, were very common. Most marine bacteria are aerobic, but some appear to be also facultatively anaerobic. Not a few form pigments, and a large number are luminous in the dark; the phosphorescent forms were most commonly met with on the surface of living fish. A number of new species are described.

SOME interesting points await settlement in the natural history of the mollusk *Gundlachia*, whose shell presents such puzzling and anomalous features. In a recently published paper on the Australasian forms (*Proc. Linn. Soc. N.S.W.* viii. 1893), Mr. Charles Hedley briefly reviews our knowledge of the genus and its distribution, and gives descriptions and figures of *G. petterdi* and *G. beddomei*. In the case of the former species, he describes a series of young shells showing the method by which the primary *Ancylus*-like shell is transformed into the curious double shell of the adult. Stimpson's suggestion that the septum which partially closes the aperture of the primary shell should be compared physiologically with the epiphragm of the Helices—as a protection during hibernation—well deserves some attempt at verification; as also does the unproved impression that under particular conditions the shell of *Gundlachia* never attains its normally double form, but remains simple and patelliform throughout life.

THE July number of *Modern Medicine and Bacteriological Review* contains an article entitled "The Value of Prof. Koch's Discovery," in which it is mentioned that the State of New York has recently passed a law authorising the use of tuberculin as a means of determining the presence or non-presence of the tuberculous process in cows. It is pointed out that though Koch's tuberculin has not fulfilled the expectations raised for it as a curative agent, as a means of diagnosis it may be of great service. Two or three drops of tuberculin injected beneath the skin of a cow will, if the animal is tuberculous, give rise within a few hours to an elevation of temperature of several degrees, whilst this characteristic reaction is absent in the case of animals free from this disease. Amongst the bacteriological notes is one on soap as a germicide, from which it appears that the so-called antiseptic soaps containing salicylic acid or carbolic acid, yield no better results than ordinary toilet soap, the latter destroying the cholera bacillus in from ten to fifteen minutes when applied in the proportion of 2·5 parts of soap to 1000 parts of water. The same journal contains an account of an electric-light bath, consisting of a small cabinet large enough to permit of one person sitting comfortably, the walls of which are completely covered with mirror-glass. From forty to fifty electric lights are so distributed that every part of the body of the "bather" is almost equally exposed to the light. Dr. Gebhardt, who communicates the article, reserves his opinion as to the curative merits of this novel bath, but mentions that the intense light, contrary to his anticipations, did not produce an unpleasant or exciting effect, but exercised a calming influence upon him. Like the ordinary vapour bath, the electric light bath is followed by the application of cold water.

PART V., completing the fifth volume of the *Transactions*, has been issued by the Norfolk and Norwich Naturalists' Society, which fully maintains the interesting character of its publications. The first paper consists of the annual "Presidential Address," in which the President (Mr. Thomas Southwell) avails himself of the twenty-fifth anniversary of the formation of the Society to give a slight sketch of its history and the work it has accomplished; and we cannot but congratulate the members on the excellent results it has to show, the five thick volumes forming not only an epitome of the natural history of the county for the past twenty-five years, with excellent lists of the fauna and flora, but numerous biographical sketches are given, often with portraits, of the men whose labours in the past have proved so valuable to their successors. The address then gives some very interesting information as to the physical features of the county in times past, as well as of its natural productions. The establishment of a branch of the Society at Great Yarmouth called for a second "address," which is devoted to an account of the local naturalists, collectors, and gunners, for which, ever since the latter part of the last century, that favoured locality has always been celebrated, as well as to the enumeration of the many ornithological rarities which have there been obtained. Prof. Newton contributes a very interesting account of the great flood in South-West Norfolk in 1852-53, which resulted in the temporary return to the fens in that district of birds, such as the black tern and black-headed gull, which had long ceased to frequent the locality. The occurrence of the bearded seal on the Norfolk Coast, for the first time in Great Britain, is announced. Mr. Stacy-Watson has a very useful paper on the varieties and distribution of the herring. There are also papers on the local occurrence of fungi and flint implements, with lists of Norfolk earthworms, ichneumons, mammalia, fishes, birds, hemiptera, and flowering plants. Of the twenty papers in the number before us there are only two which have not a strictly local bearing.

THE last number of the *Izvestia* of the Russian Geographical Society contains two papers which are sure to be welcome to geographers. The first, by G. I. Tanfilieff, is on the tundras of North-East Russia, on the shores of the Arctic Ocean, between the rivers Mezen and Pechora. Middendorff's descriptions of the tundras of northern East Siberia are classical for the subject. So are also Beketoff's "Flora of Arkhangelsk" and his additions to the Russian translation of Griesebach's work. But so much has lately been written about the tundras and the features they have in common with the steppes, that the necessity of new researches in this direction was very much felt. M. Tanfilieff fully confirms this view, and shows the further likeness which exists between the black-earth, the clay, and the sandy steppes on the one side, and the peat-bog, the clay, and the sandy tundras on the other. And he gives, moreover, a very vivid description of the inner processes of the life of the tundra, and enters into very interesting considerations relative to the extension of the ever-frozen soil, and the limits put by it to the northward spreading of forests. The southern limits of the former, and the northern limits of the forest region, are identical, and wherever there are in the tundra islands of ground which does not freeze, groves of fir-trees appear upon them; while even in the forest tracts the appearance of peat-bog islands, which remain frozen to a great depth, is always followed by a disappearance of the trees. The rivers act as drainage channels, which prevent water from percolating the soil, and therefore prevent it from freezing; this is why their courses are always followed by trees, which penetrate into the treeless tundras along the watercourses. The author's remarks on the Samoyedes and the reindeer are also very valuable. He fully confirms the excellent reputation of these children of the tundra, who, in consequence of the extremely slow growth of the reindeer lichen (*Cladonia rangifera*) are deprived of their pasture grounds, and reduced to complete ruin, by the Zyryanes and the Russians, who bring their herds of over 2000 head of reindeer into the Samoyede domains.

THE other paper, also of great interest, is by V. M. Obrucheff, on the orography of the Nang Shan. The Russian geologist has crossed this system of mountains both in the west of Lake Kuku-nor, at the western end of these highlands, and in the east of the lake; and, with the information previously gathered by Przewalsky and Potanin, he was enabled to draw a scheme map of the whole system, appended to the *Izvestia*. It appears that the highlands of Nang Shan consist of a series of parallel ridges running west-north-west to east-south-east, both in the north and in the south of Kuku-nor. The first chain is the Lung-thu-shan, in the north-east of the towns Su-choi and Han-chou. Then comes the Richthoffen ridge, continued in the east by the Momo-shan; then comes Humboldt's ridge, which is supposed by the author to have its continuation in the Maling-shan, while Ritter's ridge is continued east-south-eastwards by the Tsing-shi-ling. However, some doubt still prevails as to these last two points, on account of a want of exploration in the middle part of the highlands. The chain which rises just on the southern coast of Lake Kuku-nor (South Kuku-nor chain of Przewalsky) is continued towards west-north-west by a ridge, to which M. Obrucheff gives the name of Mushketoff's ridge, while the last chain of the group is named Semenoff's ridge. This classification brings some order, which was most desirable, into this grand group of mountains. Their geological history and later dislocations are also discussed in the same paper.

A RECENTLY published *Bulletin* of the U.S. Fish Commission (vol. xi., 1891) contains the results of a search for a fish-hatching station in the Gulf States. The character of the biological station which the United States Government desired to establish is indicated in the following extract from the instructions to Prof. Evermann: "To unite in one station the facilities for fish-cultural work with the salt-water species, for the pond culture of fresh-water species, for the investigation and development of methods for the propagation and rearing of the oyster, and for the investigation of the marine life of this coast. This means, of course, a laboratory of marine biological research, not large or expensive, but thoroughly equipped in all respects for its work." The explorations led to the conclusion that no point on the coast examined offered entirely satisfactory conditions for the establishment of a combined fresh and salt water station, though a site near Galveston presented some advantages. In addition to the reports prepared by Prof. Evermann, the volume referred to above contains reports on matters connected with his investigations. Such, for instance, is a statistical report on the fisheries of the Gulf States, by Mr. J. W. Collins and Dr. H. M. Smith; a report on a collection of fishes from the Albemarle region of North Carolina, by the latter author; a paper on the spawning habits of the shad, by Mr. S. G. Worth; a report on the aquatic invertebrate fauna of the Yellowstone National Park, and of the Flathead region of Montana, by Prof. S. A. Forbes; and a report on the fisheries of the South Atlantic States. Finally, the volume contains a description, by Mr. Bashford Dean, of the methods of oyster-culture in Italy, Spain and Portugal, Germany, Holland, Belgium, and England. Oyster-culture, as practised in France, had previously been reported upon in connection with the U.S. Fish Commission. This article, like most of the others, is excellently illustrated. They all help to disclose the possibilities of fish industries in the United States, and indicate how "the harvest of the sea" may be increased in value.

WE have received a ponderous volume (vol. vi.) of the transactions of the Reale Accademia delle Scienze Fisiche e Mathematiche, Naples. The volume contains nineteen fine plates and eighteen papers, most of which refer to natural science subjects.

MR. ROWLAND WARD, the well-known taxidermist, has published the seventh edition of his "Sportsman's Handbook," containing information on the "practical collecting, preserving, and artistic setting-up of trophies and specimens, to which is added a synoptical guide to the hunting grounds of the world."

THE second volume of Priestley's "Experiments and Observations on Different Kinds of Air"—that is to say, the one in which he first gave an account of the discovery of oxygen in 1775—is reproduced in the seventh number of the handy "Alembic Club Reprints," published by Mr. W. F. Clay, Edinburgh. The next volume in this series will contain Scheele's work in connection with the discovery of oxygen.

THE Robert Boyle lecture, delivered by Lord Kelvin before the Oxford University Junior Scientific Club, in May last, on "The Molecular Tactics of a Crystal," has been published by the Clarendon Press. No student of crystallography should neglect to read the lecture, for in it the geometry of crystalline structure is dealt with in the simplest manner. The substance of the lecture is contained in a paper read by Lord Kelvin before the Royal Society on January 18, and reprinted in these columns on March 8.

MESSRS. GEORGE PHILIP AND SON have lately published a book, of fifty pages, entitled "Knowledge through the Eye," by Mr. A. P. Wire and Mr. G. Day. The authors explain how to use the optical lantern in illustrating lectures in science and other branches of knowledge, and describe a new method of preparing lantern slides without the use of a camera. A drawing of the required illustration is first made. A piece of specially prepared transparent paper (sold by Messrs. Philip) is then placed over it, and the drawing is transferred by tracing. A lantern slide is obtained by making a contact exposure in the ordinary manner, using the picture on the transparent paper as a negative. This method, however, has very little to commend it. Line drawings are easily made upon a plate of smoked or varnished glass, or upon glass having a thin film of collodion upon it; and as the illustrations have to be drawn in any case, it is just as well to do the work directly as to make a lantern slide of a tracing made from a drawing in the way described by the authors.

THE additions to the Zoological Society's Gardens during the past week include a Hairy Armadillo (*Dasypus villosus*) from South America, presented by Mr. George Simpson; a —— Bamboo Rat (*Rhizomys*, sp. inc.) from India, presented by Mr. Angus M. Kinloch; a Himalayan Monaul (*Lophophorus impeyanus*) from the Himalayas, presented by Captain H. R. H. Helpman; two Sharp-nosed Crocodiles (*Crocodilus acutus*) from Jamaica, presented by Dr. Poole; two Common Chameleons (*Chamæleon vulgaris*) from North Africa, presented by Mr. E. Palmer; two Smooth Snakes (*Coronella lævis*) from Hampshire, presented by Mr. E. Penton; two Common Vipers (*Vipera berus*), British, presented by Mr. Hugh Bromley; a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa; two Heloderms (*Heloderma suspectum*) from Arizona, deposited; three Blood-breasted Pigeons (*Phlogœnas cruentata*) from the Philippine Islands, purchased; a Yak (*Poephagus grunniens*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SOLAR ECLIPSE PHOTOGRAPHY.—Mr. Albert Taylor recently read a paper before the Royal Dublin Society, on the selection of suitable instruments for photographing the solar corona during total solar eclipses. The photographs obtained by other observers and himself during the total eclipse of April 1893, have indicated the best methods, both photographic and instrumental, to be adopted for the next observable total solar eclipse, on August 8, 1896. One of the most disputed points in eclipse photography, says Mr. Taylor, refers to the proper exposure required to obtain the faint extensions of the corona without fogging the plate by the sunlight. Two opposite opinions are held as to the best method of photographing these diaphanous coronal extensions. Short exposures and slight photographic action are believed by some observers to give the best results, but others hold that long exposures and great photographic action are necessary to attain the desired end. An examination of the photographs obtained during the eclipse of April 1893, shows that the latter view must be abandoned; and that nothing is to be gained by using photographic actions exceeding 15 or 16. Photographic action is determined by the formula $100 \frac{a^2}{f^2} t. s.$, where a is the aperture of the instrument employed, f the focal length, t the time of exposure, and s the sensitiveness of the plate. For obtaining photographs showing the detailed structure of the inner and middle coronæ, short exposures and a long-focus object-glass are recommended. The opinion is expressed that, with a twelve-inch object-glass of between forty and sixty feet focus, one hundred seconds' exposure would give nearly all the corona that is within reach of the photographic method of attack in the present state of photography. It is believed that with an instrument having a focal length equal to ten times the aperture, all the external corona would be obtained in about fifteen or sixteen seconds.

OBSERVATIONS OF SATURN AND URANUS.—Since the beginning of this year Prof. E. E. Barnard has used the 36-inch of the Lick Observatory in some observations of Saturn and Uranus (*Astronomy and Astro-Physics*, August). Measurements of the former planet were undertaken with a view of determining whether the ball was situated in the exact centre of the rings. Between the end of the ring and the limb on the following side of Saturn the angular distance was 11″·287, while similar measures on the preceding side gave 11″·167. The difference is less than one second of arc, and it may very well be due to some peculiarity in the measures. It is certainly not sufficient as yet to suggest that the planet is not exactly at the centre of its rings. Prof. Barnard has also made a series of measures of the polar and equatorial diameters of Uranus, and a series of measures of the position angles of the equator. From these it appears that "the equator of the planet coincides with the planes of the orbits of the satellites, thus verifying the supposition that Uranus rotates on an axis deviating but little from the plane of its orbit."

BIOLOGY AT THE BRITISH ASSOCIATION.

SECTION D, in spite of the loss of Physiology, had so many papers that it was necessary to meet on most days under the two departments of Zoology and Botany. A noteworthy feature was the large number of papers by distinguished foreigners, and the theoretical nature of a large proportion of the communications.

On Thursday, in addition to the Presidential Address (NATURE, p. 371), the following reports of Committees were taken:—

(1) The Naples Zoological Station. This contains an interesting letter from Dr. Dohrn on the future maintenance and administration of the station, statistics as to the work of the station during the past year, and an account by Mr. J. E. S. Moore of his investigations on the reduction division in cartilaginous fishes. He finds that the spermatogenesis stops short at a point corresponding to the formation of the first ovicyte in ovigenesis, and also that the archoplasmic vesicle of the Elasmobranch spermatid has an intranuclear origin, while in the mammalia it is of purely cytoplasmic construction.

(2) The Plymouth Biological Laboratory. This report contains a preliminary notice of Dr. Hickson's investigation of the anatomy and development of *Alcyonium*, and of Mr. Allen's researches on the later stages in the development of Decapod Crustacea. Mr. Allen's work has been chiefly on the cells and fibres of the central nervous system.

(3) The Zoology of the Sandwich Islands. Mr. Perkins has continued his explorations since the last report, and the Committee now propose that he should return to this country and give assistance in working out the extensive collections formed.

(4) The Zoology and Botany of the West Indies. Since last year ten reports have been published, on the insects and plants, chiefly from St. Vincent. The Committee have still to deal with the Coleoptera, and propose to explore Margarita.

(5) Index Generum et Specierum Animalium. The MS. consists now of 180,000 slips, representing 90,000 genera and species.

In the Zoological Department, Prof. Hubrecht (Utrecht) read a paper on the didermic blastocyte in mammalia, in which he showed the distinctness of the trophoblast cells from the embryonic cells of the blastoderm. Mr. W. Garstang, in a paper on the ancestry of the Chordata, gave reasons for his conclusion that the Echinoderms, Enteropneusta, and Chordata trace back their descent to a common pelagic ancestor which had many striking points of resemblance to the Holothurian larva "Auricularia."

Mr. W. E. Collinge read papers on the structure of the integument in *Polyodon*, in which he showed that the occurrence of scale-plates was very similar to those found in the embryos of *Lepidosteus*, &c., and indicated a relationship to the Palæoniscidæ of the coal measures; and on the vertebræ of *Amphisile*, in which the unique character of the vertebral column of this fish was described and the views of previous writers criticised.

In the Botanical Department, Prof. Johnstone showed Algæ which deposit calcareous matter in their tissues, and so probably are better able to resist the attacks of animals. He also exhibited Algæ which are able to dissolve calcareous matter and bore minute holes in the shells of Mollusca. In a second communication he discussed the genus *Pogotrichum*. Prof. Phillips described the great variety found in the development of the cystocarps of *Polysiphonia nigrescens* and other species. Mr. A. Church exhibited collections of Algæ.

On Friday a joint meeting of zoologists and botanists was held to discuss a few important papers dealing with protoplasm, the cell, and allied matters.

Prof. E. Van Beneden led off with a paper on the relations of protoplasm, in which he gave an account of his observations on the phenomena seen in the division of cells. He regards the nucleus as being not an independent organ in the cell, but as closely connected with the ordinary protoplasm. Some discussion followed, and, on the whole, the opinions expressed were highly favourable to Van Beneden's view.

Prof. Strasburger followed next, on the periodic variation in the number of chromosomes. He thinks that the reduction in the number of chromosomes in sexual generation has a phylogenetic interpretation, and is a recurrence to the primitive number of chromosomes possessed when the organism was asexual only. He considered that many cases of asexual plants were to be regarded as due to the loss of sexuality.

The third paper was Prof. Ray Lankester's, on chlorophyll in animals. He gave an account of its occurrence in severalt groups of the Invertebrata, and pointed out that in these casesi starch is produced as in plants, and that the animal does not become green if kept in the dark. He referred to the view that all such cases were to be explained by the presence of unicellular parasitic algæ, but pointed out that these arguments would apply as well to the presence of chlorophyll in plants, and he urged that the same interpretation should be given to the facts in the case of animals as in plants.

In the Zoological Department, Prof. E. Van Beneden read a paper on the origin and morphological signification of the notochord He described the formation of the notochord and mesoblast in some bats from the external layer (apparently epiblast). He proposed that the two embryonic layers should be called blastophore and lecithopbore. He also instituted a comparison with the young *Amphioxus* and *Cerianthus* (where the axis corresponds to the long axis of the vertebrate body), and pointed out how their essential similarity bore out the conclusions as to the origin of the Chordata reached by Sedgwick fifteen years ago.

Prof. Struthers gave a paper on the carpus of the Greenland right whale compared with that of finner whales. He showed that the arrangement of the cartilages in the wrist has no functional significance (the carpus merely functioning as a whole), and can only be explained by descent with modification from the less rudimentary condition seen in other mammals. He showed that the pisiform is actually the most important element, and the only one which has a distinct function.

Miss Kirkaldy gave a critical account of the various species of *Amphioxus*. She described in all eight species, referable to three genera (*Branchiostoma*, *Heteropleuron*, and *Asymmetron*), one of which, *Heteropleuron Singalense*, she considered to be new to science.

In the Botanical Department, Miss Benson described her investigations on the fertilisation of the Chalazogamic Amentiferæ, and showed that the pollen tube passes through the chalaza in *Corylus*, *Carpinus*, *Betula*, and *Alnus*. Miss Pertz had a paper on the hygroscopic dispersal of fruits in certain Labiatæ, in which she showed that there are cases where the capsule opens when moist; and Dr. J. Clark gave an account of his investigations on the hybridisation of orchids.

On Saturday, in the Zoological Department, after the reports (1) on the migrations of birds as observed at lighthouses (the digest of which has at length been completed by Mr. Eagle Clark), and (2) on the legislative protection of wild birds' eggs (in which the recent Bill was explained and criticised by Prof. Newton, Canon Tristram, and others), the following papers on the occurrence, distribution, &c., of marine animals were taken:—

On a tow-net for opening and closing under water, by Mr. W. E. Hoyle. Mr. Hoyle described his electrical tow-net, and explained that he was now waiting for an opportunity of getting into water of over 100 fathoms depth in a steamer fitted with electric power.

On temperature as a factor in the distribution of marine animals, by Dr. O. Maas (Munich). Dr. Maas considers that the great ocean currents are of primary importance in limiting the distribution of free-swimming forms, different species being found to north and south of them. He attributes greater importance to temperature than to pressure. He points out that the existence of eurythermal and stenothermal animals must be borne in mind, and that in drawing conclusions as to distribution all animals are not equally important.

On the marine zoology of the Irish Sea, by Prof. W. A. Herdman. The object in this investigation has been not merely to collect animals, but to investigate the condition of the sea-bottom in the various parts of the area, and correlate, if possible, the fauna with the environment. This report of the year's work gives (1) details of the dredging expeditions, (2) additions to the fauna—these include four new species of *Ecteinosoma*, one of *Bradya*, one of *Pseudocyclopia*, one new Amphipod, *Nannonyx spinimanus*, and one Bopyrian, *Pleurocrypta nexa*—and (3), finally, a discussion of the submarine deposits met with, their nature, distribution, origin, and influence upon the fauna. The importance of the nature of the bottom to the animals living on it is specially emphasised.

Prof. M'Intosh gave an account of the recent marine fish-hatching operations of the Scottish Fishery Board at Dunbar. He described the ponds and buildings, their mechanism and he movements of the hatching-boxes, and gave statistics showng how remarkably successful the first season's operations had been.

In the Botanical Department papers were read by Prof. L.

Kny on the correlation between root and shoot, and an exhibition of diagrams; and by Prof. Pfeffer on the sensitiveness of the root-tip.

On Monday forenoon a series of papers dealing with various points in the theory of evolution was taken before the Zoological Department. After the report of the Committee on Telegony, Prof. D'Arcy Thompson read a paper on some difficulties of Darwinism. He doubts the efficacy of the struggle for existence in the case of humming-birds, &c., and in these cases he regards the profusion of forms, colours, and other modifications as due merely to laws of growth, and thinks that growth may be more exuberant in the absence of struggle and hardship. In other cases which are usually interpreted as the result of natural selection, Prof. Thompson gave another explanation, *e.g.* he considers the form of the Guillemot's egg is merely the natural result of the pressure caused by a relatively large egg passing down a narrow muscular passage.

Then Prof. C. V. Riley followed, on social insects and evolution. He gave a summary of what is known of the habits and economies of bees, wasps, ants, and termites, especially as to the development of the young. He considered that the varied structures and habits of neuters are perfectly explicable upon the general principles which have governed the modification of organisms, amongst which he believes natural selection plays an important but limited part. He showed that the differences between the queen and the neuter resulted entirely from the treatment of the larva, and was at the control of the colony. In ants also the differences between the different individuals is again the result of food and nurture. He believed with Darwin that the variations in social insects have been guided by natural selection amongst colonies; but that this remarkable and somewhat unexpected social selection among individuals, as exemplified in these insects, simplified the origin of neuters. Competition had been between colonies rather than individuals. The author finally pointed out that just as in man among mammals, the higher intellectual development and social organisation is found correlated with the longest period of dependent infancy.

Prof. Haycraft read a paper on the *rôle* of sex in evolution, in which he argued that variation is a quality of protoplasm, and that it has and can acquire this quality in varying degree and apart from sexual conjugation; also that sexual conjugation tends to limit or diminish variations, and that this is the *rôle* of sex in evolution; to sex therefore we owe our fairly well-defined generic and specific groups.

Dr. F. A. Dixey, in a paper on the relation of mimetic characters to the original form, gave some interesting examples of mimicry amongst butterflies, and showed how a very perfect scheme of mimicry may be established by gradual changes from a very small initial resemblance.

Prof. Osborn treated of certain principles of progressively adaptive variations observed in fossil series. He appealed for a systematic analysts and investigation of variation, and for a suspension of judgment in regard to the factors of evolution. Recent works show a lack of analysis, since all adult variations are classed together without regard to the two following lines of cleavage; first, as to adaptation, whether progressive, retrogressive, or neutral; second, as to time of origin in the individual, whether palæogenic or neogenic. Neogenic variations which point to the future may be conveniently divided into (*a*) gonagenic; (*b*) gamogenic; (*c*) embryogenic; and (*d*) somatogenic according to lines suggested by the work of Kölliker, Weismann, Roux, and others. All previous inductions as to variation have failed to recognise that the adult may exhibit variations which have their immediate causes in all these periods, although all alike spring from the potentiality of the germ. A distinct consideration rises whether, besides the "minute variations" of Darwin and the "saltatory variations" of Bateson, there may not be variations so slight as only to be measurable by the comparison between two individuals separated by a long genetic series. Evidence for variation of this kind is seen in the contrast between the evolution of the premolars and of the molars in the eocene horse series. The limitation of variation to certain lines is seen in a comparison between the horse and rhinoceros molars of the miocene. The general conclusion drawn from these facts is that the pure selection principle is contradicted by them, and there is some unknown principle of teleological mechanics yet to be discovered.

In the discussion which followed, Prof. Poulton criticised Osborn's classification of variations, and argued in favour of the action of natural selection in picking out the minute characters which distinguish individuals and in building them up into varieties. The discussion was continued by Profs. Mivart, Lankester, Seeley, Hartog, and others.

In a paper on the wing of *Archæopteryx* viewed in the light of that of some modern birds, Mr. W. P. Pycraft showed that in the development of the primary wing-feathers, as well as in the general form of the manus, in the nestling of certain gallinaceous birds there was evidence that they had descended from a strictly arboreal form in which the manus of the nestling was armed with claws to assist it in climbing the trees in which it was reared, just as is the case in the young of *Opisthocomus cristatus* to-day. He showed that there is reason to believe that the claws of *Archæopteryx* were of prime importance only during the nestling period of life. A model of a restoration of the wing of *Archæopteryx* was exhibited, in which it was demonstrated that the remiges rested upon the third digit, the bases abutting against that of the second digit, the top of which was free. It was, however, suggested that this digit supported the semiplume-like feathers seen in the fossil which possibly functioned as coverts.

In the Botanical Department:—On the origin of the sexual organs of the Pteridophytes, by Prof. Douglas H. Campbell. Notwithstanding the radical differences, especially in the Archegonium, between the Bryophytes and the Pteridophytes, a comparison of the structure and development of the sexual organs of the higher Hepatics with those of the Eusporangiate Pteridophytes shows points of resemblance enough to warrant the hypothesis that here is to be sought the connection between the Bryophytes and the Pteridophytes. Notes upon the germination of the spores of the Ophioglosseæ, by Prof. Douglas H. Campbell. The author succeeded in germinating two species, *Ophioglossum pendulum* and *Botrychium virginicum.* In both the first division of the spore occurs before any chlorophyll is formed. On sterilisation and a theory of the strobilus, by Prof. F. O. Bower. The following are some of the leading points in Prof. Bower's theory:—The spore-bearing parts of the sporophyte are to be regarded as primary in the evolutionary history and in function. The homosporous vascular cryptogams attained the climax of numerical spore-production. As a consequence of increased spore-production arose sterilisation of sporogenous tissue in form of septa partitioning off loculi, and subsequently the formation of synangia, and separation of the sporangia. The sporogonial head is the correlative of the strobilus or flower, the latter has eruptions of the surface to form sporophylls upon which sporangia are borne. The evolutionary history of the sporophylls shows progress from small and simple to large and complex forms. Foliage leaves may have been derived from sterilisation of sporophylls. The following are the remaining papers brought before the Botanical Department:—Miss N. Layard, a method of taking casts of the interior of flowers; Prof. E. Zacharias, the function of the nucleus; Prof. Errera, exhibition of diagrams; Mr. G. Murray, on *Pachytheca*; Dr. Scott, the structure of fossil plants in its bearing on modern botanical questions; Prof. Marshall Ward, a Thames bacillus; Prof. Green, influence of light on diastase; and Mr. Seward, a contribution to the geological history of Cycads.

The following are the remaining papers and exhibitions brought before the Zoological Section; most of them were taken on Tuesday:—

Dr. W. B. Benham expounded a new classification of the Polychæta, which gave rise to some discussion. Prof. Jeffrey Bell exhibited lantern slides of some magnificent colonies of reef-building corals lately acquired by the British Museum.

Dr. W. B. Benham, on the blood of *Magelona.* It differs from that of any other Chætopod hitherto examined. Instead of a red (hæmoglobin) liquid plasma in which float either a few nucleated colourless corpuscles or free nuclei, the blood-vessels of *Magelona* are completely filled with very small spherical globules of a madder pink colour, in an extremely small amount of colourless plasma. These coloured globules are *not* cells. There are free nuclei scattered amongst them, but the coloured globules are not nucleated. The colour is due to a pigment similar to hæmerythrin occurring in some Sipunculids. The globules exhibit a very marked tendency to run together like oil-drops and fuse. This viscid mass seems to be intermediate between the absolutely liquid coloured plasma of chætopods and the red corpuscles of mammals which float in a small amount of colourless plasma. Further, these globules in

Magelona probably originate within cells, from which they are released.

Prof. G. Gilson (Louvain), on the nephridial ducts of *Owenia*.

The Rev. T. R. R. Stebbing, on zoological publication, &c., suggested that the leading biological societies should arrange the work of publishing between them, so as to avoid the overlapping which now takes place. He proposed that for every country there should be a single authorised journal to receive the names of new genera and species with brief descriptions, all claims to priority being dependent on the date of this record.

Mr. J. T. Cunningham, on the significance of diagnostic characters in the Pleuronectidæ, discussed the evolution of the characters which distinguish flat-fishes into sub-families, genera, and species. He considers that the specific and many of the generic characters are not known to be adaptational, and are more probably due to generative isolation and divergent variation. His general conclusion is that animal variation is to be regarded as the resultant of two opposing influences, one internal and one external to the organism. The one is the internal tendency to definite divergent variations which have no direct relation to the struggle for existence, the other is the direct influence of adaptation, whether due to the selection of individuals or to the direct modification of individuals.

Mr. Goodrich described some of the methods adopted recently in displaying specimens in the zoological part of the Oxford University Museum. Dr. F. A. Dixey, on the plantar surface in infants, showed that his investigations on the skin of the foot in very young infants who had never walked, do not lend any support to the view that acquired characters can be transmitted by heredity.

Mr. W. E. Collinge, in a paper on the relations of the cranial nerves to the sensory canal system, showed that the canals are innervated in the Elasmobranchs chiefly by the facial nerve, in the Ganoids by the trigeminal and facial, and in the Teleostei chiefly by the trigeminal. Dr. H. B. Pollard exhibited, with remarks, models of the cranial skeletons of some rare South American and African siluroid fishes, made after the method of Born, with the addition that they were electroplated in order to give them sufficient firmness. Attention was drawn chiefly to the barbules round the mouth. These were maintained to be the homologues of the oral tentacles of *Myxine* and the cirri of *Amphioxus*, and a new theory of the origin of the head in Vertebrata, termed the cirrhostomial theory, was based on these homologies. The author contrasted this theory with the old vertebral theory of Goethe and Oken, and the subsequent theories of Gegenbaur, Balfour, v. Wijhe, and others.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

AT the Oxford meeting the popularity of the Geographical Section showed no abatement. Crowded meetings were the rule, even when papers of a severely scientific character were being read. This may be explained to some extent by the favourable situation of the section-room in close proximity to the reception-room; but perhaps the general use of lantern illustrations had more to do with it. By means of effective lantern diagrams the audience was able to follow with interest and pleasure, papers on detailed oceanography and climatology. The characteristic of the meeting may be given as the general high level of the papers offered, and the interesting discussions to which they frequently gave rise.

The President, in his address, dealt with oceanography in its widest sense, and was followed by a number of papers of similar character, though narrower scope. Unfortunately, it was found impossible for papers on similar subjects to be taken in all cases on the same day, as the convenience of the authors frequently made it necessary to alter the provisional arrangements which had been made. Mr. H. N. Dickson gave an account of the share he had taken on board H.M.S. *Jackal* in the international oceanographical observations initiated by Prof. Petterson, of Stockholm. The general conclusions arrived at were as follows:—

While the Atlantic current flowing over the Wyville-Thomson ridge attains its maximum velocity in winter, its speed is maintained during summer by the greater warmth of the upper layers of water in the Atlantic, and consequent higher level of the surface of that ocean compared with the Norwegian Sea. Passing over the ridge, the Atlantic current is cooled by mixture with the cold water of the Norwegian sea lying at the bottom of the Faeroe-Shetland Channel, and loses its horizontal motion. The warmer the Atlantic current the more rapidly does this mixture take place. Hence in a hot, windless summer a mass of Atlantic water, extending to a great depth, tends to collect on the northern and north-western edge of the North Sea bank. At all seasons Atlantic water is drawn from the Faeroe-Shetland Channel and forced into the North Sea by the tides between Orkney and Shetland. The tidal streams run north-west and south-west, and an eddy is formed to the north-west of the Orkneys, into which North Sea water is drawn, and perhaps also water from below. As the season advances the surface water of the North Sea becomes warmer, the upper layers probably receive smaller supplies of fresh water, but they become specifically lighter than the under layers, which they protect from the warming influences of the atmosphere. The upper layers becoming ultimately warmer than the Atlantic current, the surface of the North Sea becomes higher, and the surface water spreads outwards into the Faeroe-Shetland Channel, checking the surface supply of Atlantic water. Meanwhile, the mass of Atlantic water, collecting at the edge of the North Sea Bank, seeks entrance into the North Sea. Mixing with the cold bottom water already there, it increases its salinity, but reduces its specific gravity by warming it, and, at a certain stage of mixture, the temperatures and salinities of the two waters combine to form a ridge or axis of maximum specific gravity. This axis, which probably runs north-east from Shetland in the end of May or in June, turns slowly toward a north to south direction, and moves eastward. As it retreats, Atlantic water is gradually admitted round the north end of the Shetlands, passes down the east side of the groups, joins the tidal stream at the south end, and, guided by the axis of heavy water, is distributed along the east coast of Scotland, probably during July and August. Later in the summer, as the axis retreats still further, the Atlantic water is probably distributed more towards the eastward, perhaps until the latter part of September, when the diminishing supply from the Faeroe Channel, and the increasing outflow from the eastern side of the North Sea, bring about a gradual return to the conditions with which we started. Obviously the controlling conditions are complex, but it appears that the greater the winter cold and the spring supply of ice-cold water from the continent, the more slowly will Atlantic water penetrate into the North Sea below the surface; and the warmer the summer, the more will the surface supply be checked. At the same time, the warmer the summer the larger the quantity of Atlantic water seeking admission, and the greater its thermal power to drive back the axis of maximum weight.

M. A. Delebecque, of Thonon, sent an account of his methods of surveying and constructing bathymetrical maps of the French lakes, a series of which was exhibited. The geographical conditions of the English lakes were described by Dr. H. R. Mill, and in the discussion which ensued, Prof. Guido Cora, of Turin, took a leading part. Mr. J. Y. Buchanan, F.R.S., sent an account of the researches being carried out by the Prince of Monaco and himself on board the Prince's yacht *Princesse Alice*, in the Mediterranean and North Atlantic, which received considerable attention. He found that even at a distance of 600 miles south-west of the Strait of Gibraltar the salt water from the Mediterranean occupied the lower half of the whole depth, the upper half alone being occupied by Atlantic water. Numerous observations were made in the narrowest part of the Straits, with the effect of defining the manner in which the surface current of Atlantic water entering the Mediterranean is related to the deeper current of dense water escaping to the ocean.

Dr. John Murray gave a discourse on the geographical and bathymetrical distribution of organisms in the ocean, focussing all our knowledge of the distribution of marine life, and concluding with the belief that the existing distribution is a result of the gradual restriction of a universal fauna which flourished in a climate of world-wide warmth, possibly due to the larger size of the sun. This paper gave rise to an animated discussion. Although not formally organised, this was practically a joint discussion between Sections D and E, the participants in the discussion comprising Dr. Gunther, Mr. P. L. Sclater, Dr. O. Maas, Canon Norman, Dr. H. O. Forbes, and Mr. Garstang.

Papers dealing with new exploration were unusually numerous.

Mr. Osbert H. Howarth gave a magnificent series of new views of the Cordillera of North America, in illustration of a paper on the Sierra Madre of Mexico, from which he had just returned. Mr. D. G. Hogarth summarised the result of his recent journey in the valley of the Euphrates. The river was found to be so difficult of passage as to form a natural frontier of the most effective kind. Very fine remains of Roman bridges, aqueducts, and forts were found and photographed. Mr. Weld Blundell, just returned from an even more adventurous journey in the Libyan Desert, gave a paper full of interest describing his observations and photographs. Dr. A. Markoff gave a comprehensive general description of Russian Armenia. Travel papers of minor importance, but no less popular on that account, were read by Mr. W. H. Cozens-Hardy on Montenegro, and by Miss Baildon on a visit to New Guinea.

An animated discussion was also called forth in connection with a valuable paper by Mr. Somers Clarke, on the geography of Lower Nubia. He vividly described the scenery and present economic state of the site of the proposed great Nile reservoir. He said that the Wadi Kenus, the abode of the Beni Kensi tribe, is nearly coincident with the projected Nile reservoir, and if the proposed scheme is carried out the population to be displaced numbers about 30,000, inhabiting a cultivated area of some 10,000 acres. Population in the Ptolemaic times must have been greater, as there are tracks about Korti and Dakkeh, once under cultivation, now abandoned. In the Dodeka-Schoenus there is a number of temples and remains of antiquity, a further proof of considerable population; and the district is protected by a line of forts, some of very high antiquity, others of later date. The existence of Egyptian civilisation side by side with the ruder customs of the natives, is especially to be observed in the method of burial. The present inhabitants on the course of the Nile valley from Assuan to Wadi Halfa exhibit very slight variations in modes of dress, particularly among the women. Men go to Cairo, women stop in the villages, so that the men adopt the ordinary dress of fellahin in Egypt. The manner of building houses from lumps of earth, crude brick, with flat wooden or vaulted brick roofs, constructed in the same way as those used by the ancient Egyptians, was noticed. Reed shelters are also in use. Not only the unique antiquities but the present people, with all life, animal and vegetable alike, are affected by the projected reservoir. In view of the contemplated destruction it is of the utmost importance to make an exhaustive scientific investigation of the valley before it is submerged.

Mr. Norman Lockyer, in commencing the discussion on this paper, said that if the dam were constructed it might after all, if preceded by an exact scientific survey, prove to be a blessing in disguise even to Egyptologists, and that the advancement of science and the advancement of Egypt might proceed hand in hand.

Papers of more technical interest were contributed by several authors. Mr. A. Montefiore sent a detailed account of the equipments of the Jackson-Harmsworth Arctic expedition; Mr. John Thomson gave an account of the methods of photography best adapted for the use of travellers; and Mr. B. V. Darbishire showed a new method of representing the surface configuration of the British Islands. Mr. G. G. Chisholm initiated a valuable discussion on the spelling of geographical names, the purpose of which was to show that the indispensable preliminary requirement, with a view to the end stated, is to have an adequate scheme of orthography, making up for the deficiency of such signs by clear rules to be followed with respect to the sounds for which signs are lacking. To leave it to the individual judgment to decide what is the nearest sound represented in the scheme to one for which no express provision is made, is bound to lead to confusion. The inadequacy of the latest version of the Royal Geographical Society's scheme from this point of view was pointed out, and suggestions of remedies made. The addition of some subordinate rules likely to promote the efficiency with which the scheme is carried out was recommended. Attention was drawn to special difficulties in connection with Russian and Greek names, and reasons given for entertaining the hope that, with the aid of Oriental scholars, special rules might usefully be framed with regard to the spelling of Chinese and Indo-Chinese names. Finally, it was urged that, once an adequate scheme clearly expounded is adopted, it would be of great importance to make special arrangements to secure the co-operation of all contributors to the *Geographical Journal* and other geographical periodicals, of publishers and authors, and, above all, of the newspaper press towards getting the scheme carried out.

Mr. H. Yule Oldham attracted much attention to his statement of evidence, from a MS. map at Milan, of date 1448, of the discovery of Brazil before that date. In the long discussion which followed, the evidence was criticised by several speakers who were reluctant to accept it without more ample proof.

Colonel Feilden read a brilliant paper on current polar exploration, in which he explained the position of the various expeditions now in the field, and expressed a strong opinion as to the folly of inexperienced travellers adventuring themselves lightly into regions so fraught with danger.

Mr. E. G. Ravenstein presented a discussion of the climatology of tropical Africa, resulting from the observations collected by the Committee on African Climate appointed some years ago. The results present the first satisfactory generalisations on the tropical climates of Africa, but its scope cannot be conveniently summarised. Mr. Theodore Bent gave an admirably illustrated account of his recent visit to the Hadramut in Southern Arabia. The proceedings of the Section were assisted by several eminent foreign geographers, amongst whom Prof. Vambery, of Budapest, and Prof. Guido Cora, of Turin, took a leading place.

MECHANICS AT THE BRITISH ASSOCIATION.

THE sittings of Section G, at the recent meeting of the British Association at Oxford, were held in the Common Hall of Keble College, which afforded more than ample accommodation for the purpose.

We have already printed the presidential address of this Section. Prof. Kennedy, who some time ago resigned his chair, was one of the pioneers of the modern movement towards technical education in mechanical engineering, and it was natural, therefore, that he should largely deal with the training of engineering students in his address.

There was a very long list of papers down for discussion at the meeting. The first sitting was held, according to custom, on the Thursday, and the Section met on the Friday, Saturday, Monday, and Tuesday following, that is to say, from August 9 until August 14. With so long a list of papers to deal with, we can do no more in the space at our command than simply refer to some of them by name, and we therefore give the following, which is a complete list of the papers read:—

Thursday.—(1) Some reminiscences of steam locomotion on common roads, by Sir F. J. Bramwell, F.R.S.; (2) bore-hole wells for town-water supply, by H. Davey.

Friday.—(1) Joint meeting with Section A:—(*a*) On integrators, harmonic analysers and integraphs, and their application to physical and engineering problems, by Prof. O. Henrici, F.R.S.; (*b*) note on the behaviour of a rotating cylinder in a steady current, by Arnulph Mallock; (*c*) on the resistance experienced by solids moving through fluids, by Lord Kelvin, P.R.S.; (*d*) discussion on flight, in which Lord Rayleigh, Mr. Langley, Mr. Maxim, and others took part; (2) the strength and plastic extensibility of iron and steel, by Prof. T. Claxton Fidler; (3) tunnel construction by means of shield and compressed air, with special reference to the tunnel under the Thames at Blackwall, by M. Fitzmaurice.

Saturday.—(1) On methods that have been adopted for measuring pressures in the bores of guns, by Sir Andrew Noble, K.C.B., F.R.S.; (2) the most economical temperature for steam-engine cylinders, by B. Donkin.

Monday.—(1) Signalling through space, by W. H. Preece, F.R.S.; (2) some advantages of alternate currents, by Prof. S. P. Thompson, F.R.S.; (3) continuous current distribution of electricity at high voltage, being a description of the lighting of the city of Oxford, by T. Parker; (4) a special chronograph, by H. Lea; (5) a direct-reading platinum pyrometer, by G. M. Clark.

Tuesday.—(1) Report of committee on dryness of steam, by Prof. W. C. Unwin, F.R.S.; (2) the temperature entropy diagram, by H. F. Burstall; (3) the hunting of governed engines, by J. Swinburne; (4) engineering laboratory instruments and their calibration, by Prof. D. S. Capper; (5) lighthouse apparatus and lighthouse administration in 1894, by J. Kenward; (6) on spring spokes for bicycles, by Prof. J. D. Everett, F.R.S.

Sir Frederick Bramwell's paper was one of considerable interest, the veteran engineer described the experience of his youth when he was a protégé of Hancock, who was then running a steam carriage for ordinary purposes of carrying passengers on the public roads. Sir Frederick stated how he used to travel from work to his home when an apprentice, Hancock generally giving him a lift on his return journey with the steam carriage. Under the existing state of the law steam locomotion of this nature is, of course, an impossibility, the restrictions which have been put on this method of transportation being absolutely prohibitive. These restrictions were brought about in consequence of the introduction of traction engines, as we now see them on our country roads. The pace of steam-propelled vehicles is limited to three miles an hour, and it is necessary that a man should walk in front of the engine with a red flag; naturally such regulations make the carriage of passengers out of the question.

This is much to be regretted, for steam carriages, as has lately been proved by continental experience, can be made both safer and more expeditious than those drawn by horses. They are more under control, being easily stopped and turned, and they are naturally far cheaper.

To return, however, to Sir Frederick Bramwell's paper, the details of the early road steam carriages possess considerable interest at the present time, as pipe boilers were used in nearly all of them, and now that the water-tube boiler is coming to the front so rapidly, it is interesting to see what was done by the pioneers of steam engineering. Many inventors whose brains are active in this field would do well to study the earlier records, for old types are now being reinvented at an expenditure of much useless brain work and anxiety.

The second day of meeting of Section G (Friday, August 10) was a very busy one, a joint sitting having been arranged with Section A. Four subjects were down for discussion, as stated in the above list of papers.

Prof. Henrici's contribution was one of great interest, as also was Mr. Mallock's note on the behaviour of the rotating cylinder. Lord Kelvin also gave a valuable lecture on the resistance of solids moving through fluids.

Public interest, however, was chiefly centred in the paper read by Mr. Maxim, in which he described his flying machine. To hear this part of the transactions a large number of members flocked into the hall, many of them being ladies. Some of the members present did not appear to take much interest in the more abstruse subjects dealt with by the previous lecturers, and their want of attention made it a little difficult to follow the first three speakers.

Two papers, relating purely to Section G, were taken on this day; the first was Prof. Fidler's monograph on the extensibility of iron and steel, a valuable contribution which, however, was read to a very thin audience.

The author pointed out that the stress-strain diagram of ductile material as autographically drawn does not indicate any definite relation between tensile stress and plastic strain. The unit stress varies in different parts of the bar; the elongation measure by the diagram being that of the whole bar. The author's experiments indicated that the plastic extensibility under any given stress is nearly the same in all segments of the bar's length, even when the ultimate elongation varies. Volumetric measurements of the successive segments indicate that there is no sensible telescopic shear, and justify the general application of the assumption of unchanging volume. It might at first sight be supposed that a bar of uniform plastic extensibility ought to draw out uniformly over its whole length, but beyond a certain critical point a uniform extension is almost impossible. In order to illustrate these points in a bar of mild steel a diagram had been prepared. The law of plastic extension is determined by the curve, fixed mathematically the curves of the plastic limit, and it fixed also the breaking weight per square inch of original area. In regard to the possibilities of deformation in a bar of nearly uniform extensibility, as the plastic limit is approached the slightest irregularity in section or in extensibility tends to precipitate the formation of a contracted region, and beyond that limit the further extension of the bar and the further contraction of area will be confined to the same region. For stresses below the plastic limit the probabilities of deformation might be examined by considering the relative time rates of extension at two elements which may have been unequally stretched, and at first the tendency is theoretically in favour of preserving the cylindrical form of the bar. But beyond the plastic limit these conditions are reversed, and the tendencies are all in favour of precipitating the most rapid contraction of area at the point where any contraction already exists. Referring to the yield-point, sudden elongation takes place at different stresses in the different segments, while in any one short element it seems to be instantaneous. If the yield is arrested midway and the bar examined, it may be found that the elongation has been completed in some segments and not commenced in others.

In the discussion which followed, Profs. Unwin, Ewing, and Hele-Shaw and Sir Benjamin Baker took part. Prof. Hele-Shaw pointed out that certain bronzes, unlike steel, would contract in several places at once.

Mr. Fitzmaurice's paper on the Blackwall Tunnel gave an interesting description of that important work, now being carried out under Mr. Binnie, for the London County Council.

Two papers only were read on Saturday of the meeting. The first an extremely interesting contribution by Sir Andrew Noble, of Elswick. The author referred to the early experiments of Count Rumford to ascertain the pressures in the bores of guns, and pointed out the errors into which that investigator was led. He referred to the researches of Robins, Cavalli, Rodman, and those of the Prussian Artillery Committee of 1854. He also gave details of experiments made by himself, from which it would appear that with projectiles of increasing weight very different results are obtained, in regard to pressure, with modern slow-burning powders than with the older fine grain powders.

Mr. Bryan Donkin's paper was also one of considerable interest, and gave details of an extensive series of experiments made by the author. He pointed out that in most cases cylinder walls of engines are much colder than the steam, and often one-half the weight of steam is condensed during admission. The details of this will be published later, and at greater length, in the Proceedings of the Institution of Mechanical Engineers. It may be said generally, that throughout the experiments an increase of economy with hotter walls was always verified.

On Monday the proceedings were largely devoted, according to custom, to electrical engineering.

Mr. Preece's paper, on signalling through space, was of a very popular nature, and attracted a large audience. He described the operations which took place at Kilbrannan Sound. It is satisfactory to know that the Post Office authorities are introducing metallic returns wherever possible for telephone circuits.

Prof. Sylvanus Thompson's paper was in praise of alternate currents. The author expressing his opinion that the alternate current system would entirely supersede continuous currents for lighting and power distribution purposes. The continuous current being superior for electrolytic purposes alone. Mr. Preece supported the paper, whilst Prof. Kennedy and Mr. T. Parker took entirely different views.

Mr. Parker's paper was an excellent description of the electric lighting in the city of Oxford. Mr. Lea described a special form of chronograph he had had made to his own designs. Mr. Clark's paper was also one of value, and should be studied in the original by those interested in the measurement of high temperatures.

Tuesday's proceedings commenced with the reading of the Report of Prof. Unwin, of the Committee on the Dryness of Steam. This is a long and valuable report, but as it will appear in full in the Transactions of the Association, it is not necessary we should deal with it on the present occasion.

Mr. Burstall, in his paper, and by aid of a model which he exhibited, has given a new means of illustrating the temperature entropy diagram. This model will doubtless be seen on future occasions. Considerable ingenuity has been shown in its construction. Mr. Swinburne's paper was one of practical interest to engineers, whilst Prof. Capper's contribution on the calibration of laboratory instruments will prove of value, and is worthy of passing notice. The author stated that the reliance to be placed upon observations made with measuring instruments evidently depends upon the accuracy with which those instruments record. Neglect of this fundamental truth often leads to inaccurate and erroneous deductions from experiments which are themselves of the highest scientific value; not infrequently the whole value of observations may be destroyed by insufficient care in the calibration of the instruments used. The subject is therefore one of some importance. The author described the chief sources of error in some of the most common engineering investigations, and their probable value, and pointed out some of the possible methods of correction where such exist. For example, in engine trials there are many possible sources of error. Most of these may be reduced in percentage value by continuing the trial for a sufficient period. But this is not the case with errors which may occur in the indicators, gauges, or spring balances used in the determination of power. In these, unless properly calibrated before trial, very serious errors may be introduced, amounting in some cases to 5 or 6 per cent. of the total power indicated. It is therefore, he said, absurd, even if proper precautions have been taken, to rely upon horse-power measurements to two places of decimals. With regard to tension and compression experiments with standard 10-inch bars, calibration of the testing machine is extremely difficult, and can in general only be carried out over a small portion of the range of the experiments. Deductions have therefore to be made from the less to the greater, with the result that small errors in the calibration will tend to be magnified. Vertical testing machines have fewer sources of error, and can be calibrated with more certainty, than horizontal machines. Extensometers are, however, much more easily applied to a horizontal bar than a vertical, and variable jockey weights, which are requisite if the same accuracy is to be maintained at low loads as at high, are also more readily adapted to horizontal machines. Extensometers can be made and calibrated well up to the accuracy of the testing machine. With standard bars and a measuring instrument true to the ten-thousandth of an inch, the modulus can be relied upon to the second significant figure. It is doubtful if more can be obtained without very special construction and calibration of the testing machine. The difficulty in bending experiments, again, lies in the accurate application of load. Unless the beams are very short or of unmanageable cross-sections, the load measurement must be very delicate if readings approaching the accuracy of those in tension are to be obtained. It is possible that some of the discrepancies in published beam experiments may be due to this cause. The paper dealt briefly with other cases where calibration is specially needed.

Mr. Kenward's paper was of value, both from an historical and a practical point of view. It was illustrated by a number of drawings and photographs.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THURSDAY, August 9.—Dr. E. B. Tylor read a paper on the distribution of mythical beliefs as evidence in the history of culture. The author showed that the wide distribution of several mythical beliefs, such as the idea of souls being weighed in a spiritual balance, and that of the Bridge of the Dead, gave evidence of connecting links between the great religions of the world. The theory that the pre-Columbian culture of America took shape under Asiatic influence was supported by evidence of a similar nature. Thus, in the religion of ancient Mexico four great scenes in the journey of the soul in the land of spirits are depicted in a group in the Aztec picture-writing known as the Vatican Codex: first, the crossing of the river of death; second, the passage of the soul between two mountains that clash together; third, the soul climbing up a mountain set with sharp obsidian knives; fourth, the dangers resulting from these knives being carried about by the wind. There is a close resemblance between these Mexican pictures and certain scenes from the Buddhist purgatory depicted on Japanese temple scrolls. Here are seen, first, souls wading across the river of death; second, souls passing between two huge iron mountains, which are pushed together by demons; third, souls climbing the mountain of knives, whose sharp blades cut their hands and feet; fourth, knife-blades flying through the air. Dr. Tylor also referred to Humboldt's argument from the calendars and mythic catastrophes in Mexico and Asia, and to the correspondence in Bronze-Age work and in games in both regions, and expressed the opinion that the evidence was sufficient to justify anthropologists in considering that ancient American culture was due to a great extent to Asiatic influence.

Dr. Beddoe read a paper on complexional differences between the Irish with indigenous and exotic surnames. The author showed that dark hair and light eyes are much more prevalent among the former class of Irishmen than among the latter.

The following reports were also read:—Report of the Anthropometric Laboratory Committee, report of the Ethnographical Survey Committee, report of the Anthropometry in Schools' Committee.

Friday, August 10.—The greater part of the day was devoted to a joint discussion with the Geological Section on the plateau flint implements of North Kent. The discussion was opened by Prof. T. Rupert Jones, in a paper in which he expressed general concurrence with the views of Prof. Prestwich as to the genuineness and antiquity of the implements found in the plateau gravels. He argued that the gravel in which the flints were found must have been of pre-Glacial Age. Mr. Whitaker could not admit that there was any good evidence to connect the men who worked the flints with pre-Glacial or even with glacial times, as there were no deposits of undoubted Glacial Age in or near the district. Mr. Montgomerie Bell stated his reasons for believing that the collections of flints from the plateau gravels were of human handiwork. He said that all the evidence pointed to the working of a race of men with strongly-developed body but weakly-developed mind, and this was exactly the conclusion we should expect. Sir John Evans said that the evidence as to the Palæolithic Age in Suffolk being locally post-Glacial was irrefragable, and that the principal outcome of the recent discoveries was, to his mind, the fact that the existence of palæolithic man could be carried further back in time than the valley gravels, inasmuch as his implements are now found in gravels on plateaus at far higher levels. General Pitt-Rivers contended that a single bulb of percussion was not in itself sufficient to prove human workmanship. The bulb of percussion shows the direction in which the blow was given, but any hard knock would produce it, and it was necessary that two or three blows at least should have been given in some definite direction in order to prove design on the part of the fabricator. Dr. H. Hicks, Prof. Boyd Dawkins, Sir Henry Howorth, and Lieut.-Colonel Godwin Austen also took part in the discussion. Mr. H. Stopes read a paper on the evolution of stone implements, and the following reports were presented:—Report of the Prehistoric and Ancient Remains in Glamorganshire Committee, report of the Elbolton Cave Exploration Committee, report of the Explorations at Oldbury Hill Committee.

Saturday, August 11.—Mr. Arthur Evans read a paper on the discovery of a new hieroglyphic system, and pre-Phœnician script in Crete. During the exploration of the ancient sites of Central and Eastern Crete, the author had succeeded in bringing to light a series of stones presenting pictographic symbols of a hieroglyphic nature, and was now able to put together over seventy symbols belonging to an independent hieroglyphic system. More than this, he had discovered partly on stones of similar form, partly engraved on prehistoric vases and other materials, a series of linear characters, a certain proportion of which seemed to grow out of the pictorial forms. As in the case of the Egyptian and Hittite symbols, the Cretan hieroglyphics fell into certain distinct classes, such as parts of the human body, arms and implements, animal and vegetable forms, objects relating to maritime life, astronomical and geometrical symbols. Some of them belonged to that interesting class of pictographs which is rooted in primitive gesture language. The symbols occurred in groups, and there were traces of a boustrophedon arrangement in the several lines. The comparisons instituted showed some interesting affinities to Hittite forms. The linear and more alphabetic series of symbols fitted on to certain signs engraved on the walls of what was apparently a Mycenean palace at Knôsos, and again to two groups of signs on vase handles from Mycenæ. It was thus possible to construct a Mycenean script of some twenty-four characters, each probably having a syllabic value. The author gave reasons for believing that the Philistines, who, according to unanimous Hebrew tradition, came from the Mediterranean islands, and who were actually called Kretbi in the Bible, in fact represented this old indigenous Cretan stock, and that they had here the relics and the writing of "the Philistines at home."

Mr. Arthur Evans exhibited a number of prehistoric objects collected during his journey and explorations in Central and Eastern Crete.

Mr. H. Balfour, in a paper on the evolution of the bow as a musical instrument, gave the aboriginal races of Africa and India the credit of providing us with the prototype of many of our best string instruments.

Miss Weld read a paper on the possibility of a common language between man and beast, in the course of which she mentioned that she had herself reduced a large and savage dog to a state of the most abject terror by imitating some of the deeper tones of his growl.

The Rev. G. Hartwell Jones read a paper on the relation between the body and mind, as expressed in early languages, customs, and myths. The conclusions at which the author arrived were that (1) the primitive condition of the pioneers of civilisation was no higher than that of modern savages; (2) the parallels presented by words and ideas in countries widely separated from one another cannot be satisfactorily explained by mere coincidence; and (3) the civilisation of Western Europe viewed as a whole began in contact with the East.

The following papers were also read:—Prof. A. Macalister, on the heredity of acquired characters; Prof. Arthur Thomson, notes on skin, hair and pigment; Dr. Louis Robinson, the anthropological significance of ticklishness; H. Ling Roth, on the presence of Negritoes in Borneo; Prof. B. Windle, on mythical pygmy races; report of the Mental and Physical Condition of Children Committee.

Monday, August 13.—A paper by Prof. J. Kollmann, on pygmies in Europe, was read. Near Schaffhausen, in Switzerland, a prehistoric settlement has been discovered, in which the remains of two races were found interred side by side. The average stature of one of these races was that of Frenchmen of the present day, but the average height of the other race was only 1424 mm., and they must be looked upon as pygmies of the Neolithic period in Europe. There have recently been discovered some living pygmies in Sicily and Sardinia, and in the author's opinion these small types must be regarded, not as diminutive examples of normal races, but as a distinct variety of mankind which occurs in several types dispersed over the globe; and he believes that they have been the precursors of the larger types of man.

The present state of prehistoric studies in Belgium was described in a paper by Count Goblet d'Alviella. The manufacture of flint implements appeared to have been an important industry, extending all over Belgium, and there have been recent discoveries of megalithic monuments, the existence of which was till lately denied.

General Pitt-Rivers described the explorations of British camps and a long barrow near Rushmore. The skeletons of upwards of twenty-five persons found in and around the barrow give evidence of a people of small stature with long, narrow skulls. They belonged to the polished stone age.

The following communications were also received:—Dr. E. B. Tylor, on some stone implements of Australian type from Tasmania; H. Ling Roth, on Tasmanian stone implements; Dr. Emile Cartailhac, on the art and industry of the Troglodytes of Bruniquel, France; Dr. Emile Cartailhac, on a new ivory statuette of a woman in the reindeer period; Dr. Emile Cartailhac, on the close of the stone period on the borders of the Mediterranean; Prof. Max Lohest, observations relative to the antiquity of man in Belgium; General Pitt-Rivers, on a new craniometer; Dr. J. G. Garson, on the long barrow skeletons from near Rushmore; Dr. R. Munro, notes on ancient bone skates; Prof. A. C. Haddon, exhibition of lantern slides illustrating the people of Western Ireland and their mode of life; report of the Glastonbury Exploration Committee.

Tuesday, August 14.—Mr. Theodore Bent read a paper on the natives of the Hadramut. This valley was formerly the great centre from which frankincense and myrrh were exported to Europe by caravan routes across the desert, and the modern inhabitants of this district are quite distinct from the Bedouins of northern Arabia; they have many curious customs and a religion of their own, and are in all probability an aboriginal race.

Mr. J. Gray contributed a paper on the distribution of the Picts in Britain as indicated by place names. The evidence of place names showed that probably the whole country from the north of Britain to the south of Gaul was at one time or another occupied by the same race. The pre-Pictish inhabitants were Iberians, and prevailed mostly in Ireland, South Wales, Cumberland, and South Scotland.

The following communications were also received:—Mrs. H. Stopes, on three neolithic settlements in Kent; Lionel Decle, on the native tribes of Africa between the Zambezi and Uganda; Prof. Max Kovalevsky, on the Lex Barbarorum of the Daghestan; J. D. C. Schmeltz, on snails and mussels in the house-keeping of the Indoneses; Basil H. Thomson, on the ancient religion of Fiji; B. P. Kehlpannala, on ceremonies observed by the Kandyans in paddy cultivation.

Wednesday, August 15.—Prof. L. Manouvrier described the brain of a young Fuegian, and pointed out that the external morphology of this brain showed little or no distinction from that of a European.

The Rev. Lorimer Fison read a paper on the classificatory system of relationship. The Fuegian system of relationship divide the sexes in any one generation into groups of non-marriageable persons and other groups of marriageable persons, and it was shown that precisely the same groups appeared as the result of the division of the community into two exogamous intermarrying divisions such as are found in Australia. The inference was that wherever the classificatory terms appeared these divisions had existed in the past.

Mr. J. Graham Kerr read a paper on the Tobas of South America. These Indians are nomadic in their habits, and live entirely on the products of the chase. They believe in the existence of numerous minor evil spirits who cause diseases, accidents, and other misfortunes, but the author had not discovered that they had any notion of a supreme deity.

Mr. Alfred P. Maudslay read some notes on native buildings at Chichen Itsa, Yucatan, and the customs of the Maya Indians. The author gave an account of some excavations of a burial mound in the Vera Paz of Guatemala, and the discovery of small jars containing the bones of little fingers, probably deposited by mourners. The earliest notices of the great Maya ruins at Chichen Itsa were discussed, and extracts were given from a document recently discovered in Seville, in which are described the ceremonies performed by the Mayas at the time of the Spanish conquest.

The other communications received were: Prof. L. Manouvrier, on a method of valuation of proportional dimensions in the description of the brain; H. Bellyse Baildon, notes on some of the natives of British New Guinea; Miss A. W. Buckland, on the philosophy of holes; report of the North-western Tribes of Canada Committee.

SCIENTIFIC SERIALS.

American Journal of Science, August.—On certain astronomical conditions favourable to glaciation, by G. F. Becker. The elements of the earth's orbit undergo slow variations, some of which affect climate. These are the time of perihelion, which affects the length of the two great seasons; the eccentricity of the earth's orbit, and the obliquity of the ecliptic. The winter of the period of maximum eccentricity in the rigorous hemisphere would be intensely cold as compared with that of the period of zero eccentricity, but the difference would be most marked in the tropics. The summer would be intensely hot, and also wet. On the whole, the period would be most unfavourable to glaciation; the snowfall being the smallest, and the warm rainfall the largest that can occur with the present obliquity. A difference of 1° 9', however, in the obliquity would make the area to the north of the Tropic of Capricorn 1,800,000 square miles greater than it is to-day, this area being rather more than the combined areas of the Mediterranean and the Gulf of Mexico. The area of evaporation supplying precipitation to the northern latitudes would thus be increased, and the conditions would be favourable to glaciation. Thus a glacial age would be due to the combination of a low eccentricity and a high obliquity, more than to any other set of circumstances pertaining to the earth's orbit. The epochs of such combinations should be deducible from astronomical data.—Development of the lungs of spiders, by Orville L. Simmons. The connection between Limulus and the Arachnida can only be established by a study of the development of the lungs and tracheæ of spiders. The lungs arise as infoldings upon the posterior surface of the appendages of the second abdominal somite, in the same manner as described by Kingsley for the gills of Limulus. The tracheæ develop from the next pair of limbs. The lung-book condition is the primitive, the tracheæ of the Arachnids being derived from it. No ground is left for those who regard the "Tracheata" as a natural group of the animal kingdom.—The generation of chlorine for laboratory purposes, by F. A. Gooch and D. A. Kreider. Chlorine may be conveniently generated by the action of hot hydrochloric acid in a half-strength solution upon lumps of potassium chlorate. These are placed in the upper chamber of a side-neck test tube constricted in the middle. The tube is fitted with a funnel tube reaching to the bottom, and immersed in a flask filled with hot water. When the acid is at 81° the percentage of chlorine in the gas given off is 84. The chlorine dioxide may be destroyed by passing the gases through a wash bottle containing a saturated solution of $MnCl_2$ in strong hydrochloric acid at 90°, and may be still further eliminated by passing the gas through a hard glass tube filled with asbestos and heated.

The Quarterly Journal of Microscopical Science for March contains studies in mammalian embryology (iii.). The placentation of the Shrew (*Sorex vulgaris*, L.), by A. A. W. Hubrecht. (Plates 31 to 39.) The author shows that the placenta is essentially an embryonic neo-formation, which is permeated by maternal blood that circulates in spaces devoid of endothelium. This embryonic neo-formation is preceded by a considerable proliferation of maternal epithelium, which, however, does not enter into the coostitution of the ripe placenta, but affords facilities of fixation and nutrition for the embryonic neo-formation in its earliest stages. The discoid placenta is, in the later stages of pregoancy, the only connection between fœtus and mother.—On some further contributions to our knowledge of the minute anatomy of *Limnocodium Sowerbii*, by R. T. Gunther. (Plate 40.) Some further details regarding the structure of the tentacles, the sense organs, and the male reproductive organs are added to those already recorded by Allman and Lankester. Allman placed this medusa among the Leptomedusæ; Lankester, on the contrary, referred it to the Trachomedusæ. The author writes: "*Limnocodium Sowerbii* is a medusa descended from Leptomedusan ancestors, which has developed sense organs, with an endodermal axis independently of the Tiachomedusæ." Allman's paper on *L. victoria*, in which he adopts Lankester's specific name of *Sowerbii*, was published in July 1880, not in 1881, as stated in the list of authors quoted.—Note on the mesenteries of Actinias, by A. Francis Dixon.

June.—Contains studies on the comparative anatomy of sponges (vi.). On the anatomy and relationships of *Lelapia australis*, a living representative of the fossil Pharetrones, by Arthur Dendy. (Plate 13.) By far the most interesting feature of this species is the very remarkable reticulated fibrous character of the skeleton, which appears to have hitherto escaped notice. This character is unknown in any other living calcareous sponge, while it forms the most prominent feature in the large fossil group "Pharetrones" of Zittel, hitherto regarded as extinct. *Lelapia australis* may therefore be regarded as the only known living representative of this important group. The author sums up his interesting and important paper by introducing the family Pharetrones into the system of recent Calcarea, and regards Lelapia as a very specialised type of Grantidæ.—The structure of the bill and hairs of *Ornithorhynchus paradoxus*, with a discussion of the homologies and origin of mammalian hair, by Ed. B. Poulton. (Plates 14, 15, and 15A.)—A contribution to our knowledge of the Oligochæta of tropical Eastern Africa, by Frank E. Beddard (plates 16 and 17), describes eight new species belonging to the genera *Eudriloides*, *Polytoreutus*, and *Gordiodrilus*, and describes the new genera *Pareudrilus*, *Alluroides*, and all the species collected in Zanzibar and Mombassa.—A further contribution to the anatomy of *Limnocnida tanganyicæ*, by R. T. Gunther. (Plates 18, 19.) The author bases his researches on material caught and fixed in osmic acid by Mr. A. Swann, on the shores of Lake Tanganyika.—Notes on the minute structure of *Pelomyxa palustris* (Greeff), by Lilian J. Gould. (Plates 20 and 21.) The appearance of "a central mass of doubtful significance" is noted; the "glanzkorper" of Greeff were found to stain with several reagents, and the rod-like bodies appear to be certainly bacteria.

The Mathematical Gazette, No. 2. (Macmillan, July.)—W. J. Greenstreet gives a summary of Herbart's views of the place of mathematics in education. The key-note to Herbart's position is "no one can be expected to think himself into the strict uniformity of nature, who has had no training in the rigorous discipline of mathematics and its deductions." G. Heppel takes for the first of his mathematical worthies Edward Wright, who was "probably born about 1560, and died in 1615." In the matter of the New River, Wright appears to have afforded an illustration of the Virgilian "Sic vos non vobis," as he conceived the project, but was ousted by Sir Hugh Middleton. Further interesting particulars of this too-little-known mathematician are given by (De Morgan?) in the *Penny Cyclopædia*, and in Ball's "History." E. P. Rouse contributes a note on the "Director circle of a conic inscribed in a triangle." Solutions of questions, and questions and short notes complete a good number.

Bulletin of the New York Mathematical Society, vol. iii. No. 10. (New York: Macmillan, July.)—Prof. A. Vasiliev (pp. 231–235) furnishes many items of interest in his note, Lobachèvsky as Algebraist and Analyst. In this it is shown that Lobachèvsky's genius was not confined to geometry only. In Macfarlane's "Algebra of Physics" (pp. 235–242), Dr. Chapman analyses the Principles of the Algebra of Physics, and the paper on the Imaginary of Algebra, by that mathematician. Dr. G. A. Miller supplements his note in the April number by a note on the substitution groups of eight and nine letters (pp. 242–245). Prof. Webster (pp. 245–248) reviews Byerly's elementary treatise on Fourier's series and spherical, cylindrical, and ellipsoidal harmonics, and at the outset discusses "a rather singular review (of the book) in a leading New York paper, in which a number of curious statements are made." Prof. D. E. Smith's review of Cajori's history (see NATURE, No. 1288, p. 235) is the subject of a critique, by Prof. Halsted, to which Prof. Smith replies (pp. 249–251). The concluding notice is on orthogonal substitutions, by Prof. H. Taber (pp. 251–259). A long list of publications, notes, and an index closes vol. iii.

Memoires de la Société d'Anthropologie de Paris, tome i. (3e serie), 2e fascicule.—Recherches Ethnologiques sur le Morvan, by Ab. Hovelacque and Georges Hervé. The district known as Morvan includes parts of four Departments—Yonne, Côte-d'Or, Nièvre, and Saône-et-Loire; it is distinguished from the surrounding country by the volcanic nature of the soil, and the central portion, or Upper Morvan, has a mean elevation of 600 to 700 metres (about 2000 feet) above sea-level. The climate is exceedingly inclement, the temperature cold and variable, the winters long and severe. Morvan is essentially Celtic, and the primitive inhabitants have been very slightly influenced by contact with the people around them. The stature indicates two ethnic elements, the one moderately tall—the Kymric; the other shorter—the Celtic, such as we find distributed over a great part of Central Europe. About two-thirds of the population of Morvan have grey or sometimes blue eyes; the others have brown eyes, light rather than dark. Usually the children have auburn hair, and the adults dark brown hair.

Memoires de la Société d'Anthropologie de Paris, tome i. (3e serie), 3e fascicule.—The Anthropology of France—Dordogne, Charente, Creuse, Corrèze, Haute-Vienne—by Dr. R. Collignon. The author has turned to good account the observations made during recruiting operations in the five departments mentioned in the title. The mean stature shows greater variation than in any other part of France, the maximum being 1·667m., while a minimum of 1·568m. was observed at Saint-Mathieu (Haute-Vienne). All the tall cantons are grouped at the circumference of the five departments, and the people of short stature are collected in groups in the centre. As the result of his investigations, the author shows that in this district we have three great groups: first, the brachycephalic—some dark, others fair—tall or short; second, dolichocephalic and fair; third, dolichocephalic and dark. This last group may be further subdivided into some three types: the first, platycephalic, with a disharmonic face; the next, dolichopsic, with a high head; the last, somewhat rarely met with and characterised by prognathism, a low and retreating forehead, black hair, and narrow face. The dolichocephalic brunettes are nearly allied to the Cro-Magnon type, while those who are prognathous, and who have the long narrow face, are perhaps distant relatives of the men of Canstadt and Spy, possibly also they may be distantly allied to the swarthy inhabitants of the south Algerian oasis.

Bulletins de la Société d'Anthropologie de Paris, tome v. (4e serie), No. 1, January; No. 2, February.—In a paper on the various forms of the teeth of different races, Dr. F. Regnault says that the canines of the lower races of man differ from those of the higher races, in that the crown of the tooth is larger in comparison with the neck, and that, like those of the apes, they terminate in a sharp point, which is usually much worn. M. Emile Schmit, in a paper on the "Boves" of Champagne, describes two of these curious subterranean chambers, excavated in the chalk, and approached by low narrow passages of some length. A paper by M. Zaborowski, on ten crania from Rochefort, is continued from the January to the February number. M. Zaborowski argues in favour of the primitive ethnical identity of the blondes, wherever they are found in a state of purity, whether in the Caucasus, in England, or in Charente-Inférieure.—M. Zaborowski also contributes a paper on the circumcision of boys and the excision of girls as initiation ceremonies. He traces the origin of the custom in Asia and Europe to the influence of ancient Egypt.—M. de Saporta describes certain popular medical practices in Provence. In cases of delirium or meningitis, if the warm body of a recently killed pigeon is not available, they have recourse to a fried egg, which is placed, burning hot, on the forehead of the patient. M. de Saporta does not think that any supernatural virtue is attached to these practices.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 31.—"On the Effect of Magnetisation upon the Dimensions of Iron Rings in Directions perpendicular to the Magnetisation, and upon the Volume of the Rings." By Shelford Bidwell, F.R.S.

A recent communication (*Roy. Soc. Proc.* vol. lv. p. 228) to the Society contained an account of some experiments relating to the effects of magnetisation upon the dimensions of two iron rings, one of which was annealed and the other hardened. The rings had the form of short cylinders about 6 cm. in diameter, 3 cm. in height, and 0·4 cm. in thickness. The experiments in question were concerned with the circumferential variations which took place along the lines of magnetisation; those to be here described deal with the concomitant variations in the height of the cylinders (width of the rings) transversely to the magnetisation. On the assumption that variations similar to the latter occur at the same time in the thickness of the metal, it is possible to deduce the changes in the volume of the ring which attend magnetisation.

Fig. 1, from a photograph, shows how the rings were prepared for the experiments. Four brass rods were hard-soldered to the iron, two of them being in a line with a diameter, while the other two were attached to the edges, opposite to one another, and parallel to the axis of the ring. The ring was inserted in a wooden case, also shown, through holes in which the four brass rods projected. Insulated wire for carrying the magnetising current was wound over the wooden jacket.

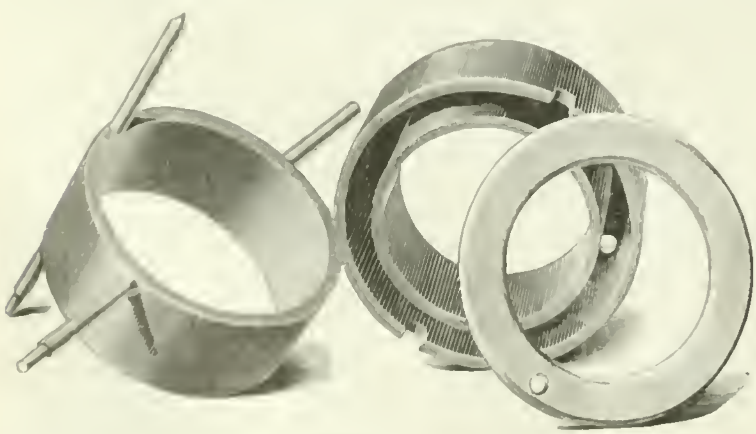


FIG. 1.

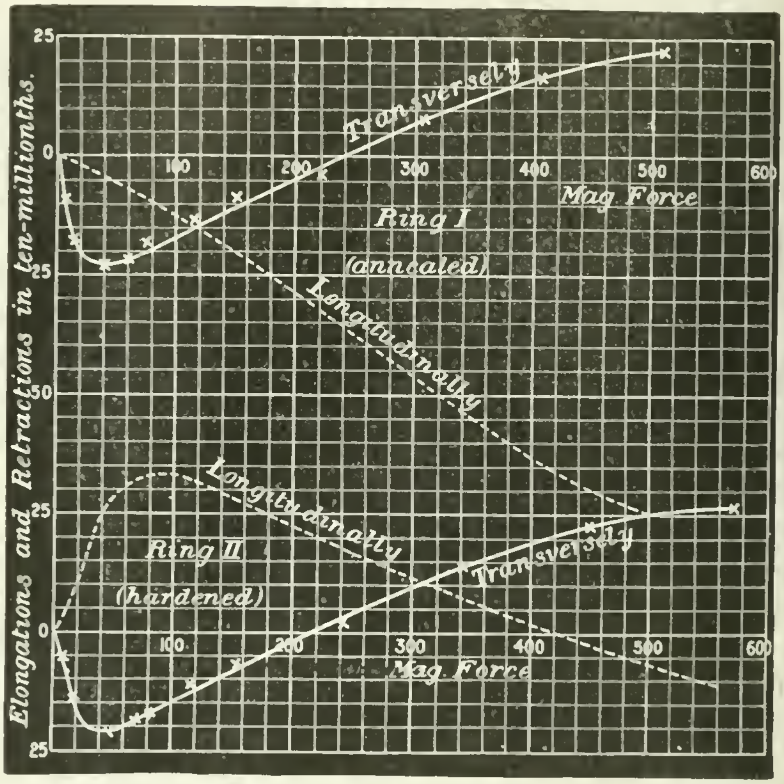


FIG. 2.—The curves marked "longitudinally" relate to circumferential changes, *along* the lines of magnetisation. Those marked "transversely" relate to changes in the width, *perpendicularly* to the magnetisation.

For the new experiments the ring was placed in a horizontal position, one of the edge rods resting upon a brass socket on the adjustable base of the instrument, and the other, which had a chisel-shaped end (not shown in the figure), actuating the lever. To counterbalance the weight of the ring a horizontal arm, carrying a sliding weight, was fixed to the lower rod.

The annealed ring will, as before, be distinguished as Ring I. and the hardened one as Ring II.

The changes observed in the widths of the two rings (transversely to the magnetisation) are indicated in the curves of Fig. 2. It will be seen that they are quite similar in the two cases, little or no effect being produced by annealing. Under gradually ascending forces both rings first become narrower, then recover their original width, and ultimately become wider than when unmagnetised.

As was shown in my last paper, the effects along the lines of magnetisation are very different in the two rings. The annealed ring (Ring I.) begins to contract circumferentially with the smallest forces, and continues to contract with the large ones; while the hardened ring expands with small forces and contracts with large ones. These effects are indicated in the figure by the dotted curves.

By combining the results of the old and of the new experiments we can ascertain the nature of the changes produced by magnetisation in the volumes of the rings. These are indicated in Fig. 3, which shows that the volume of the annealed ring is rather suddenly diminished by a small magnetising force, passes a minimum under a force of about 50 units, and then slowly increases, until, with a force of 500 units, it is about 30 ten-millionths less than at starting. The unannealed ring also at

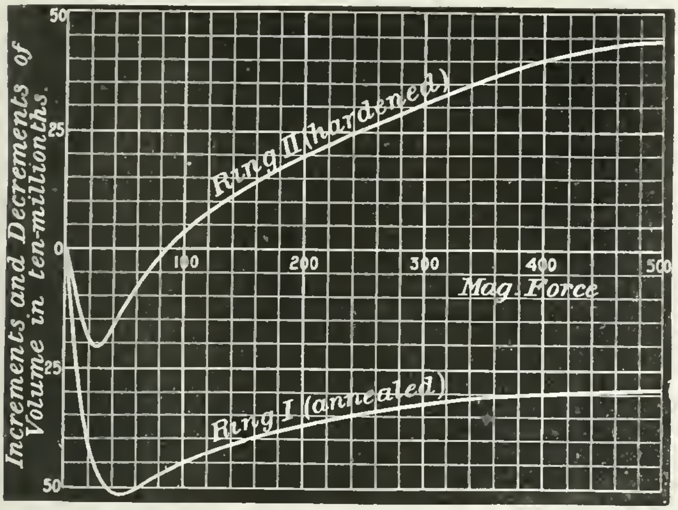


FIG. 3.

first suffers diminution, but its original volume is recovered with a force of about 90 and with higher values is increased.

The behaviour of this latter ring may be regarded as probably similar to that of the great majority of rods and rings, the annealed ring used in these experiments being the only specimen of iron that has yet been found to contract along the lines of magnetisation with the smallest forces that produced any effect at all.

EDINBURGH.

Royal Society, May 28.—Prof. James Geikie, Vice-President, in the chair.—Dr. Ramsey Traquair described some fossils from Forfarshire.—Dr. James Buchanan Young read a paper on the chemical and bacteriological examination of soil, with special reference to the soil of graveyards. He discussed the results of a series of experiments which he had made on samples of virgin soils, pure agricultural soils, and soils which had been, and were being, used for purposes of inhumation. From these results as judged by the amount of organic carbon and nitrogen present in the various samples, it would appear that soil which has been used for burial, does not materially differ as regards the amount of organic matter it contains from pure good agricultural soil. This fact goes far to support the idea that inhumation properly conducted in suitable and well-drained soils can cause no risk to the public health. The results of the bacteriological examination of the various soils goes to corroborate the results arrived at by chemical means. No pathogenic organisms were found in graveyard soils; and, although the number of bacteria present was greater than at similar depths in virgin soil, the number found was by no means so great as one might have expected. There was, moreover, a very marked and sudden fall in the number of micro-organisms in the soil below the layer containing the coffins. So that, as Reimers has pointed out, the "ground-water region" is practically free from bacteria. The broad results of the chemical examination of the samples is well seen in the annexed table. The results are stated in parts per hundred.

	Carbon.	Nitrogen.
Virgin soils	0·265	0·0257
Pure agricultural soils ...	0·842	0·0936
Soils used for inhumation	0·870	0·1073

—A paper, by Dr. J. G. Gilchrist, on the pallial complex of *Dolabella*, was read.—Dr. James Walker communicated an account of hydrolysis in some aqueous solutions.

June 4.—The Hon. Lord M'Laren, Vice-President, in the chair.—Prof. Tait read a note on the application of Van der Waal's equation to the compression of ordinary liquids.—Prof. Geikie read a note, by Messrs. G. Sharman and E. T. Newton, on fossils from Seymour Island, collected by a recent Dundee expedition to the Antarctic Seas. Nine specimens had been found in a district farther south than districts previously explored. All represented existing genera of wide distribution, but the fossils indicated more genial climatic conditions than those now existing.—Prof. D'Arcy Thompson read a paper on certain difficulties in the study of classical zoology.

June 18.—Sir W. Turner, Vice-President, in the chair.—Prof. Copeland read a paper on the path of the meteor of May 18, 1894. This was a large meteor seen in daylight, and first observed somewhere between the island of Mull and the north end of Jura. It was last seen in the north-west district of Yorkshire. Observers judged it to be moving slowly, but calculation showed that it moved over 190 miles in about fifteen seconds.—Prof. Tait read a paper on the elastic equations of the ether in æolotropic dielectrics. He has not yet discussed the question of the stability of the condition of the ether indicated by his equations.—Dr. John Murray gave a comparison of the extra-tropical marine fauna of the northern and southern hemispheres. The similarity of the Arctic and Antarctic marine fauna, and the difference of both from the fauna of intermediate waters, indicate, according to Dr. Murray, a not very remote geological time at which a universal fauna—implying uniformity of temperature—existed. He believes that in Mesozoic times forms of life were driven from the poles towards the tropics, while the fauna which was able to remain under the altered polar conditions gave rise to the present polar fauna.—Prof. Tait gave some illustrations of the range of application of Van der Waal's equation, contrasting the results got from the equation with observed results regarding the compression of liquids.—Dr. C. G. Knott and Mr. A. Shand read a paper on magnetic induction in nickel tubes. Three nickel tubes were compared, as regards their magnetic properties, with a nickel bar. All were cut from the same rod, were of the same length (44 cm.), and the same external diameter (4·2 cm.), but differed in diameter of bore. As with the iron and steel tubes formerly described (*Proc.* R.S.E., 1893), a tendency was shown, in low fields, for the magnetic movements to approximate to the same value. But the tendency was not so well marked. The explanation seems to be that, because of the comparatively low susceptibility of nickel in low fields, the "diamagnetising factor" (so called by Dr. Du Bois) is not of the same paramount importance as in the case of iron or steel. A simple calculation showed that this factor was approximately proportional to the area of section of the metal wall of the tube.

July 2.—The Hon. Lord M'Laren, Vice-President, in the chair.—A paper, by Prof. Cayley, on co-ordinates *versus* quaternions, was communicated.—Prof. Tait read a paper on the intrinsic nature of the quaternion method.—Dr. C. G. Knott and Mr. A. Shand communicated a preliminary note on volume changes which accompany magnetism in nickel tubes. The three tubes, referred to the authors in their previous paper on magnetic induction in nickel, were employed. In high fields the internal volumes were markedly diminished in all three. The greatest measured change in volume was 2·4 cubic millimetres; this was in the tube of thinnest wall in field 600. The greatest cubical dilatation was $-2{\cdot}3(10)^{-5}$, which was got in the tube of narrowest bore in field 600. The cubical dilatation, though negative in high fields, was positive in moderate fields, the change of sign occurring in a field which was lower as the wall of the tube was thinner. With the tubes of widest and intermediate bore, the cubical dilatation was negative in very low fields, each having critical fields for which the dilatation was zero. The tube of narrowest bore did not show this double change of sign. As was perhaps to be expected, the volume changes in the nickel tubes were distinctly greater than the like changes in the iron or steel tubes formerly investigated.—Dr. Gustave Mann communicated a paper on histological changes produced in nerve cells by their functional activity. Experiments on rabbits and dogs have shown that the nuclei and cells were larger in stimulated, than in non-stimulated ganglia. In the stimulated ganglia the lymph spaces practically disappear, while they are quite evident in the non-stimulated ganglia.

Paris.

Academy of Sciences, August 20.—M. Lœwy in the chair.—Electricity considered as a vortical movement, by M. Ch. V. Zenger. The author shows that an electrical discharge produces a whirling movement in the gas through which it is discharged, which may be said to be a cyclone on a small scale, so completely are the phenomena of cyclones reproduced. The particles appear to describe a trajectory which may be represented by a screw of variable pitch traced on a conical surface.—New experiments permitting the comparison of the delivery of liquids, gases, and vapour from the same orifices, by M. H. Parenty. (1) The coefficients of delivery of gases are precisely equivalent to those of the submerged delivery of liquids. (2) These coefficients are not sensibly varied when the pressure and the back-pressure are modified in various ways; they are independent of the temperature and the atmospheric pressure. (3) There exists, for liquids, no analogous phenomena to the regularity of delivery of gases. The delivery of liquids is exactly and always the ordinate of a parabola, of which the loss of charge is the abscissa.—On the periodicity of the absorption rays of isotropic substances, by M. G. Moreau. The author concludes a mathematical investigation of this question as follows: In an isotropic absorbent, there should be two possible kinds of waves of propagation. The one gives bands by anomalous dispersion (they may be reduced to very fine and black rays by regular dispersion), the other gives less intense rays, but they are periodic and more numerous. They would form a kind of double refraction which observation does not seem to have indicated.—On the action of the halogen hydracids on formaldehyde in presence of alcohols, by M. Louis Henry. A claim for priority as against M. C. Fabre.—Action of camphoric anhydride on benzene in presence of aluminic chloride, by MM. E. Burcker and C. Stabil. Two substances besides the principal product, phenylcamphoric acid, have been isolated, namely, phenylcamphoric anhydride, $C_{16}H_{18}O_2$, and a diphenyl compound represented by the formula

$$PhCO\ .\ CPh\begin{matrix} \diagup CO\ .\ CH_2 \diagdown \\ \diagdown CH_2\ .\ CH_2 \diagup \end{matrix}CH\ .\ C_3H_7.$$

—The extraction of free acids from bees-wax, by M. T. Maire.—Influence of lesions of tissues on their aptitude for fixing dissolved substances, by MM. A. Charrin and P. Carnot. It is shown that dissolved substances tend to accumulate in unhealthy or injured tissues.—On some antitoxic properties of the blood of the terrestrial salamander (*Salamandra maculosa*) against curare, by MM. C. Phisalix and Ch. Contejean. The salamander requires eighty times as much curare as the frog for poisoning to take place. The immunity of the salamander may be due to the presence in its blood of some substance which neutralises the effect of this poison. In support of this hypothesis, it is found that a mixture of salamander-blood and curare in proper proportions does not act on the frog. This substance has a physiological action conferring immunity against curare, and not a direct chemical action on the latter, for the inoculation of frogs with salamander-blood twenty-four hours before the injection of curare enables the frogs to withstand a much larger dose than when the salamander-blood has been mixed with curare previous to injection.—On the budding of Diplosomidæ and Didemnidæ, by M. Maurice Caullery.—Researches on the respiration and assimilation of the Muscineæ, by M. B. Jonsson. There are great differences among the Muscineæ in regard to the intensity of respiration and chlorophyllian assimilation. For example, the different species disengage in the dark very different quantities of carbon dioxide per gramme of dry weight. The proportion of water present in the plants is an important cause of variation, the greater this proportion the more intense are the gaseous exchanges. Specimens taken from a very damp place give off more gas than specimens of the same species taken from a dry location. The reddish coloration of many mosses, very marked when the plants have been developed in the light, diminishes considerably the intensity of respiration and assimilation.—On the perithecæ of the "Rot blanc" of the vine (*Charrinia diplodiella*), by MM. P. Viala and L. Ravaz.—On the chemical constitution of the atmosphere, by M. T. L. Phipson.

New South Wales.

Linnean Society, June 27.—Prof. David, President, in the chair.—Description of five new fishes from the Australasian region, by J. Douglas Ogilby. Of the species described, *Gillichthys mirabilis* and *Clinus whiteleggei* were from the coast of New South Wales, *Ophioclinus de visi* from Queensland, *Petroscirtes icelii* from Lord Howe Island, and *Eleotris huttoni* from New Zealand.—The land molluscan fauna of British New Guinea, by C. Hedley. Two new species, *Sitala anthropophagorum* and *Otopoma macgregoriæ*, were described and figured. It was considered that Mousson's genus *Trochonanina* should be merged into *Sitala*. Anatomical details of several species not before dissected were added.—Studies in Australian entomology. No. vii. New genera and species of *Carabidæ*, by Thomas G. Sloane. Three genera—*Notolestus* (type, *Abax sulcipennis*, Macl.), *Setalimorpha* (Feronini), and *Lestianthus* (Helluonini)—and thirty-six species were described as new.—Wood moths: with some account of their life-histories, chiefly compiled from the notes of Mr. R. Thornton of Newcastle, by W. W. Froggatt. This paper gave a general account of the habits and food-plants of several species of *Eudoxyla* and *Charagia*, and of *Leto Stacyi*.—Botanical notes from the Technological Museum, Part ii., by J. H. Maiden and R. T. Baker. The notes included (1) a list of additional localities of New South Wales plants, (2) new varieties of New South Wales plants, (3) Queensland species new for New South Wales, (4) remarks on naturalised species in the colony, and (5) descriptions of unrecorded fruits.—Notes on plants collected on a trip to the Don Dorrigo Forest Reserve, by J. H. Maiden. The author traced the southern extension of plants hitherto recorded from the Clarence River and further north, and the northern extension of plants hitherto not recorded further north than the Macleay River, Blue Mountains, &c. He also described a number of well-marked varieties of certain species, and added notes on imperfectly-described or little-known plants.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

Books.—Peregrinazioni Psicologiche: Dr. T. Vignoli (Milano, Hoepli).—The Sportsman's Handbook: R. Ward, 7th edition (R. Ward).—Controversen in der Ethnologie: A. Bastian, i. ii. iii. (Berlin, Weidmann).—Celestial Objects for Common Telescopes: Rev. T. W. Webb, vol. 2, 5th edition (Longmans).—A Journey in other Worlds: J. J. Astor (Longmans).—Précis de Météorologie Endogène: F. Cann (Paris, Gauthier-Villars).—Evolution and Ethics: T. H. Huxley (Macmillan).

Pamphlet.—The Molecular Tactics of a Crystal: Lord Kelvin (Oxford, Clarendon Press).

Serials.—American Naturalist, August (Philadelphia).—Bulletin de L'Académie Royale des Sciences de Belgique, 1894, No. 7 (Bruxelles).—English Illustrated Magazine, September (198 Strand).—Good Words, September (Isbister).—Sunday Magazine, September (Isbister).—Longman's Magazine, September (Longmans).—Chambers's Journal, September (Chambers).—Geographical Journal, September (Stanford).—Natural Science, September (Macmillan).—Humanitarian, September (Hutchinson).—Century Illustrated Magazine, September (Unwin).

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THURSDAY, SEPTEMBER 6, 1894.

A NEO-LAMARCKIAN THEORY OF EVOLUTION.

A Theory of Development and Heredity. By Henry B. Orr, Ph.D., Professor at the Tulane University of Louisiana. (New York and London: Macmillan and Co., 1893.)

THE appearance of a new work on the causes of evolution, by an American biologist, raised the hope that more solid arguments would be forthcoming in favour of the conclusions accepted by so many well-known writers and workers on the other side of the Atlantic. This hope was doomed to disappointment, the evidence adduced being even more slender than usual, and the conclusions even more rash.

According to a view which has been recently put forward by Lamarckian writers, the facts of adaptation are explained by the supposition that organisms possess such a constitution that they are compelled, by the incidence of external forces, to react adaptively, viz. by the production of useful variations. This view appears to be supported by the author (chapter i.), although no evidence is brought forward in favour of it. The hypothesis in question seems to be little more than the old "internal developmental force," or "innate tendency towards perfection," in a modern dress. Furthermore, a little consideration of the essential nature of adaptations proves the futility of any such attempt at explanation. The ultimate objects of adaptations are to obtain food, to escape enemies, or to subserve reproduction. In the vast majority of cases adaptations are relative to the condition of other individuals of the same and other species—a condition which is and has been continually changing. But the environment with which the organism is in continual contact, and which is presumably supposed to bear a pre-eminent part in working these useful variations, is the inorganic environment. So that stimuli provided by one form of environment are looked upon as the direct causes of adaptations which are essentially related to another and very different environment. It would be necessary, in order to make the suggestion valid, to prove that the changes in the organic environment which render some adjustment of adaptation necessary, are invariably accompanied by corresponding changes in those forces (chiefly inorganic) by which it is believed that the adjustment is effected.

In discussing "the limits of natural selection," the following supposition is believed to constitute an insuperable objection to Weismann's theory of heredity, viz. "the supposition that the germ-plasm may exist in the body and still be no more affected by the changes which pass over the body than if it were enclosed in an hermetically sealed vial." It is well known that in all his later writings Weismann has abandoned the hypothesis of a germ-plasm endowed with an almost resistless stability. But the admission of the converse supposition, that the germ-plasm is profoundly affected by the external forces which also affect the body, is very far from the admission that acquired characters are transmitted; and it is this latter, and nothing less, which is required as a foundation for the Lamarckian hypotheses, as, indeed, the author freely admits. In order to prove that the one proposition involves the other, it would be necessary to show that an external force producing a certain effect on the body must produce, upon a totally different thing—the germ-plasm—not, indeed, the same effect, but its precursor.

Considering "the many cases of wholesale destruction of animals—for instance, the killing of countless fishes by a sudden change in the temperature of the ocean, the killing of birds and insects by cold and storms of wind and rain, and the killing of myriads of organisms of all kinds by circumstances over which they have no control, and from which no mere individual variations could save them," the author is led "to doubt that natural selection acts with such mathematical accuracy in accumulating slight individual variations." It is difficult to understand the grounds upon which the non-operation of natural selection in certain kinds of destruction is held to cast doubts upon the efficiency of its action when it does come into operation. Furthermore, it is easy to point to results which are consistent with the view that natural selection may act "with mathematical accuracy" even in the class of cases brought forward. The peculiar condition of the wings of insects living in islands in stormy zones, and a power of resisting temperature related to the needs which follow from the geographical distribution of plants and animals, may be cited as examples.

The author quotes with approval Prof. Cope's contention that "the useful additions which have constituted certain genera, families, orders, &c., what they are," were produced as a direct consequence of needs, and were not formed first and selected afterwards, inasmuch as "it would be incredible that a blind or undirected variation should not fail, in a vast majority of instances, to produce a single case of the beautiful adaptation to means and ends which we see so abundantly around us. The amount of attempt, failure, and consequent destruction would be preposterously large, and in nowise consistent with the facts of teleology as we behold them."

This antithesis suggests that it is believed that "the useful additions" were fully formed as complete organs or parts before they were selected. According to the theory of natural selection, however, such "additions" have been led by selection from the very first—from the time when the parent organ or part first began to be used for a new purpose (for such is almost invariably the origin of the last "addition")—right back to the remote period when the original ancestor of a long succession of organs and parts came into being. But even accepting Prof. Cope's antithesis, surely, when we consider the slow succession of forms throughout geological time, and the amount of extinction which took place in every generation, we may accept his conclusion as to the amount of "attempt, failure, and consequent destruction," and reply that on this very account the Lamarckian explanation is extremely improbable, inasmuch as it would imply a direct and rapid evolution, whereas we know that evolution has been slow and interrupted.

Unnecessary confusion has been introduced into the discussion of instincts by the inclusion under this term of the clearest results of education and experience, containing nothing in common with true instinctive actions. Thus we read on p. 21:—"That the Kea-bird of New Zealand has learned to dig the kidney-fat out of living sheep since the introduction of sheep into that country, is another wonderful instance of change of instinct hardly to be accounted for by means of natural selection, but rather as the result of intelligent experience."

Speaking of instinct, he maintains "this seems to be a well-defined case of the inheritance of acquired characters. We cannot deny that the idea or knowledge has been acquired, neither can we deny that it has been inherited." And yet many instinctive actions of the greatest complexity and interest take place under conditions which preclude the possibility of the acquisition of any idea or knowledge. Thus many insects before pupation take the most elaborate precautions, which tend to prevent their detection by enemies they have never seen and never will see in the helpless stage they are about to enter. If knowledge cannot have had any part in the origin of such marvellous instincts, it is unnecessary to suppose that it is an element in the rise of any truly instinctive action.

In considering the source of organic energy in chapter ii., the author supposes that by the law of conservation of energy all the forces of the environment which act upon an organism must be transferred into some form of energy within it, accounting for "all changes in shape and all changes in the method of activity." In order to help to understand how this may occur, he instances a number of photochemical changes taking place in inorganic bodies. But the law of conservation of energy demands nothing of the kind. The forces which fall upon the organism must indeed persist, but not necessarily in any form which can be made use of by the organism; or they may, and indeed frequently do, serve to expend part of the store of potential energy derived by the organism from other forces. Thus the effect of any external force (*e.g.* light, heat, sound, &c.) upon a peripheral end organ is only conveyed to the brain by the expenditure of potential energy derived from food. The animal may benefit by the information received, but the transmission itself is a loss, and not a gain to the store of force at its disposal.

When, in chapter iii., the author considers in further detail the action of environing forces, many instances are brought forward, in which it is clear that some *necessary condition* of development, such as food or heat, is interpreted as a *cause* of development. It is surprising that the author did not think of applying his conclusion that "food is one of the stimulating forces which guide and determine the developmental reactions of the organism" to the vegetable world; where an endless variety of forms depend upon a food supply which is, when compared with that of animals, remarkably uniform.

The naive manner in which conclusions are drawn is surprising in an author who is evidently a trained biologist, and is accustomed to the indirect and excessively complex relation of causes to effects met with in organic nature. Thus, on p. 47 we are told that "pigment increases in quantity or brilliancy as we approach the equator, where the light is most intense. There is thus a direct ratio between the amount of light and amount of pigment"; and again on p. 49: "The plain facts lead to the conclusion that pigment is caused by light acting upon the tissues, and where there is no light there can be no pigment." It is interesting to compare these bald statements with the evidence produced by Dr. A. R. Wallace, that there is no proportionate increase in quantity or brilliancy of colour—either animal or vegetable—in tropical as compared with temperate countries; but that such increase as there is, is merely proportionate to the increase in variety and number of forms of life. But apart from this deliberate conviction of one whose opinion on such a subject is entitled to so much consideration, the mode of development of pigment in animals is entirely opposed to the author's conclusions. The bright colours of insect-imagines are developed in an earlier stage, during which they are comparatively screened from light, and when in the final stage the colours are exposed, they undergo no change in the direction of increasing brilliancy. Even such changes as the darkening of the freshly exposed pupal cuticle long assumed to be photochemical—have been shown by the writer to be independent of light, and almost certainly due to oxidation.

Equally rash and ill-considered is the conclusion, in the same chapter, that the colours of desert animals and of those living among the sea-weed of the Gulf Stream are due to a direct photochemical influence of the respective environments, and that the whiteness of Arctic animals "may be primarily due to the small amount of light in those regions." In reaching this last conclusion the author relies upon the supposed fact that *all* classes of animals are similarly coloured, forgetting that when, as in the raven &c., a white appearance is not needed for attack or defence, it is not attained.

In considering the action of the nervous system, in chapter iv., it is "safely" concluded that "the energy of the forces, acting from without, persists within the living matter as nervous activity and change of nervous condition." It has been already pointed out that such persistence is frequently attended by a loss rather than a gain to the energy at the command of the organism. The author has thought it worth while to translate long passages from Detmer, and does not appear to be aware that the conclusions he quotes have been refuted by Weismann, and are even rejected by botanists who do not agree with the views of the latter.

In chapter v. it is contended that development has been dependent on association and repetition. It is forgotten that many essential actions are performed but once in the life of the individual (*e.g.* cocoon-spinning), or are as perfectly performed the first time as on subsequent occasions (*e.g.* web-spinning of spiders, sucking of mammals). The author freely admits that such a theory of development demands the transmission of acquired characters, and it is therefore remarkable that his discussion in chapter vii. of this question—the foundation of every conclusion he brings forward—should be so brief, and his reasons for accepting such transmission so unconvincing.

In chapter ix. the author attempts to illustrate in the approved Neo-Lamarckian manner the moulding of limbs and the skeleton generally as the result of the forces to which they are exposed during the life of the individual. In the explanation of the remarkable lengthening of the fore-part of the giraffe we meet with a suggestion which is, I believe, new in the history of Lamarckian speculation. In stretching for food it is contended that the animal "must have constantly raised itself off its fore-feet, and as it dropped must have received a shock that made itself felt from the hoofs through the legs and vertical neck to the head. In the hind-legs the shock would not be felt. . . . The principle of increased growth in the direction of the shock resulting from superabundant repair of the momentary compression, explains how the giraffe acquired the phenomenal length of the bones of its fore-leg and neck; and the absence of the shock in the hind-quarters shows why they remained undeveloped and absurdly disproportionate to the rest of the body." (pp. 164–165.) It is unnecessary to take the trouble to refute the details of the various suggestions brought forward by the upholders of the Lamarckian hypothesis: they refute each other. One of them explains a lengthened neck as the result of extension, another as the result of compression; while neither give any approach to a proof that such an effect is likely to result from the antagonistic forces which they respectively invoke.

E. B. P.

CELESTIAL PHOTOGRAPHS.

A Selection of Photographs of Stars, Star Clusters and Nebulæ, together with information concerning the Instruments and the Methods employed in the Pursuit of Celestial Photography. By Isaac Roberts, D.Sc., F.R.S., &c. (London: The Universal Press, 1894.)

THIS handsome collection of celestial photographs is a remarkable example of what can be done single-handed in a new line of research. Taking up celestial photography more than ten years ago, Dr. Roberts has devoted himself entirely to it, and has been rewarded with an amount of success that must be to him a source of intense satisfaction.

This success, however, has not been obtained by merely exposing plates in the telescope and watching the images come out in the developing dish. The work that Dr. Roberts set himself to do was planned at the outset in a thorough manner, and has been carried out apparently without regard to either labour or expense; even to the extent of the removal of the observatory near Liverpool, to a better position, selected after a most exhaustive discussion of weather conditions in the south of England.

In the introduction of his book Dr. Roberts tells us that a reflector of twenty inches aperture was the instrument decided upon, in consultation with Sir Howard Grubb, as the most likely to give the best results. An instrument of this size, arranged for exposing the plate without the use of a plane or prism, was made and mounted by Sir Howard Grubb in 1885. With this instrument all the celestial photographs have been taken.

The first arrangements do not appear to have been quite satisfactory, so that the telescope had in great part to be reconstructed; but even then the star images were found, on trial, to be elongated, though this defect seems to have been remedied later on, if one may judge by the remarkable absence of any deformation of image in some of the very long exposure photographs.

The question of the utility of the photographic chart is discussed, and the fact mentioned that Dr. Roberts had already, in 1885, begun a photographic chart of the northern heavens, and made some progress, when the International Congress for the Photographic Chart of the Heavens took up this work. The use of the paper copies of celestial photographs might, it is suggested, be (1) the detection of changes in the structure of nebulæ; (2) the detection, on a large scale, of movements amongst the stars; (3) determinations of variations in stellar magnitudes; (4) relative distribution of stars in space; (5) detection of new stars and disappearance of others.

In cases, however, where measurements to a second of arc are required to be made, then the original negatives must be used for the purpose; and in this we quite agree with Dr. Roberts. It would have been well worth while to picture, in this connection, the instance given by Dr. Roberts of his comparison of a chart of the heavens, made in 1863 by D'Arrest, showing 212 stars, with a photograph of the same region taken in 1890, which showed that considerable changes had taken place among the stars in this small area of the sky (comprised within one degree of declination and half a degree of right ascension) during the interval of twenty-six years between the epochs of the charts.

The relative advantages of refractors and reflectors as photo-instruments, and the requirements and adjustments of a reflector for celestial photography are discussed; and the ideal instrument for photographing the sun, moon, and planets is given as a refractor of six or eight inches aperture and very great focal length; but for the delineation of faint stars and faint nebulosity, Dr. Roberts gives a preference to the silver-on-glass reflector, and he would choose an instrument of twenty-seven inches clear aperture and eleven feet three inches focal length, the mirror being figured, and every part of the mechanism made in the most perfect manner possible, and with a guiding telescope with an objective ten inches in aperture. To anyone contemplating the erection of an instrument for celestial photography, these hints—the results of many years' experience—should be of great value.

The other chapters, on the collimation of the mirror, the essentials of a photo-telescope, method of testing the stability of a photo-instrument, and photographic plates, their exposures and developments, will be read with great interest by all photo-astronomers.

The chapter on the collimation of the mirror gives an account of the method employed to check the guiding telescope, and is perhaps the only point on which something might be said in the way of criticism of Dr. Roberts' method. It is difficult to see why the method described should not be varied so as to be always available, and so dispense with the guiding telescope; a matter of no slight importance in the case of such an instrument as Dr. Roberts has suggested, the ten-inch objective of which would cost as much or more than the mirror. We believe Sir Howard Grubb has already suggested some such method.

We should have very much liked further information about the instrument, the supports of the mirror and the plate-holder, and other details, but these are perhaps rather in the province of the telescope-maker than the photo-astronomer. A photograph of the double telescope, however, gives a very good idea of the general arrangements, and there is also a photograph of the observatory.

Of the forty-nine celestial objects reproduced on paper, four are star charts, twenty-two are clusters of stars, and twenty-three are nebulæ. The earlier and most important photographs in this collection have already been published in various ways, and many of the others exhibited at the meetings of the Royal Astronomical Society; for Dr. Roberts, with proper scientific spirit, has always been ready to place any of them at the disposal of astronomers: but they lose nothing of their great interest by being seen in the collected form.

Had Dr. Roberts' work been only to produce the first photograph, that of the great nebula in Andromeda, and had that been the only result of all his labour, he would have been amply repaid, for it is certainly not too much to say that, in this picture, photography has done more to justify its use by the astronomer than in any other case; and one can feel that the hopes that were formed by Rutherford and others in the early days of photography, and which lay dormant for so many years, have now been realised. The perfection of delineation enables the true character of this marvellous object, which remained hidden from the closest scrutiny of such a careful and competent investigator as G. P. Bond, to be at once seen and appreciated. It is difficult to imagine that such an enormous object as the Andromeda nebula must be, is not very near to us; perhaps it may be found to be the nearest celestial object of all beyond the Solar System. It is one that offers the best chance of the detection of parallax, as it seems to be projected on a crowd of stars, and there are well-defined points that might be taken as fiducial points for measurement. Apart from the great promise this nebula thus seems to give of determining parallax, there is a fair presumption that in course of time the rotation of the outer portion may perhaps be detected by observation of the positions of the two outer detached portions in relation to the neighbouring stars.

The photographs are arranged in order of right ascension, each has its position given, and many have marked fiducial stars whose position is given for 1900. The scale of enlargement is also given, so that with the help of a table of corrections of errors due to the slight alterations in scale in enlarging or printing, any point on the photograph can be determined with an accuracy sufficient at least for purposes of identification.

For some purposes, no doubt, it will be absolutely essential to have recourse to the original negatives, but, as Dr. Roberts has pointed out, there are many purposes for which these paper copies are available. In addition to the full date of each object, which is admirably done, there are various useful references to previous observations. The accuracy with which the telescope is kept pointed during a long exposure is seen by a glance at the shape of the brighter star images, as a shift, if not at once corrected, produces deformation. In nearly every photograph the stars are round, in some they seem absolutely so, which shows the perfection of the instrumental arrangements of Sir Howard Grubb, and the care with which the exposures have been made. Some of the star photographs—as, for instance, plate 43—show a perfection of image and an absence of distortion over a large field that is very satisfactory. A comparison with a plate of the same region taken by an International Chart refractor would be interesting.

In looking at the examples of spiral nebulæ, of which there are several, one cannot help thinking of Lord Rosse, and the correctness with which he delineated these objects, though his views at the time were not generally accepted by astronomers. These most interesting nebulæ will repay further study, perhaps, more than any other.

Some of the cluster photographs are too much enlarged for the ordinary distance at which one reads a book, but the proper effect can be obtained by looking at them about three feet away. All the photographs are about as good as it is possible to take with an instrument of the size used by Dr. Roberts, and the present dry plates; better photographs can only be obtained by the use of a larger telescope, or by means of dry plates that will, with the same or greater sensitiveness, give a finer grain. This is shown by a comparison of the photograph of the cluster M. 5, taken by Dr. Roberts, with one taken with a larger telescope of a similar kind. Dr. Roberts states (p. 91) that "the cluster is enclosed in dense nebulosity about the centre, the nebulosity hides the stars, even on the negative"; but an inspection of the photographs by a larger instrument shows that the stars are quite distinct, though the exposure was very much longer, a result that might fairly be expected.

A comparison of photographs of this object, taken at different dates, shows that many of the stars of this cluster are variables, and of course it is just possible that there may be variability in the central portions.

Excellent as are the paper reproductions of these photographs, they cannot give all the beautiful detail to be seen on the original negative of a nebula. If change be taking place, it is more than likely that it may be seen in the finer detail first, in which case the original negative must be seen. This points to the absolute necessity of preserving the negative where it shall be available in after years. We hope that all valuable originals will find their way eventually to the keeping of the Royal Astronomical Society, which now undertakes this important duty.

This volume shows that Dr. Roberts has spared neither himself nor his purse in fulfilling the task he set himself to do, more than ten years ago. By the great labour and devotion he has shown for many years in carrying out his carefully considered plans, he has set a model for others to follow in taking up a research of this kind, of which there are so many in astronomy, that from the nature of the case can only be well done by those who, like him, undertake it solely as a labour of love.

A. A. COMMON.

DEAF-MUTISM.

Deaf-Mutism. By Holger Mygind, M.D., Copenhagen. (London: F. J. Rebman, 1894.)

A FEW months ago, in noticing "The History of American Schools for the Deaf," we spoke of the treatment of deaf-mutes, and regretted the fact that we hear so little of that work in England. Before us we have another book, again of foreign origin, in which is described, exhaustively and systematically, the pathology of deaf-mutism. The materials used in its compilation are almost entirely obtained from Denmark, and, although published in England, and revised by an English specialist of note, the book may be said to have a somewhat foreign flavour. With the exception of special chapters upon the subject in Wilde's, Field's, and Toynbee's works on diseases of the ear, little is to be found in English writings, and there are no books dealing solely with deaf-mutism written by Englishmen. This may, perhaps, be accounted for by the fact that in the table of recent statistics of the distribution of deaf-mutes in various countries, England and Wales stand twentieth in a list of twenty-three, showing only fifty-one of these unfortunates per thousand inhabitants. Ireland and Scotland stand higher in the table, with seventy-seven and fifty-seven per thousand respectively. Still, even with the happily low rate of deaf-mutism in this country, it is a matter for regret that no Englishman has produced a work upon the subject.

Dr. Holger Mygind performs his task very well. To begin with, he arranges it in a systematic manner, and treats each part as exhaustively as lies in his power. Devoting his introduction to definition, literature, classification, and distribution, he gives evidence of considerable patient research. In discarding the classification of deaf-mutes according to the degree of its symptoms for that according to its etiology, he does wisely, the former being as unscientific as it is misleading. It is a pity that "Creed" should have been included under the heading "Distribution," since Dr. Mygind shows that the apparent greater frequency among certain religions is, as one would expect, really due to the relative numbers of persons professing such religions; while the well-known fact that the Jews produce a larger number of blind, idiotic, and deaf-mute individuals than the races among which they live, is due, doubtless, to the consanguineous marriages practised by the Hebrews.

Perhaps the most interesting part of the work (the whole of which cannot be otherwise to the student of pathology) is the chapter which deals with etiology and pathogenesis, and in which such conditions as climate, water, hygiene, heredity, and the like are discussed. With regard to heredity, Dr. Mygind brings forward a series of facts (the collection of which must have caused considerable labour) referring to the appearance of deaf-mutism and other pathological conditions among the relatives of deaf-mutes, and from these facts endeavours to formulate some definite laws concerning the heredity of deaf-mutism. These laws, it is stated, are difficult of interpretation, and seem in many respects to differ from those which relate to other pathological conditions and diseases, a fact to be accounted for by the number and variety of the causes of deaf-mutism, and consequently of the causes of each individual case. The matter is further complicated by the presence of factors, equally important, which tend to neutralise the transmission of morbid tendencies. It appears that deaf-mutism is, in many instances, the combined result of the transmission of various influences which fall into two groups—those which originate in ear diseases, and those which originate in nervous diseases in the family.

The material from which the chapter on morbid anatomy is based is formed from the reports of some 139 autopsies, the principal of which are collected in an appendix. The morbid changes in the ear are classified under the heads of external ear, middle ear, and labyrinth. From the evidence here collected, it seems that the pathological conditions differ rather in extent and intensity than in quality from those generally found in ear diseases, and, from appearances alone, it is in many cases impossible to decide whether the changes are of fœtal or post-fœtal origin. Dr. Mygind sums up the question of pathology in these words: "Deaf-mutism is, therefore, from an anatomical point of view, in most cases to be considered as a result of an abnormality of the labyrinth."

We congratulate Dr. Mygind upon the successful completion of a task which must have been at once laborious and interesting. To the pathologist, whether general or special, the work cannot fail to be a source of interest, and it is to be hoped that the work done by the author in thus bringing together so much that is known upon the subject will be productive of good.

P. Macleod Yearsley.

OUR BOOK SHELF.

A Text-book of Physiological Chemistry. By O. Hammarsten, Professor of Medical and Physiological Chemistry in the University of Upsala. Authorised translation from the second Swedish and from the Author's enlarged and revised German edition, by J. A. Mandel, Assistant to the Chair of Chemistry, Bellevue Hospital Medical College, New York. (New York: John Wiley and Sons, 1893.)

Prof. Hammarsten is so highly esteemed for his work and views on the more specially chemical side of physiology, that a text-book from his pen was looked for with keen anticipation. Unfortunately a knowledge of the Swedish language is not as yet an accomplishment possessed by more than a favoured few, however essential it may become in the future, so that when his text-book first appeared its contents were largely inaccessible to the majority of would-be readers. As a consequence of this, Prof. Hammarsten was asked by numerous colleagues to provide a German version of the first Swedish edition. Unable to comply with this earlier request, he yielded to a strongly renewed similar proposal after the appearance of the second Swedish edition, and in 1890 he published the work in German, translating it himself. In its German dress the text-book is so well known and approved that detailed criticism or renewed commendation is now scarcely necessary. Written "to supply students and physicians with a condensed and as far as possible objective representation of the principal results of physiologico-chemical research, and also with the principal features of physiologico-chemical methods of work," the book was not regarded by its author as "complete or detailed" from the point of view of the specialist. Clear, yet concise, and dealing not only with the well-known facts and methods of physiological chemistry, but also with the more important points of pathologico-chemical interest, this work is peculiarly suited for the student while going through a course of laboratory instruction. From this point of view the present English version should be widely welcomed. The translation has been made without additions or changes from the author's German edition and the original Swedish. Judged by a comparison with the German, the translator must be congratulated on the way he has done his work. While adhering very closely and literally to the original, the translation reads well and is free from the awkward and often clumsy expressions which frequently result from attempts to render German phrases too closely into English equivalents.

After a short introduction (chapter i.), treating in a general way of some of the more important chemical processes and agents which have to be dealt with in the living body, the next twelve chapters give an account of proteids, the animal cell, blood, chyle, lymph transudations and exudations, the liver, digestion, connective tissues, muscle, brain and nerves, organs of generation, milk, the skin and its secretions. Chapter xiv., the longest and one of the most important in the book, is on urine. Here, from the practical importance of the subject, the treatment is more elaborate than in the preceding chapters, more especially as regards details of analytical methods and urinary analysis. Here also, as in the other chapters, the analytico-chemical parts are distinguished from the rest of the text by special type, an excellent plan which facilitates the work of those who may wish merely to learn what is most definitely known of the substances and processes of the animal body. The last chapter contains a concise but clear account of the more important facts of the exchange of material (Stoffwechsel) or metabolism, and of its relationship to various foods and to the conditions of starvation, exercise, rest, &c. Some useful tables of the composition of various foods are placed at the end of this chapter, and, after the index, which is full and carefully made, a plate is given of the more common and important absorption-spectra.

Electricity, Electrometer, Magnetism and Electrolysis. By G. Chrystal, M.A., LL.D. and W. N. Shaw, M.A., F.R.S. (London: A. and C. Black, 1894.)

THE present cheap reprint of these articles from the Encyclopædia Britannica should meet with a hearty welcome from all students of electricity and magnetism, and more especially from those who are desirous of extending their acquaintance with the science beyond the limits of ordinary elementary text-books. Such students generally find a difficulty in selecting a work from which to read the higher parts of the subject. Maxwell's treatise is too mathematical for the majority of students; one work is, perhaps, too technical in character, while another deals too exclusively with practical measurements. The division of the subject after the first stages into mathematical and technical branches is certainly a natural one, and corresponds in some measure with the requirements of students. It does not, however, lighten the labours of those who wish to obtain a grasp of general theory and experiment without being cumbered with the details of machines on the one hand, or degenerating into pure mathematics on the other. For such students the articles of Prof. Chrystal and Mr. Shaw help to fill a gap left behind by the existing text-books. The historical, experimental, and mathematical portions are nicely balanced, and together form an epitome of the whole subject, which is made more valuable by the addition of references to original papers and standard works. The student will find it both a guide and a key to his reading, and by looking up its references he may pursue the subject to any desired degree of detail.

In the interval which has elapsed since the first publication of the articles, knowledge has been accumulated, and it is a matter for regret that the circumstances of the present issue do not permit of the articles being brought up to date. The absence of all reference to the work of Hertz in electricity, and of Ewing in magnetism, is attributable to this cause; while Mr. Shaw's Reports to the British Association show that much work has been done in connection with electrolysis since his article was written. Similarly in Electro-metallurgy—an article which, by the way, is not specified on the title-page—considerable progress has to be reported.

Apart from these additions, there is one point in Prof. Chrystal's article which might be improved, namely, the definition of the statical unit of electricity (p. 21). It ought to be stated that the force exerted on the conductors carrying the charges is measured *in vacuo*. Indeed, it would be better to introduce the idea of specific inductive capacity at this point, and so avoid a certain amount of confusion between electric induction and electric force in the following pages. The same remarks apply to the unit of magnetism (art. "Magnetism," p. 227). But although it is easy to criticise past writings in the light of present knowledge, we venture to think that the articles before us will stand a far more severe test than many works written at a later date.

JAMES L. HOWARD.

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.*]

On the Velocity of the Constantinople Earthquake-Pulsations of July 10, 1894.

ACCORDING to the accounts so far published, it would appear that the epicentrum of this earthquake was situated under the Sea of Marmora, at a short distance from San Stefano; but, for the purpose of this paper, no very sensible error will be introduced by assuming it to coincide with Constantinople itself.

To ascertain the time at the origin, I applied to M. Coumbary, director of the Meteorological Observatory at Constantinople, and to Mr. W. H. Wrench, H.M. Consul-General in that city. M. Coumbary informs me that the first great shock was felt at 12h. 24m. p.m. Constantinople mean time (or 10h. 28m. a.m. Greenwich mean time); its direction was from south-west to north-east, and its duration eight to ten seconds. A second shock, lasting three seconds, followed immediately; and a third, of one second duration, at 12h. 31m. A number of slight shocks succeeded these, but I have received no certain record of them from distant stations. Mr. Wrench kindly made inquiries of several watchmakers in the city. Two regulating clocks were stopped by the principal shock, one at 12h. 20½m., the other at 12h. 21¾m.; both, according to their owners, having previously indicated correct local time.

The earthquake was felt at Bucharest, and it was also registered by a horizontal pendulum at Nicolaiew, and by magnetic instruments at Pola, Potsdam, Wilhelmshaven, Utrecht, Parc Saint-Maur, and Kew. In the following summary the times are reduced to Greenwich mean time:—

Bucharest (Dr. S. C. Hepites).—A very slight shock was felt at 10h. 30m. 11s. a.m., of intensity 3 (Rossi Forel scale), direction from east to west. Two pendulums, placed on north-south walls at the Meteorological Institute, were stopped.

Nicolaiew (Prof. S. Kortazzi).—The curve traced by the horizontal pendulum was suddenly broken at 10h. 30m. 36s. a.m.; the pendulum itself was thrown out of position, and was found afterwards leaning against one of the side-supports.

Pola (Dr. S. Muller).—The declination curve shows two disturbances, at 10h. 36m. 37s. and 10h. 41m. 37s. a.m. The movements indicated on the bifilar and Lloyd's balance curves are very slight.

Potsdam (Dr. Eschenhagen).—First shock at 10h. 34m. 44s. a.m., amplitude ½′; second shock at 10h. 36m. 24s., amplitude 9–10′; third shock (slight) at 10h. 41m. 14s.; all three registered on the declination curve.

Wilhelmshaven (Dr. C. Börgen).—The needles of two instruments (declination and Lloyd's balance) oscillated so strongly that the light-point for some time made no impression on the paper. Declination: from 10h. 37m. 55s. to 10h. 43m. 25s. a.m., gap in the curve, oscillations perceptible till 10h. 49m. 55s.; the needle then became steady, but oscillations were again visible from 10h. 52m. 25s. to 10h. 56m. 25s. Bifilar: magnet in oscillation from 10h. 38m. 55s. to 10h. 44m. 55s. Lloyd's balance: from 10h. 38m. 25s. to 10h. 47m. 55s., gap in the curve, then till 10h. 54m. 25s. oscillations traceable.

Utrecht (M. M. Snellen).—The magnetic curves show a disturbance beginning at 10h. 37m. a.m., reaching a maximum at 10h. 41m., and followed by a second maximum at 10h. 52m. 46s.

Parc Saint-Maur (M. Moureaux).—The pulsations are registered on the magnetic curves at 10h. 40m. a.m. They are most marked on the bifilar curve, and much less appreciable on the vertical force curve. The declination curve shows a second movement seven or eight minutes after the first. The gravity-barometer curve indicates a slight depression of the mercury at the moment of the principal shock. The two copper bars, with bifilar suspension, orientated north-south and east-west, were undisturbed by the shock.[1]

Kew (Mr. C. Chree).—There is a very slight movement on both the horizontal force and declination curves, from 10h. 41m. to 10h. 46m., that on the former being the more conspicuous. The vertical force curve shows no disturbance.

In the following table are given the velocities of the earthquake-pulsations obtained from the different records. The epoch used in each case is the beginning of the pulsations, and the initial time that given by M. Coumbary.

Place.	Distance from epi-centrum in km.	Time-interval in secs.	Velocity in km. per sec.
Bucharest	416	131	3·18
Nicolaiew	707	156	4·53
Pola	1303	517	2·52
Potsdam	1742	504	3·46
Wilhelmshaven (Declination)	2097	595	3·52
,, (Bifilar)	,,	655	3·20
,, (Lloyd's balance)	,,	625	3·36
Utrecht	2185	540	4·05
Parc Saint-Maur	2240	720	3·11
Kew	2518	780	3·23

The average velocity of the pulsations of the principal earthquake obtained from the above ten records is 3·42 ± ·12 km. per sec.[2] A more reliable estimate will probably be obtained by omitting the records from Nicolaiew and Utrecht; the former because the horizontal pendulum is far more sensitive than the magnetographs, and the latter because the time given is that of the beginning of the small pulsations. The remaining records (of the beginning of the large pulsations) give for the average velocity 3·20 ± ·07 km. per.sec.

This value agrees very closely with that obtained for the pulsations of the Greek earthquake of April 27, 1894, namely 3·21 ± ·07 km. per second (Report of the B.A. Earth Tremor Committee, 1894), and also with several values determined by Dr. von Rebeur-Paschwitz. It hardly differs, again, from the average velocity between Constantinople and Bucharest, showing that the pulsations and the vibrations which constitute the shock, even if they were independent, travelled at about the same rate.

There is some doubt as to the identity of the second group of pulsations recorded on some of the curves with one another or with one of the earthquakes at Constantinople. Those at Wilhelmshaven and Utrecht seem to follow by too long an interval to be due to the third shock at 10h. 35m. a.m. G.M.T. It is not impossible, however, that the second group at Pola, Potsdam, and Parc Saint-Maur may be connected with this earthquake. If this be the case, the velocity of the pulsations to these places would be 3·28, 4·79, and 2·99 km. per second, respectively, and the average of the three 3·69 km. per second.

CHARLES DAVISON.

King Edward's High School, Birmingham.

[1] It has been inferred, from the steadiness of the copper bars, that the movement of the needles is of magnetic and not of mechanical origin (see *Comptes Rendus*, vol. cxix. 1894, pp. 251-252, and NATURE, vol. l. 1894, p. 394). But is not the centre of gravity of the copper bar equidistant from the two points of support, and that of the declination needle nearer the south support (in order that the needle may rest horizontally)? And, if so, might not the movement be of mechanical origin? (See *Geol. Mag.* vol. ii. 1885, pp. 210-211).

[2] With the initial times as given by the two stopped clocks mentioned by Mr. Wrench, the corresponding values of the velocity would be 2·30 and 2·56 km. per sec.

Photo-electric Phenomena.

A SHORT time ago, a report was given in NATURE (vol. xlix. p. 226) of modern researches respecting the photo-electric discharge of negatively electrified bodies. But no mention was made of our investigations on the same subject, although they were published in a series of articles, from 1889 to 1894, in *Wiedemann's Annalen* and in the *Wiener Berichte*. As the results of these researches seem to be unknown to English physicists, we enumerate them here in brief, in the hope that they will prove of some interest.

Well-cleaned plates of aluminium, magnesium, and pure or amalgamated zinc are, when negatively electrified, discharged in a few seconds by the light of the sun and the cloudless sky. The active rays extend from the blue part of the spectrum to the farthest ultra-violet, so that the active rays are almost completely absorbed by transmission through glass. Hence a well-amalgamated ball of zinc connected with Exner's aluminium-leaf electroscope may be used as a photometric apparatus to settle the amount of ultra-violet radiation emitted by the sun and the sky which reaches the earth's surface. Measurements of this kind were made by us in 1890, during June in Wolfenbüttel, and during July on the top of the Sonnblick. The discharging power of sunlight at a level of 3100 metres (*i.e.* on the Sonnblick) was found to be twice as great as at a level of 80 metres (Wolfenbüttel), corresponding to the greater proportion of blue and ultra-violet rays. These results are in conformity with Langley's well-known researches on the absorption of the blue sunlight by the atmosphere.

The more electro-positive a metal is, the larger the wave-length of light capable of producing a photo-electric discharge. Photo-electric cells of high sensibility were therefore made by using cathodes of metallic sodium, potassium, and rubidium, arranged in a glass bulb, and dipping in an atmosphere of rarefied hydrogen. The leakage of negative electricity from a sodium or potassium surface is produced even by the light of a candle at six or seven metres distance from the cell, and rubidium-cells are sensible to the weak light sent out from a red-hot glass-rod.

The photoelectric discharge by the action of ordinary daylight is also shown in a clear way by some *non-metallic* bodies, *e.g.* by the phosphorescent combinations of calcium with sulphur, and by the dark-coloured kinds of fluorite. Other minerals show traces of the same phenomenon. It is, therefore, probable that the sunlight and the daylight cause the negative electricity of the earth's surface to be partly dissipated into the air. If this theory were correct, it would give a foundation to the explanation of the daily and yearly variation of atmospheric electricity. For three years we have together made measurements respecting the ultra-violet radiation of the sun and the amount of atmospheric potential at the same time, and the results agree with this supposition.

By using the liquid alloy of potassium and sodium, which, in an atmosphere of rarefied hydrogen, shows a reflecting surface, we are able to study the influence of polarised light upon the photo-electric discharge. The maximum intensity of the photo-electric current is observed when the plane of polarisation is perpendicular to that of incidence.

The photo-electric discharge is sensitive to exterior magnetic influences in a similar way to the luminous discharge in a Geissler's tube. In a strong magnetic field it almost entirely ceases.

Electrical vibrations set up by the Hertz vibrator pass through a Geissler tube provided with an alkaline metal electrode far easier in daylight than in darkness. With a sensitive arrangement the weakest traces of light are sufficient to start the luminous discharge.

In one case the disruptive electrical discharge *ceases* when light is applied. If the sparks of an influence machine are allowed to pass between a brass ball as anode, and the cleaned surface of an amalgamated zinc disc as cathode, they *disappear* in the presence of magnesium light. And if the distance between ball and plate be enlarged, the magnesium light will also hinder the formation of positive electrical brushes.

[*Cf. Wiedemann's Annalen*, Bd. 38, p. 40; 38, p. 497; 39, p. 332; 41, p. 161; 41, p. 166; 42, p. 564; 43, p. 225; 44, p. 722; 46, p. 281; 48, p. 625; 52, p. 433; and *Wiener Berichte*, Bd. 101, p. 703. March 1892.]

J. ELSTER.
H. GEITEL.

Wolfenbüttel, August 12.

A Remarkable Meteor.

ON the evening of August 26 (Sunday) I saw what was to me an unprecedented sight: a brilliant and curious "meteor" fell near Gloucester. Starting from a point a little to the west of κ "Draco," at 10h. 19m., falling in the direction shown in Fig. 1, through about an angle of 40°; when it reached point X,

FIG. 1.

it appeared to melt, and its path from X to Y was marked by a most brilliant stream of light, equalling in intensity a magnesium flame.

This luminous streak from X to Y remained stationary and brilliant for nearly two minutes; then the lower extremity gradually curled around, forming the letter J, as shown in Fig. 2; the ends gradually converged until they met, forming a somewhat irregular band, and travelling in the path indicated by the arrow in Fig. 2.

As it traversed the heavens it seemed like a phosphorescent or nebulous cloud, finally assuming the shape shown in Fig. 2;

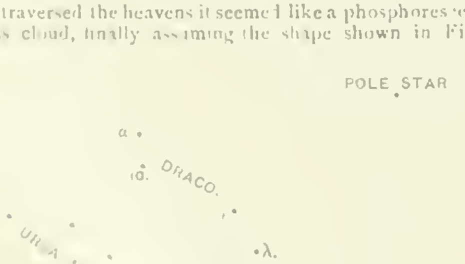

FIG. 2.

between κ and λ "Draco," then gradually becoming fainter and fainter, until at 10h. 41m. just twenty-two minutes after the "meteor" fell it became invisible, at a point as much to the eastward of κ "Draco" as the "meteor" had started from the westward of it. I should like to know if any of your readers have seen a similar phenomenon, or if it is of common occurrence.

JOHN W. EARLE.

Gloucester, August 27.

A New Rhynchobdellid.

IT seems hard to believe that a leech, common and abundant and possessing a chitinous dorsal scute, should have hitherto escaped notice. But Jackson, in his edition of the "Forms of Animal Life," does not refer to such a structure, nor does Lang, and I do not find notice of it in more recent literature. In the hope that I am not adding a needless synonym, I give a short description of the animal, of which a detailed account is in preparation.

(*Glossiphonia?*) *scutifera*, n. sp. Sub-cartilaginous, semi-transparent, greenish grey above, paler beneath; obscurely striated above, with a row of dark spots on either side of the middle line. Body widest about 40th annulus, tapering thence abruptly to the disc and gradually to the head, which is narrowest, and not marked off from the succeeding annuli. Annuli 64, ganglia 22. Length in full extension about 1 inch, at rest 3-8ths of an inch. Eyes two in centre of head. Genital apertures behind 21st and 23rd annuli. The 9th annulus is broader than its neighbours, and carries on the hinder part of its richly glandular dorsum a chitinous plate slightly elongated transversely, covering about an eighth of the width of the annulus; in young specimens the margins are overlapped by the integument. Anus dorsal.

This species is meanwhile referred to Glossiphonia, to which it bears a general resemblance.

JOHN YOUNG.

Glasgow University, August 28.

The Bleaching of Beeswax.

CAN any of your correspondents inform me how to bleach beeswax chemically, satisfactorily, and at a moderate cost?

August 28.

J. S. D.

SUNSHINE AND WATER-MICROBES.

THE bactericidal action of light is perhaps of most general hygienic significance in connection with the fate of micro-organisms in water, and there is ample field open for investigation in this direction, which so far has been but little explored. It is, therefore, with especial interest that we note Prof. Buchner's important contribution to this subject in the *Archiv fur Hygiene.* The title of the paper ("Ueber den Einfluss des Lichtes auf Bacterien und uber die Selbstreinigung der Flusse") already indicates that the practical aspect of the question has been considered, and indeed several experiments have been planned and carried out with the object of ascertaining what is the part played by sunshine in the alleged bacterial purification which takes place in river-water during its flow.

In the first series of experiments samples of boiled tap-water were inoculated with three drops of broth-cultures of the typhoid bacillus, *B. coli communis* and *B. pyocyaneus* respectively. The typhoid bacilli, even in diffused daylight, were reduced in numbers from 7400 per c.c. to start with, to 5000 at the end of one day, whilst on the second day none whatever were found. The *B. coli communis* sample had only 220 left on the third day, out of 22,000 at the commencement of the experiment, and was sterile on the fourth day; the *B. pyocyaneus* was, however, hardly affected at all during four days' exposure to diffused light.

The direct rays of the sun, however, were far more destructive. Thus about 30 c.c. of a sample of typhoid-infected water, placed in glass dishes and exposed to sunshine, contained no typhoid organisms at the end of six hours, and similar results were obtained with the *B. pyocyaneus*.

In all these experiments the perfectly admissible objection could be urged that the diminution in the numbers present might, at any rate in part, be attributed to a process of starvation in consequence of the absence of food-material, inasmuch as a marked decrease was also observed in those samples kept in the dark. To meet this objection, in the next series unsterile water was used, and to a litre and a half as much as 1 c.c. of the broth-culture of the particular organism was added, thus affording ample provision, both in light and darkness, for the support of the bacteria under observation. Instead of a decrease taking place in the samples kept in the dark, the numbers rose; on the other hand, in the samples placed in the sunshine, three hours' exposure in the case of the typhoid, colon, and pyocyaneus bacilli brought about their entire destruction, thus placing beyond doubt the direct bactericidal action which had taken place during insolation.

The amount of water used being small, no indication was given, in these experiments, of the *depth* to which the bactericidal action of the sun's rays could extend. Fol and Saracen ("Sur la pénétration de la lumière du jour dans les eaux du lac de Genève," *Comptes Rendus*, 1884) have shown by the exposure of gelatine-bromide plates that daylight penetrates to a depth of 170 metres in the water of the Lake of Geneva, the degree of light at this depth being about equal to that which we find during a bright but moonless night, whilst at a depth of 120 metres the strength of light is still considerable. These investigators also made the curious observation that in the experiments they conducted, the light penetrated far deeper into the water in September, during cloudy weather, than in the month of August with a perfectly clear sky. Thus not only does the power of light vary at different depths and, doubtless, in different waters, but it is also influenced by the time of year; and what, therefore, may be correct of a given water under certain circumstances, may not necessarily apply to it on another occasion, and hence a good deal of uncertainty attaches to the exact degree of light capable of transmission in any particular mass of water.

Prof. Buchner has endeavoured to ascertain at what depth in the water of the Starnberger Lake, near Munich, light ceases to have any *bactericidal* action. For this purpose he used his well-known process (described in the *Centralblatt für Bakteriologie*, vol. xii. August 1892) of exposing partially protected agar-agar dish cultures. This ingenious method consists in covering over parts of a glass dish containing agar-agar, in which certain varieties of bacteria have been evenly distributed, with variously-shaped strips of black paper or lead, so that the light is screened from these particular portions of the surface. In this manner the bacteria immediately beneath the covered part of the culture-medium are protected from the antiseptic action of light, whilst the rest of the agar-agar and its contents is freely exposed; the result of which is that, in the shaded part of the dish the colonies make their appearance, but in the remainder, having been subjected to the action of light, no bacterial growths, or only very feeble ones, are visible. This is beautifully exhibited in a few days' time by the shape of the black letters or other figures being sharply delineated by the abundant growths which have taken place beneath them from the blank remainder of the dish where nothing is visible, no colonies having developed.

Recently infected agar-agar dishes, partially screened with a leaden cross, were lowered to particular depths in the Starnberger Lake. The day selected was very fine and sunny, and the exposure was continued for 4½ hours, the temperature of the water being 15° R. The site was the starting-place of the steamers, and the water was not quite clear, this being doubtless due to the disturbance caused by the plying to and fro of the vessels.

It would have been more striking, perhaps, if Prof. Buchner had used only one variety of organism throughout, as then all chance of characteristic individual differences disturbing the progressive results would have been obliterated.

The following table shows the results obtained:—

Depth of the dish in the water.	Particular organism employed.	Development of the colonies.	
		In the shaded portion of the dish.	In the exposed part of the dish
0·1 m.	Cholera	Very strong	None
1·1 m.	*B. pyocyaneus*	,,	,,
1·6 m.	Typhoid	,,	,,
2·6 m.	*B. pyocyaneus*	Decidedly stronger than in exposed portion	Fairly strong
3·1 m.	Typhoid	Slightly stronger than in exposed portion	Strong

At a depth of 1·6 m. the bactericidal action of the sun's rays, as shown by this method, is equal to that produced outside the water; but at 2·6 m., however, the action is much less apparent, and in fact is only just perceptible. Thus, as has been suggested elsewhere,[1] the antiseptic potency of the sun's rays ceases a long time before the light becomes affected by the depth of water it has to traverse.

These experiments are of particular interest and importance, because they show very clearly that the agency of light in purifying water cannot be regarded as of much importance. So much stress has recently in Germany been laid upon the self-purification of river-water, that the advisability of permitting the sewage of cities of the magnitude of Cologne to pass untreated into the Rhine, has been publicly discussed on the assumption that in its subsequent flow all objectionable matters will disappear, one of the agencies cited as materially assisting in this magic destruction being sunlight. It is, however, sufficiently apparent that the action of light can only affect a very small fraction of the whole mass of water, for we know that bacteria exist in large numbers at depths very considerably below those which insolation can embrace, whilst there are only a few months in the year, at any rate in our northern climes, when the sun's action is sufficiently strong or prolonged to produce any appreciable effect even in the upper layers of the water.

Prof. Buchner concludes his paper with some investigations carried out by his assistants on the River Isar, 10 km. above Munich. These experiments were made to ascertain if any increase from the number of organisms present during the daytime takes place in the night, as in the absence of light might reasonably be anticipated. Dr. Minck and Dr. Neumayer, therefore, undertook on a September night to abstract samples from the river at ¼ m. below the surface at intervals of from 1–2 hours from 6 o'clock in the evening until 6 o'clock the next morning. The temperature of the water during this time only varied between 9°–10° R., and the samples were examined immediately after collection. The results are recorded in the following table:—

Time of taking sample.	Number of microbes in about 20 drops of water.
6¼ evening	160
8¼ ,,	5[2]
11 ,,	8[2]
12 ,,	107
1¾ morning	380
3 ,,	460
4 ,,	520
5 ,,	510
6¼ ,,	250

It would be interesting to have further confirmation of the results here given, other factors having doubtless assisted besides the absence or presence of light; but the arduous nature of the experiments will doubtless greatly militate against such a series being sufficiently often made to permit of any definite conclusions being arrived

[1] "Bacterial Life and Light," *Longman's Magazine*, September, 1893.
[2] No explanation is offered for these abnormally low figures.

at. In this connection, it may also be noted that in the year 1886 the Thames water at Hampton contained twenty times as many microbes in the winter as were found in the summer months. Here again the consideration of other agencies also tending to influence the bacterial condition of the river water cannot be excluded, but sunshine undoubtedly assisted in the banishment of the microbes. G. C. Frankland.

NOTES.

The Municipal Council of Paris has opened competitions for the best means of suppressing or diminishing the smoke of cities, and of purifying water. To the author of the best memoir on the former subject, the sum of ten thousand francs will be given, and two other prizes will be awarded of five thousand and two thousand francs respectively. The memoirs must be sent in before November 1. Prizes varying from one thousand to three thousand francs will be awarded for the processes of water purification which give the best results. Papers relating to this must reach the Council before September 15.

The death is announced of Dr. Karl Neumann, Professor of Chemistry in Zurich Polytechnic School, at the age of forty-three.

We learn from the *Athenæum* that Father Epping, S.J., died on August 22. He was one of the highest authorities on Assyrian astronomy and chronology, on which subject he published, in conjunction with Father Strassmaier, a valuable treatise some years ago.

The tenth International Congress of Orientalists was opened at Geneva on Tuesday. Fourteen Governments, and ninety-seven Universities or learned societies, have sent delegates to the meeting.

The International Congress of Hygiene and Demography is now being held at Budapest. We hope to give a report of the proceedings after the meeting has ended.

The Association Géodésique Internationale met at Innsbruck yesterday. M. Faye, M. Bouquet de la Grye, and M. Tisserand were delegated by the Paris Academy of Sciences to attend the meeting.

The International Meteorological Committee held its meeting, as arranged, at Upsala, August 20-24. M. Wild, the president, was unfortunately prevented from attending, owing to indisposition. M. Mascart was elected president for the meeting, and Mr. Scott, as usual, secretary; the other members present were Prof. v. Bezold (Berlin), Dr. Billwiller (Zürich), Mr. W. G. Davis (Cordoba), Dr. Hann (Vienna), M. Hepites (Bucharest), Dr. Hildebrandsson (Upsala), Prof. Mohn (Christiania), Dr. Paulsen (Copenhagen), M. Snellen (Utrecht), and Prof. Tacchini (Rome); the absentees were, in addition to the president, Admiral de Brito Capello (Lisbon), owing to health, and Messrs. Eliot (Simla), Ellery (Melbourne), and Harrington (Washington), owing to distance. The principal points dealt with at the meeting were as follows:—(1) The establishment of an International Meteorological Bureau was recognised as impracticable. (2) It was resolved to publish in the report of the meeting a *résumé* of the measures adopted in all countries to communicate to agriculturists meteorological results likely to be useful to them. (3) The acceleration of meteorological telegrams. It was decided to address the International Telegraphic Bureau at Berne on this subject. (4) The scintillation of stars as an indication of weather. A paper by M. C. Dufour will be reproduced in the report. (5) The study of clouds. This was the *pièce de résistance* at the meeting. The Cloud Committee, appointed at Munich in 1891, held a meeting at the same time as the International Meteorological Committee, and presented a report dealing with definitions for the ten classes (Hildebrandsson and Abercromby) adopted at Munich, and with instructions for cloud observations. They also proposed to prepare and issue an authoritative cloud atlas. This report was carefully discussed and, after modification, adopted. The members of the Cloud Committee who were present at the meeting, were Prof. Hildebrandsson, Dr. Hann, Prof. Mohn, Mr. A. L. Rotch (Blue Hill Observatory), M. Teisserenc de Bort. In addition, the following gentlemen were admitted, but without voting power: Prof. v. Bezold, Dr. Billwiller, and Mr. Davis (of the International Meteorological Committee), and Prof. Broounof (Kieff), Dr. Fineman and Dr. Hagström (Upsala), Prof. Riggenbach (Basle), Prof. Sprung (Potsdam), and M. Philip Weilbach (Copenhagen). (6) The subject of the treatment of the wet bulb below the freezing point was discussed, and the use of Ekholm's formula was recommended *ad interim*. (7) It was decided to arrange for a conference of the same character as that at Munich in 1891, which was not an official congress, to be held in Paris in September 1896. M. Mascart and Mr. Scott were requested to make the necessary preparations, such as the arrangement of the programme, &c.

The great pine forest region in the States of Minnesota and Wisconsin has been devastated by fire. There had been no rain in the district for nine weeks, and the trees had therefore become very dry and inflammable. Forest fires occurred in the early part of last week, but their advance was checked. On Friday, however, several fires broke out almost simultaneously, and the flames spread with alarming rapidity. Many towns and villages were entirely destroyed, and it is estimated that nearly one thousand lives were lost.

A recent number of the official organ of the National Department of Hygiene in Buenos Ayres, a copy of which has been sent to us, calls attention to a hygienic exhibition which is to be held in that city at the close of this month. The authorities hope that it may render important service in helping to establish a permanent museum of practical hygiene, besides stimulating public interest in sanitary questions generally. The journal also contains many useful notices of original work published in various foreign papers.

The current numbers of the *British Medical Journal* and the *Lancet* should be obtained by everyone desirous of entering the medical profession. They are almost entirely devoted to descriptions of the universities, corporations, and colleges which grant the degrees and diplomas required by a medical practitioner. Prospective students will find our contemporaries complete guides to the medical calling. They will also find that to succeed in this noble profession it is necessary that a man "should be imbued with a love of humanity and a love of science, and should be indifferent to the worship of the god of the modern world—the golden calf. No man whose aim is to make a fortune should dream of entering the medical profession. Let him learn the grocery business or the drapery business; he will not only fail in medicine, but will help to degrade it." These remarks are applicable to students of most branches of science.

Some years ago, an observatory was established on the Saint-Jacques tower in Paris, under the direction of M. J. Jaubert. The institution is of a private nature, but it is furnished with good instruments, and has from time to time issued useful bulletins. An interesting report upon the atmosphere of Paris is published in the supplement of *La Nature* of August 25, based on the observations made between July 1, 1891, and December 31, 1893, which shows very clearly the influence exerted on meteorological elements by a large mass of houses. M. Jaubert had compared the observations at his own observatory with those at the official observatory at Parc Saint-Maur, in the suburbs of Paris. The tables show that the variations of pressure between the two places are very small, but that temperature, especially towards the evening, is from 3 to 4° F. higher in the city, while the maxima and minima occur some hour or two later than in the country. The amount of cloud has this peculiarity, that during the evening the sky is clearer over Paris than in the suburbs. All other elements, rainfall, wind, &c., have been compared, and some interesting details as to visibility are also given. We published some time since (vol. xlix. p. 460) a similar comparison with reference to the temperature of Berlin. Such statistics are of great practical value, especially to persons living near large towns.

AMONG some of the old German legends concerning the weather, the recent meteorological conditions experienced in Göttingen and its neighbourhood have turned nearly everyone's mind to that very old one called the "seven sleepers," or "Die Siebenschläfer" That such a belief should still be held to these old legends is not to be wondered at, even in these days of forecasts, &c., for were they not to a great extent founded on real, although roughly observed, facts which had been noticed over the space of many years, and at last become legendised? The legend of the Siebenschläfer runs as follows:—Seven Christian youths, Maximianus, Malchus, Serapion, Dionysius, Johannes, Martinianus, and Konstantinus, in the reign of King Decius, 251, fled to the mountains because they would not follow the Jewish religion. In a mountain called Kalion, near Ephesus, they found a large cave, into which they entered, slept, and ultimately became shut in. It was not till the year 446, under the reign of Theodosius, that this cave was accidentally opened, and the seven sleepers woke up from their long sleep of nearly 200 years, Bishop Martin and the king being both witnesses to this wonder. The Christians died eventually surrounded with glory and honour. The saying which has come down to us to-day, and which, curiously enough, connects these holy men with the weather, is that, if it should rain on June 27, we must expect rain for the following seven weeks; this is for the Roman Church. In the Greek Church this day is held on August 4, while the "Acta Sanctorum" name July 27 for its remembrance. It may be of interest, however, to see whether the application of this old legend to the weather recently experienced holds good. Taking the Roman Church Calendar as our reckoning, and commencing on June 27, the seven weeks would then terminate on August 14. Unfortunately rain did not happen to fall on the 27th at the place in question, but records show that both the day before and after it was experienced. On the 29th and 30th also no rain fell, but with the exception of July 6, 29, and 30, rain has fallen daily until August 14. Thus from June 27 to August 14, both days inclusive, a period of 49 days, only six days were recorded without rain, but rain did *not* actually fall on the 27th. One infers from the legend that at the end of this period fine weather should be the order of the day, that is to say, if according to the "Sieben Brüdern" it did not rain on July 10. Unfortunately or not, as the case may be, 1·5mm. on 200 square cm of rain were recorded, which means, according to the latter legend, that it must rain for seven weeks after this date. At the time of writing, August 24 (7 p.m. Central European time), it has rained daily since the 14th, so that the "Sieben Brüdern" seems as if it will be verified. The meteorological records referred to above we owe to Herr A. Spörhase, meteorological observer at the Physical Institute, Göttingen.

AT a recent meeting of the Société Française de Physique, M. Bouty read a paper on the capacity of the capillary electrometer. The author supposes that the two quantities of mercury are brought to a difference of potential e, and that the surface of the mercury in the capillary is brought back to the zero by increasing the pressure, and that a quantity of electricity dQ is then supplied without changing the pressure. The capacity of the apparatus, under these conditions, consists, according to Lippmann's theory, of two parts, one term proportional to the square of $\frac{dA}{de}$ where A is the surface tension and represents the quantity of electricity absorbed or produced by the change in the form of the small surface of mercury, and has the preponderating influence when e is nearly zero. The other term which is proportional to $-\frac{d^2A}{de^2}$ is only of importance when A is near its maximum. In order to measure the capacity C which is equal to $\frac{dQ}{de}$ the author measures separately the corresponding values of δQ and δe within such limits that proportionality exists between these quantities. He produces a constant quantity of electricity (δQ) by means of a piezo-electric piece of quartz, and discharges it into the electrometer, whose capacity may be considered as infinite compared to that of the quartz. He then determines by means of a derivation on the circuit of the charging battery the increase δe of the electromotive force necessary to reproduce the same shift in the mercury as was produced by δQ. In every case the observed values agreed with those deduced by means of Lippmann's theory.

M. W. SPRING, who about fifteen years ago proved the possibility of welding metallic bodies by simple pressure at temperatures far below their fusing point, publishes an interesting extension of his researches in the *Bulletin de l'Académie Royale de Belgique*. He was led to the conclusion that at a certain temperature, where a metal is to all appearances a perfect solid, a certain proportion of the molecules attain a rate of vibration corresponding to the liquid state, and that these molecules, by softening the body, make it capable of welding and of producing alloys with other metals. The metals were put in the shape of cylinders bounded by plane surfaces, upon the purity of which great care was bestowed. They were then mounted in a stirrup, and pressed together by means of a hand-screw. In this state they were placed in a heating oven, and kept at a constant temperature between 200° and 400° for from three to twelve hours. The most perfect joints were produced with gold, lead, and tin, and the worst with bismuth and antimony. Two cylinders thus welded together could be put in a lathe, one of them only being held in the chuck, while the other was being worked upon by a cutting tool, without coming apart. They could be separated with the aid of pincers, but then a rough breakage was produced which did not coincide with the original plane of separation. It appears that the more crystalline the bodies are the less do they exhibit this phenomenon of incipient liquefaction, which begins to show in the case of platinum, for instance, at 1600° below its fusing-point. That such a liquefaction or softening actually takes place was proved by cutting a delicate spiral 0·2 mm. deep on the end surface of a piece of copper weighing 130 grammes, and placing it upon a sheet of mica. After keeping it at 400° for eight hours, the spiral had entirely disappeared, and the surface looked as if just fused before the blowpipe. Where two metals were employed, alloys were formed, which, in the case of lead and tin, were fusible and flowed out at 180°. By placing a perforated disc of mica between the two, the outflow could be prevented, but the alloy formed at the centre and the metals were hollowed out in the proportion of their degrees of liquefaction. In a lead-antimony couple, the hole in the lead was 8 mm. or 9 mm., and that in the antimony 2 mm. The most striking and novel experiments, however, were those showing the evaporation of metals, or rather their sublimation, at temperatures between 300° and 400°. This was also shown by inserting a disc of mica, say, between a zinc and copper couple at 360°. When air was carefully kept away from the surfaces, the copper was tinted a golden yellow over the area of the hole in the mica, the exact colour of tombac, and a brown layer was produced on the zinc, which chemical analysis proved to contain copper. Similar results were obtained with cadmium, the thickness of the mica being 0·8 mm.

WE have received a copy of the *Jahres-Bericht des Vereins fur Naturkunde of Mannheim*, in which a brief account is given of the proceedings of the Society during the years 1889–93 inclusive. It appears that in spite of the population of Mannheim having doubled itself during the past eighteen years, the Society has not increased in numbers. That it should have maintained a bare existence must be considered very creditable to the energy of its members, for we read that Mannheim, as perhaps no other commercial or industrial centre, possesses so few attractions in the shape of social or scientific intercourse that the inhabitants as soon as they can retire from work leave the city to settle elsewhere. A similar nemesis unfortunately overtakes some of our local naturalist societies, and Mannheim cannot claim the unique position ascribed to it by the president of its Naturkunde Verein! The greater part of the pamphlet is occupied by an elaborate paper, by Dr. Migula, entitled "Methode und Aufgabe der biologischen Wasseruntersuchung." The endeavour is made to build up a bacteriological standard of purity for water, not according to the number of microbes, but from an estimation of the particular varieties present in a given sample of water. We are not surprised to find Dr. Migula willing to resign this herculean task to others to work out.

MR. W. A. SANFORD read before the Somerset Archæological and Natural History Society, at its late meeting at Langport, a paper in which he announced his discovery, in the Rhætic beds at Wedmore, of a large Dinosaur. The animal appears to have been carnivorous, and, though very much larger, to have resembled *Megalosaurus Bucklandi* of the Stonesfield slate. The remains at present available for study are about twelve vertebræ, a large portion of the pelvis, some portions of the mandible, some teeth, a nearly complete femur, parts of a tibia and of both fibulæ, some phalanges, including a perfect claw-bone, and fragments of ribs and of other small bones, and other larger fragments that may be placed. The bones are accompanied by fossils of Triassic date, which render their geological position a matter of nearly absolute certainty. The results of a complete and close examination of the bones will be of considerable interest.

IN addition to a preliminary note on some new species of fish, belonging to the genera *Cyprinodon* and *Atherinichthys*, from the Mexican Seas, by Dr. F. Steindachner, the June number of the *Proceedings* of the Imperial Academy of Science of Vienna (1894, No. xv. pp. 147–154) contains a communication from Prof. Weisner upon the results of a physiological investigation upon some interesting points in the germination of the mistletoe and its European and tropical allies (*Viscum* and *Loranthus*). The author finds a considerable difference between the seeds of the European and tropical forms as regards their reaction to light and moisture, and as to the existence or duration of a "resting period." These differences and peculiarities, however, he is in all cases able to interpret as specific adaptations to differences in the natural conditions of life. The viscid envelope of the seeds in all the parasitic species is undoubtedly an adaptation for ensuring the attachment of the seed to the bark of its host; but Prof. Weisner regards its great development in the common mistletoe (*Viscum album*) as also serving to retard the process of germination. There is practically no resting period in the case of the tropical species, and in them the viscid pericarp is developed in much smaller quantity; and the seeds of our own *Viscum album* germinate most readily when freed from their mucilaginous investment. It is to be hoped that Prof. Weisner will publish before long a fuller account of his interesting researches, and that he will also incorporate some statements as to the effects of temperature upon the germination of the same seeds.

IN an elaborate paper "Étude expérimentale sur le charbon symptomatique" (*Annales de l'Institut Pasteur*), Dr. Duenschmann describes some extremely interesting and suggestive experiments which he has made on the effect of associating a virulent with a non-virulent micro-organism in animal inoculations. For this purpose the well-known bacillus *prodigiosus* was introduced into guinea-pigs along with the bacterium *Chauvæi*, the exciting cause of symptomatic anthrax. Under ordinary circumstances the latter microbe will kill guinea-pigs in eighteen hours, but, strange to say, its lethal action is delayed for four days, when it is associated with the *B. prodigiosus*. M. Roger already found that the rabbit, an animal not easily susceptible to symptomatic anthrax, may be readily infected if cultures of the *B. prodigiosus* are introduced along with the *B. Chauvæi*, and similar observations in the case of other disease microbes, associated with this harmless bacillus, have been made by others. Dr. Duenschmann, however, has carried his investigations still further, and has found that the *B. prodigiosus*, usually regarded as an innocent saprophyte, will, if used in sufficient quantities, kill guinea-pigs when introduced into the peritoneum. The chief interest of Dr. Duenschmann's experiments lies in the contribution which they afford to the important subject of the *associated* action of micro-organisms. The bacteriological study of disease has so far been mainly carried on with single varieties of microbes; but it must not be forgotten that in nature infection with a pure culture, or one variety of organism, is the exception and not the rule, and that in working with mixtures of micro-organisms we may obtain much important assistance in understanding the intricate and puzzling course run by so many diseases.

THE annual report of the Russian Geographical Society for the year 1893 is so full, that only in a publication specially devoted to geography would it be desirable even to enumerate the headings of its varied contents. All we can do is to mention the parts which possess general interest. Such are the remarks of M. Obrucheff on the Eastern Gobi between Urga and Pekin, which has the characters of a steppe, but not of a desert, as it receives a regular amount of rain in the summer, and is covered then with grass, while true deserts are found in small limited portions only of its vast area. M. Obrucheff's find of a skull of a rhinoceros, probably *Tichorhinus*, in the lake deposits of the Ordos, in latitude 38° N., is also worth mentioning. E. G. Fritsche's measurements of the magnetic elements in the neighbourhood of Moscow, where an anomalous distribution had been observed, show that the anomaly is due to the presence, at a depth which is estimated at ten kilometres, of large iron masses. M. Komaroff's measurements of the movement of the Zerafshan glacier and the exploration of its former much greater extension, as also his levellings in the Transcaspian territory in the region which is supposed to have been the *Area Palus* of the ancients, promise to yield very interesting results. The yearly reports of both the East and the West Siberian Branches of the Geographical Society are also full of geographical information. In East Siberia, M. Prein has explored the vegetation of the Olkhon Island in Lake Baikal, which offers great interest for its curious mixture of species characteristic of the steppes with purely forest species, and which also contains a number of varieties, either unknown or intermediary between different formerly known varieties. In West Siberia, we notice the steady work of the Meteorological Committee which opened last year, in connection with the Central Meteorological Observatory, eight stations in different parts of the territory; M. Siyazoff's work on the flora of the Ishim Steppes, and its comparison with the flora of Tyumen, at the eastern slope of the Urals; M. Katanaeff's larger work on the Kirghiz Steppes; and Slovtsoff's, on the Pelym region and on the Siberian cedar—all published in the memoirs of the West Siberian branch—are also of interest.

A report, showing the distribution and production of some of the most important minerals worked in India, has been issued by the Department of Revenue and Agriculture of the Indian Government.

The principles of the manufacture of steel are ably described in "Fabrication de la Fonte," by M. E. de Billy, the volume being the latest addition to the Aide-Mémoire series published jointly by Gauthier-Villars and Masson.

The fifth part of Kerner and Oliver's "Natural History of Plants" (Blackie) has been published. Its contents refer to metabolism and the transport of materials, and to the growth and construction of plants.

We have received a paper "On the Analytical Treatment of Alternating Currents," read by Prof. A. Macfarlane before the International Electrical Congress held at Chicago a year ago, and reprinted from the Congress' *Proceedings*.

All regulations referring to the registration and inspection of classes held in connection with the City and Guilds of London Institute are given in the "Programme of Technological Examinations" just published for the Institute by Messrs. Whittaker and Co.

Under the title "Peregrinazioni Psicologiche," U. Hoepli, of Milan, has published a collection of psychological papers by Dr. Tito Vignoli, Professor of Anthropology in the R. Accademia Scienze e Lettere di Milano, and Director of the Museo Civico di Storia Naturale.

The September number of *The Country Month by Month*, by Mrs. Owen and Prof. Boulger, appears to us to be better than some that have preceded it. The poet-naturalist will find the authors' descriptions of autumnal plant and bird life greatly to his liking. Some parts of the book are really very fine. Messrs. Bliss, Sands, and Foster are the publishers.

The Manchester Microscopical Society, with a membership of 245, ranks high among provincial scientific societies. Several interesting papers are printed in the *Transactions* of the Society for 1893. Among these we note the address of the president, Prof. F. E. Weiss, on recent researches and speculations on the structure of protoplasm; a paper on modern views of the plant cell, by Mr. Thomas Hick; and one on the organic forms of silica, by Mr. W. Blackburn. A useful summary of information on the plans of growth and the forms of Foraminifera is contributed by Mr. E. Halkyard; and a survey of typical examples of some common microscopic fungi is given by Mr. A. T. Gillanders. These papers show that interest in the Society is still maintained.

The Meteorological Sub-Committee of the Croydon Microscopical and Natural History Club is doing good work by the collection of rainfall statistics; its report for 1893 contains daily and monthly values for sixty-three stations in the counties of Kent and Surrey. The Hon. Sec., Mr. F. C. Bayard, points out that the smallness of the total rainfall during the year is very remarkable. The average yearly fall for Greenwich for seventy-five years (1816–90) is 25·11 inches; but in the year 1893 there was a deficiency of 5·02 inches, which quantity nearly represents the deficiency of the district dealt with by the Club. Most of this deficiency, viz. 4·77 inches, occurred during the first six months of the year.

The additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mr. Darent McDonald; a Pinche Monkey (*Midas œdipus*) from New Granada, presented by Lieut. W. N. Gordon, R.A.; a Puma (*Felis concolor*) from Argentina, presented by Mr. Ponsonby Ogle; a Stone Curlew (*Œdicnemus scolopax*), British, presented by Colonel H. W. Fielden; two Poe Honeyeaters (*Prosthemadera novæ-zealandiæ*), from New Zealand, presented by Mr. Reginald Moorhouse; an Elephantine Tortoise (*Testudo elephantina*) from the Seychelles, presented by Mr. Arthur Gladstone; two Hawks-billed Turtle (*Chelone imbricata*) from the East Indies, presented by Captain E. Fleetham; a black-headed Lemur (*Lemur brunneus*) from Madagascar, five Meyer's Parrots (*Pœocephalus meyeri*) from East Africa; two Brown-throated Conures (*Conurus æruginosus*) from South America, deposited; two Javan Wild Swine (*Sus vittatus*) from Java, presented by Mr. E. J. Kerkhoven.

OUR ASTRONOMICAL COLUMN.

Recent Observations of Mars.—Mr. John Ritchie, jun., has kindly sent us a cutting from the Boston *Commonwealth* containing some observations of Mars, made at the Lowell Observatory, Arizona, since those recorded in our issue of August 16. The staff of the observatory includes Mr. Percival Lowell, Prof. W. H. Pickering, and Mr. E. A. Douglass. Mr. Lowell himself communicated the following observations to the *Commonwealth*: July 5. Both Pickering and Douglass observed that the terminator was flattened in a certain place. Light from the Sabaeus Sinus was found to be polarised. July 19. Douglass observed a protuberance on the terminator, and a notch. The height of the former was estimated at 0″·1, which suggests an elevation of about five-eighths of a mile. July 20. The notch seen by Douglass was confirmed by Pickering. July 21. Douglass saw two notches which were afterwards confirmed by Pickering. July 23. Other notches on the terminator observed by Douglass. July 26. A large protuberance observed by Pickering. The light from the larger "lakes" found to be unpolarised, even when near the limb of the planet. (Mr. Ritchie points out that the projection seen by Pickering was in all probability the one seen by Javelle at Nice, on July 28.) The first observation of a canal, Eumenides, was made on June 6 by Pickering. The same channel was seen by the other observers on June 7, and appeared persistently on June 9. During the whole of June and July the snow-cap diminished in size. On July 10, a minute patch of white, in the position of the former star-like points, was seen as a difficult object, entirely detached from the snow-cap. On July 18, Pickering reported that the cap had materially diminished, and that the canals were coming out more clearly. He had some views of clouds and glimpses of some of his "lakes." Early in August he reported that he had seen seventeen of these lakes, two of them new. By the end of June the canal Ganges was seen twice, and both times single. July 29, a light grey tint was seen on an extended region. Some canals were well developed, no duplication visible. July 30, early in the evening, with the seeing 4 and 3 on a scale of 10, Pickering thought he saw Ganges double. Later in the evening, when the seeing had improved to 8 and 9, it was evident that such was not the case. The apparent double was a canal from Fons Juvente and a north branch of Tithonus. The latter observations have an interest, since the canal Ganges has been reported as having been seen double at the Lick Observatory.

A circular just distributed by the Centralstelle für Astronomische Telegramme, Kiel, states that a telegram, of which the following is a translation, was received from Teramo on August 31:—"Greenish-white spot on the northern cap of Mars. Length thirty to forty degrees. *Nix borea* apparently covers *Mare acidalium*. Cerulli."

THE MASS OF JUPITER.—It was more than twenty years ago, Prof. Simon Newcomb reminds us in the *Astronomische Nachrichten* No. 3249, that he called attention to the great value of observations on the minor planet Polyhymnia for determining the mass of Jupiter. Prof. G. C. Comstock's computations of the special perturbations of the elements of the former planet from the date of discovery in 1854, together with the observations made during the opposition of 1888, have enabled Prof. Newcomb to make this determination. The result obtained shows that the mass of Jupiter is $\frac{1}{1047 \cdot 34}$ part the mass of the sun. Other determinations of Jupiter's mass are shown in the following table, and also the weights assigned to them by Prof. Newcomb, who proposes to regard the weighted mean as definitive, and to use that mass in his work on the planetary theories.

	Jupiter's Mass.	Weight of Determination.
All observations on the satellites ...	1047·82	... 1
Action on Faye's Comet (Möller) ...	1047·79	... 1
Action on Themis (Krueger) ...	1047·54	... 5
Action on Saturn (Hill)	1047·38	... 7
Action on Polyhymnia	1047·34	... 20
Action on Winnecke's Comet (v. Haerdtl)	1047·17	... 10
Weighted mean	1047·35	± 0·065

It is pointed out that in the interests of the astronomy of the future, it is very desirable to apply Gill's heliometer method to the continuous observation of a selected number of minor planets.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE forty-third annual meeting of the American Association for the Advancement of Science was held at Brooklyn, N.Y., from August, 16–22.

The marvel is that no meeting had previously been held in that great city. Overshadowed as it is by the greater metropolis of New York, its next neighbour, many strangers fail to realise that Brooklyn is one of the great cities of the world. By a recent act of the legislature its area has been doubled, and its population now exceeds one million, making it the fourth city in America; until the last census it was the third, but Chicago has now outstripped it.

Not merely as a portion of the metropolis of America, but also in those features which are distinctively peculiar to itself, Brooklyn offers unrivalled attractions to men of science. The massive bridge which spans the East River, connecting it with New York, is a world-renowned triumph of engineering. The United States Navy Yard attracts the attention of those who study applied science, and eleven thousand manufacturing establishments provide valuable object-lessons.

The city is also notable for educational institutions of the best character, including the Pratt Institution, the Packer, the Polytechnic, the Long Island Medical College, the Hoogland Biological Laboratory, a large and well-equipped High School for each sex, and several Roman Catholic Seminaries.

A marked feature of recent meetings of the Association has been the increasing number of affiliated societies which hold meetings in connection with the general Association. Two new accessions bring the number of these already up to nine, and next year the American Botanical Society will still further swell the list, which now includes the American Mathematical Society, the Society for Promoting Engineering Education, the Society for the Promotion of Agricultural Science, the American Microscopical Society, the Geological Society of America, the Association of Economic Entomologists, the American Chemical Society, the Association of State Weather Services, and the American Forestry Association.

The citizens of Brooklyn entered into the arrangements with an evident determination to do everything to insure the success of the meeting. The reception at the Academy of Music and the Art Building, on the opening evening, was perfect in all its details. The excursions were of unusual number and variety, and included features of exceptional scientific interest, such as dredging expeditions by the steamer *Fish Hawk*, furnished by the United States Government. Special mention is also due to the elegant excursion to West End, and entertainment furnished by Mrs. Herrman, a patron of the Association, and of the sterling silver badges of her own design given as souvenirs.

The weather continued cool and comfortable throughout, so that all the external conditions were as favourable as possible. Teleologists even found evidence of providence and prevision in the unusual circumstance that nine century plants bloomed together to welcome the coming Association.

The attendance of members was well above the average of recent years, and if to the registry of the general Association be added the names of specialists attending the affiliated societies, it will raise the total to an aggregate comparing favourably with the largest meetings, notwithstanding that the depression of business and the fear of detention by railroad strikes exerted a deterrent influence.

Three evenings were occupied with popular scientific lectures. Paul du Chaillu spoke on the Vikings, their civilisation and expeditions; Edward D. Cope, on the relation of human structure and physiognomy to those of the other mammalia; and B. E. Fernow, on the battle of the forest.

The annual address of the retiring president, Prof. William Harkness, was on the magnitude of the solar system. An exhaustive account was given of the various methods of measuring the sun's distance. Many of Prof. Harkness' hearers were surprised to learn that but little accuracy has been attained for many years. He states as his conclusion after comparing all the corrected results of these various methods, that the sun's distance is 92,797,000 miles with a probable error of 59,700, and the diameter of the solar system, measured by that of its outermost member, the planet Neptune, 5,578,400,000 miles.

The address of Vice-President George C. Comstock, on binary stars, was of interest, as will be seen from the following extracts. After a general review of the subject, he said that the orbits of forty-two binary stars based on motion of over 80° have been computed. The shortest are δ Equulei and κ Pegasi, each less than twelve years.

ζ Cancri presents a curious study. Two stars less than a second apart revolve in an ellipse; a third star 6″ distant revolves in loops, suggesting an invisible companion. Four binaries have been discovered by the spectroscope: β Aurigæ, revolving in a period of four days; α Virginis, four days; ζ Ursæ Majoris, 105 days; and Algol, three days.

The masses of the visual and of spectroscopic binaries are derived by totally different methods, but both classes of bodies indicate that the sun is an undersized star, a result that is confirmed by other and independent lines of investigation. The small range of values presented by the masses of the stars is remarkable, and points to an unexplained uniformity of size in the heavenly bodies, the average component of a double star having a mass somewhat greater than the mass of the earth.

If binary stars are classified with respect to their type of spectrum, it will be found that on the average the distance of a star possessing a Sirian spectrum is about three times as great as that of a star possessing a solar spectrum, and it will further be found that although stars of the Sirian type are, on the whole, more numerous than solar stars, binaries of solar type outnumber their Sirian fellows three to one.

Four-fifths of the binaries, with periods of less than two hundred years, have orbits smaller than Neptune, while the fastest have orbits between Jupiter and Saturn.

A combination of measured amounts of light with elements of orbit is mass-brightness, or "candle-power per ton" (Young). γ Leonis has more than 1000 times the mass-brightness of 61 Cygni—probably. Confining ourselves to those with well-determined orbits, we find at extremes of the list ϕ Ursæ Majoris, with a mass-brightness fifty-times that of 70 Ophiuchi. The mass-brightness of the sun is probably not much greater than that of 70 Ophiuchi.

It has long been known that if the components of a double star are of approximately equal brilliancy, they are of the same colour, and if of unequal brilliancy the colour of the fainter companion lies nearer to the violet end of the spectrum than does the colour of the brighter one. The spectra of the stars furnish a partial explanation of their difference in colour by showing, in at least some cases, that the stars possess spectra of different types, the fainter companion having a Sirian, and the brighter one a solar spectrum.

Few researches upon double stars exceed in theoretical interest the mathematical investigations of Mr. See with regard to the mode of development of these bodies. As early as 1878, Doberck had shown, from a statistical comparison of double star obits, that, in general, the longer the period of revolution of the compounds the larger and more eccentric are their orbits. That the orbits would be larger might be expected as a consequence of the law of gravitation, but it required a special investigation based upon the theory of tidal friction, as developed by Prof. G. H. Darwin, to show that the increasing eccentricities are also a necessary consequence of the same law. The conclusions of Mr. See may be briefly summarised as follows:—If we suppose the components of a double star to be composed of a plastic material, they will produce in each other bodily tides whose effect will be to push the stars asunder, and at the same time to increase the eccentricity of their orbits. This increase of eccentricity will not continue indefinitely, but in the later stages of developments will give way to a diminution of the eccentricities, which will ultimately produce circular orbits. But since the energy of the star is being constantly wasted by radiation, it will, in the later stages of its career, be reduced to invisibility, and during the period of its existence as a luminous body its history will present a continuous increase in the size and eccentricity of its orbit. It is of interest to note in this connection that the two orbits of spectroscopic binaries which have been computed, present eccentricities very much less than that of the average double star orbit, while the dimensions of their orbits are so small as to suggest an early stage in the development of the systems.

Prof. Wm. A. Rogers year by year brings to the Association either new and more refined apparatus, or the result of delicate experiments with the perfected apparatus already at his command. This year he presided over the Section of Physics, and read an elaborate address on obscure heat as an agent in producing the expansion of metals under air contact.

Vice-President Thomas H. Norton addressed the Chemical Section, on the battle with fire; Mansfield Merriman, the Engineering Section, on paradoxes in the resistance of materials; Samuel Calvin, the Geol gical Section, on some points in geological history illustrated in North-eastern Iona, exhibiting and using American chalk obtained from the Niobrora beds; Lucien M. Underwood, the Botanical Section, on the evolution of the Hepaticæ, a subject to which he has devoted especial attention, and on which he is probably the foremost authority; Franz Boas, the Anthropological Section, on human faculty as determined by race; and Henry Farquhar, the Economic Section, on a stable monetary standard.

One hundred and seventy-eight papers were read before the Sections, the largest number being before the Section of Anthropology.

It was decided to visit San Francisco next year if suitable rail rates can be secured, and the date of meeting recommended is June or early in July. Definite action, however, was deferred, owing to the expense of crossing the continent, so that time may be taken to apply for special rates of fare.

The following officers for the ensuing year were recommended by the nominating committee, approved by the council, and elected by the Association:—

President, E. W. Morley, Cleveland. Vice-presidents: Mathematics and Astronomy—E. S. Holden, Lick Observatory. Physics—W. Le C. Stevens, Troy, N.Y. Chemistry—William McMurtrie, Brooklyn, N Y. Mechanical Science and Engineering—William Kent, Passaic, N.J. Geology and Geography—Jed. Hotchkiss, Staunton, Va. Zoology—D. S. Jordan, Palo Alto, Cal. Botany—J. C. Arthur, Lafayette, Ind. Anthropology—F. H. Cushing, Washington, D.C. Economic Science and Statistics—B. E. Fernow, Washington, D.C.; permanent secretary, F. W. Putnam, Cambridge, Mass.; general secretary, James Lewis Howe, Louisville, Ky.; secretary of the council, Charles R. Barnes, Morrison, Wis. Secretaries of the Sections: Mathematics and Astronomy—E. H. Moore, Chicago, Ill.; Physics—E. Merritt, Ithaca, N.Y.; Chemistry—William P. Mason, Troy, N.Y.; Mechanical Science and Engineering—H. S. Jacoby, Ithaca, N.Y. Geology and Geography—J. Perrin Smith, Palo Alto, Cal. Zoology—S. A. Forbes, Champaign, Ill. Botany—B. T. Galloway, Washington, D.C. Anthropology—Mrs. Anita Newcombe McGee, Washington, D.C. Economic Science and Statistics—E. A. Ross, Palo Alto, Cal. Treasurer, R. S. Woodward, New York.

WM. H. HALE.

THE IRON AND STEEL INSTITUTE.

THE summer meeting of the Iron and Steel Institute has been held this year, for the second time in the history of the Institute, in Belgium, the former meeting in that country having taken place at Liège just twenty-one years ago.

This year's meeting commenced on Monday, August 20, and continued until the following Friday. The President of the Institute, Mr. E. Windsor Richards, presided throughout. The proceedings commenced on the evening of the first day by a reception of members at the beautiful and historic Hôtel de Ville at Brussels, the civic authorities being the hosts. The proceedings were of an exceptionally successful character. On the following morning, Tuesday the 21st ult., the first sitting for the reading of papers was held. The following is a list of the contributions submitted:—

(1) "On the Use of Caustic Lime in the Blast-Furnace," by Sir Lowthian Bell.

(2) "On the History of Crucible Steel," by R. A. Hadfield.

(3) "On the Coal-mining Industry of Belgium," by A. Briart, President of the Society of Engineers, Hainaut.

(4) "On the Iron and Steel Industries of Belgium," by A. Gillon, President of the Society of Engineers, Liège.

(5) "On the Influence of Aluminium upon the Carbon in Ferro-Carbon Alloys," by T. W. Hogg, of the Newburn Steel Works.

(6) "On the Manufacture of Open Hearth Steel," by J. A. Lencauchez, Paris.

(7) "On Colour Gauges for Carbon Determinatioo," by W. G. McMillan.

(8) "On Electrical Power in Belgian Iron Works," by D. Selby Bigge.

(9) "On the Manufacture of Coke," by the late R. de Soldenhoff.

(10) "On the Iron Ores of the Mediterranean Seaboard," by Arthur P. Wilson.

The papers of Mr. Hadfield and the late M. de Soldenhoff were taken as read.

The members were received in the Burse des Métaux, where the sittings were held, by M. Gillon and M. Briart, on behalf of the reception committee, and the usual complimentary speeches having been made, business was commenced by the reading of M. Gillon's paper. The title sufficiently indicates the scope of this contribution, and it is evident that an abstract such as, in any case, we could give here would be quite inadequate to so large a subject. The same remark applies to M. Briart's paper, which followed. Both contributions are of considerable interest from an industrial point of view: the first because the Belgians are such keen and successful competitors of our own iron and steel manufacturers in some branches of the industry, and the second from the fact that the coal-mining practice of the Belgians is of a very advanced character. Coal is won in Belgium often under conditions of extreme difficulty, such indeed as would cause despair to mining engineers in our own more favoured land, though doubtless we should rise to the occasion were the necessity put upon us. The natural obstacles which the Belgian engineers are forced to meet have necessitated the highest skill in mining practice, and we cannot but look with admiration at the patience, ingenuity, and skill displayed in the working of many collieries of the country. Sir Lowthian Bell's paper followed. The controversy regarding the respective merits of using caustic lime or raw limestone in the blast furnace is one of much antiquity, and though Sir Lowthian's paper did not perhaps do very much in itself to determine the dispute, it may be said that the paper and the discussion together served to determine the lines upon which the controversy should be carried on. The author said that in the older type of blast furnace it was a desirable thing to calcine the limestone separately, but with the higher furnaces now in vogue there was, on the balance, practically no advantage. In the discussion which followed, Mr. Charles Wood said that when iron ore and limestone were calcined together there was a distinct gain. We gathered from Sir Lowthian's reply to the discussion that he had not tried the plan Mr. Wood referred to—and which the latter had been following for twenty-five years—but that he would make further experiments on those lines. Perhaps the most striking feature in connection with this paper and discussion is its illustration of the value of societies of the nature of the Iron and Steel Institute. Here we have one practical detail which cheapens the cost of iron-making—at least, that is the opinion of a very competent ironmaster—in use for years, and it might have remained unknown to the majority of manufacturers had not the fact been elicited in this discussion. If Mr. Wood be right in his contention, he will doubtless receive confirmation from Sir Lowthian Bell at a subsequent meeting.

Mr. Hogg's paper followed, and in it were given the results of a large number of experiments, from which the author concluded that in the purer classes of iron the tendency of carbon to be retained in a combined state is prevented by the addition of 1 per cent. of aluminium, but curiously enough every increase above that percentage has an opposite tendency. It was also stated that the more rapidly cooled ferro-carbon alloys containing aluminium also contain a larger proportion of graphite. A short discussion followed the reading of this paper, and the meeting was then adjourned until the next day.

On the members reassembling on the following day, Wednesday, August 22, Mr. Selby Bigge's paper was first read. The author gave some interesting particulars of the progress that has been made in Belgium in using electricity as a means of distributing power in factories and workshops. The question has become one of commercial expediency, and the author boldly attacks it from this point of view, stating that his "whole contention in advocating electricity as the right and proper agent of operating new works, and as a means whereby old works can be remodelled, may be summarised by the one word 'economy.'" As an instance in point, he quoted the National Arms Factory at Herstal, near Liège. These works were recently founded to execute, in the first instance, an order for 200,000 rifles, the production being guaranteed at 250 rifles every twelve working hours. The Compagnie Internationale d'Electricite supplied the electric power installation, laying down thirteen motors, ranging between 16 and 37 horse-power, and giving a total of 260 horse-power. For the former size of motors they guaranteed a commercial efficiency of 87 per cent., and for the latter 89 per cent. The total power of the motors (260 horse-power) would therefore be obtained by 296·9 initial horse-power. There was a large amount of electric lighting to be done also, so that an engine and dynamo of 500 horse-power was installed. The ratio between the electric energy available and the energy transmitted to the shaft by the engine was guaranteed to be 90 per cent. The electric motors drive the line shafting of the machines, and the efficiency of transmission—that is to say, the ratio between the power available and the effective horse-power developed by the steam engine—is given by the product of three efficiencies, as follows:

90 per cent. for the dynamo, 98 per cent. for the conductors, and 87 per cent. for the motors = 76·6 per cent. The installation has now been running for three years without being the cause of cessation of work for a single minute.

It is a very difficult matter to form comparisons between the respective efficiencies of different methods of power distribution, and it may be pointed out that in the Herstal case the electric system does not appear to its greatest advantage, as the motors drive line shafting in place of being attached directly to the machines. There is no doubt, however, that a very strong case can be made out for electricity, and electrical engineers may look forward with confidence to a large extension of their field of activity in regard to power distribution.

The paper of M. Lencauchez dealt with a novel description of open hearth furnace in which jets of air and gas appear to be blown on the bath of molten metal to assist oxidation. The device did not receive much commendation in the discussion which followed the reading of the paper, but in the absence of illustrations referred to by the author, it was very difficult for those who had not had the advantage of seeing the furnace to follow the description.

The paper of Mr. McMillan, on colour gauges, was read in brief abstract, and Mr. Wilson's paper was also considerably curtailed in delivery, the time of the meeting having expired.

There were several excursions in connection with the meeting. The first, on the Tuesday afternoon, was to the Antwerp Exhibition, and on Wednesday evening members were received by the King of the Belgians, at the Royal Palace in Brussels. This was the chief feature of the meeting, the King receiving his guests in person, and apparently thoroughly enjoying the many conversations he had with the English metallurgists and engineers present. On the Thursday and Friday of the meeting, visits were paid to steel works, collieries, glass works, and engineering establishments. The last excursion on the list was to the important works known as the Société Cockerill at Seraing, near Liège. These works date from the beginning of the century, having been founded by a British subject, we believe a Scotchman. At present 5500 workmen are employed. According to particulars given to members in the shape of a handbill, there are five blast furnaces, an open steel plant, a basic steel plant, 250 coke ovens, 40 puddling, 15 reheating furnaces, 10 rolling mills, 3 foundries, 9 winding engines, 5 pumping engines, 4 blowing engines, 28 engines for rolling mills, 204 machine tools, 14 locomotives, and 184 steam boilers supplying 17,000 horse-power. The Company has also a shipbuilding establishment at Hoboken.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE meeting of the Association this year was a memorable one for physiology, since this subject was for the first time placed by the Council on an independent footing. This action of the Council has been amply justified by the success of the new Section I, there being a very representative attendance of English and continental physiologists, and great wealth of material for their consideration. The number of papers was so large that even when the sittings were extended to the final Wednesday morning, the business of the Section could only be got through with difficulty, and the opinion of all concerned was emphatic as to the high quality and great interest of many of the communications. In addition to the sectional meetings, advantage was taken of the presence of so many physiologists to dovetail a meeting of the Physiological Society into the proceedings; this was held on Saturday afternoon, when several interesting communications were made, and the meeting was followed by the dinner of the Society in Magdalen College, under the presidency of Prof. Burdon Sanderson.

The following summary will furnish a general account of some of the chief points in the many varied papers read before this Section:—

Thursday, August 9.—The proceedings opened with a communication by Mr. M. S. Pembrey, on the reaction of animals to changes of external temperature. The observed reaction was that of the production of heat, this being estimated by the amount of CO_2 discharged from the animal. Experiments upon the mouse were described, which showed that in proportion as the external temperature was lowered, the CO_2 output of the animal was rapidly increased (in one minute the increase amounted to 60 per cent. when the temperature fell from 33° to 17 C.), and concurrently with this increase the animal's muscular activity became far more vigorous. Experiments made upon the developing chick showed that up to the twenty-first day the effect of external cold was to decrease the CO_2 output, the chick in this stage behaving like a cold-blooded animal, but that a comparatively sudden change took place from this day onwards, the chick reacting like the warm-blooded animal previously referred to. This change in reaction is probably related to the development of the neuro-muscular mechanisms, and is undoubtedly influenced by the activity of the animal. Observations made upon newly-hatched pigeons showed that these birds, being more or less helpless when hatched, react for the first few days like cold-blooded animals, the output of CO_2 decreasing with a fall in the external temperature; it is probably for this reason that these young birds are kept warm by the parent until their muscular activity is more developed. The influence of the muscular activity upon the production of heat was further shown by details of observations made upon mice after section of the spinal cord, as well as during anæsthesia; in both cases the muscular paralysis was accompanied by a change in the reaction, which now resembled that of a cold-blooded animal.

Mr. Harris described the results of an investigation into the muscular rhythm of voluntary tetanus in man. The muscle thrill during contraction was ascertained by recording the continuous contraction in a great variety of ways, as well as by ascertaining through a suitable telephone and microphone the muscle note. The observations confirmed in the main those of Schafer and of Griffith, and indicated that the thrill was due to a muscle vibration, the rate of which varied from 10 to 15 in the second, with an average of about 12 or 13 vibrations.

Prof. Allen gave a short demonstration of mirror writing.

Prof. McKendrick showed a phonograph, and demonstrated some of its effects to the audience. He explained the working of the instrument and the means by which he was now endeavouring to adapt it for such physiological investigations as those connected with the nature of the vowel and consonant sounds, and those in which it was desirable to obtain a permanent record of the cardiac and respiratory sounds. He then showed a new model, constructed by himself, to illustrate a possible mode in which the essential structures of the basilar membrane of the cochlea might be supposed to respond to compound tones. The model consisted of a glass box containing two cavities separated by a horizontal membrane and filled with liquid, the box communicating with the exterior by two apertures covered by membrane analogous to the fenestræ ovalis and rotunda. Two pistons rested by their bases on the horizontal membrane, and could be arranged of such size and weight that their periods of vibration should be as 1 : 2. In this scheme it was shown that in accordance with the rate of vibration communicated to the liquid the two pistons responded in variable amounts, thus analysing the wave in the liquid.

Prof. Gaule showed microscopic specimens and slides illustrating the remarkable changes observed by himself as following the section in the rabbit of the inferior cervical sympathetic ganglion or its branches. After a definite lesion these changes were found to be localised in particular muscles and special parts of the nervous system. Thus he found that after section of one branch of the ganglion the observed changes occurred in the rami communicantes, the lower cervical spinal cord, the anterior roots of the brachial plexus, and the biceps muscle of the forelimb. He considered that the changes indicated trophic disturbances in the affected parts due to the lesion, and showed muscles in which the substance had suffered at various points the alteration in question.

Prof. Haycraft described an extensive research which he had made upon the development of the kidney, and showed a large number of micro-photographs to illustrate his remarks. The examination of continuous series of sections through this organ in different stages of its early growth, had convinced him that both the glomerular and tubular portions of the gland substance were formed as ingrowths from the same epithelium, viz. that lining the genito urinary canal. The view thus advanced as to the development of the kidney makes it analogous to that of other glands in opposition to former opinions.

Friday.—The Section commenced with the opening address of its President, Prof. Schäfer. This was followed by a communication by Prof. Heger, on the unequal diffusion of poisons into the organs of the body. In this paper an account was given of some of the chief means by which the organism was continually struggling against toxic substances, the principal objects to be effected being either the elimination of the unaltered poison, its neutralisation, or its destruction. The neutralisation might be either a true chemical combination, as in the case of CO_2, or a physical localisation in some special organs which could endure this excess, and so remove it from the rest of the organism. Thus morphine, if given in a series of increasing doses, accumulated in the liver, spleen, and marrow of the bones. In the case of microbic poisoning, Prof. Heger, whilst admitting that the constant multiplication of the microbes necessitated the destruction of the poison by phagocytosis, &c., pointed out that some such process of neutralisation as that just referred to was not only a possible but a probable antecedent to this destruction. Thus the liver cells and their secretion or extract appeared to have exceptional antitoxic properties. Experiments were quoted which showed the extent to which the frog's liver could not only retain and digest such poisons as hyoscyamine, but actually utilise the products derived from them as a food supply for the organ.

Mr. Hurst explained a new hypothesis as to the mode in which he conceived the organ of Corti and adjacent structures might be supposed to be affected by such alterations of pressure in the endolymph as must be produced by sound waves.

Prof. Schäfer showed photographs to illustrate a research made by Dr. Oliver and himself as to the functions of the suprarenal bodies. The photographs were chiefly those of tracings indicating the blood pressure, the heart beats, and the volume of the blood-vessels in such localised parts as a limb or the kidney. The injection of suprarenal extract was seen to cause a great rise of blood pressure, due not to any modification in the heart beat, but to the constriction of the blood-vessels, this constriction being dependent upon the integrity of the central nervous system.

Prof. Rutherford showed the result of an extensive series of observations in which the reaction time was measured for sight, hearing, and touch. The stimulus for the ear was the response of a telephone to a current, that for the eye the movement of an electro-magnetic signal, and that for the touch an induction current sent through the skin; the stimulus in all cases being made by the closure of a circuit. The response of the individual was the break of a current sent through a suitable electro-magnetic recording arrangement. By means of the pendulum a large series of records were obtained, in which as the initial starting-point occurred always at one place, and the different observations were arranged in series beneath one another, a comparison between different reaction times was rendered very conspicuous. He found that with eight intelligent men of ages varying from 19 to 62, the time for sight varied from $\frac{16}{100}$ to $\frac{42}{100}$ second, for hearing, $\frac{14}{100}$ to $\frac{19}{100}$, for touch, $\frac{14}{100}$ to $\frac{19}{100}$. The shortest reaction times were obtained when the response was that of the hand on the same side of the body as the ear or cheek which was stimulated.

Mr. D'Arcy Power showed a series of preparations of the conjunctival and vaginal mucous membranes taken from rabbits and guinea-pigs which had been subjected to mechanical and chemical irritation. Many of the epithelial cells presented appearances which were identical with those described as being parasitic when they were met with in cancer. The changes in the epithelium were summarised as a general vacuolation of cells; various forms of intracellular œdema; epithelial "pearls," collections of leucocytes, and the spaces left after these leucocytes had migrated. The series of preparations shown on the present occasion indicated that many squamous epithelial cells had the power of phagocytosis, for in no other way could the remarkable intracellular appearances be explained; cells were shown containing a leucocyte, and others containing a microcyte. Partial necrosis of the cell also took place as a result of irritation, and there was an invasion of large eosinophile cells into the conjunctival epithelium.

Saturday.—Prof. Hermann gave a most interesting communication upon the production of vowel and consonant sounds. His investigations were made by means of the phonograph, the excursions of the stylus being magnified, for which purpose a small mirror was attached to this part, and the character of its movement recorded by photographing the reflection in the mirror of a beam of light. Observations were also made in which a special telephone was introduced, thus rendering the excursions still larger. Numerous photographic records of various vowel and consonant sounds were exhibited, and each was seen to produce its own characteristic tracing. A matter of much theoretical interest in connection with the previous work of Helmholtz and others, was the character of the tracing when the same vowel sound was sounded in notes of different intensity but of similar pitch, or *vice versâ*.

Prof. Fredericq showed a new aerotonometer and gas pipette, which he had made in order to investigate the causation of the gaseous interchange between the blood and air of the lungs. By means of this apparatus the tension of the gases in these two media had been ascertained, and the results were laid before the Section. These furnished, in the author's opinion, material for criticising the view advanced by Prof. Bohr, that, as the Oxygen tension in the circulating blood often exceeded, whilst the CO_2 tension fell short of, that in the pulmonary air, the interchange could not be brought about in accordance solely with the laws of diffusion, but must be largely modified by the special vital activity of the lung epithelium. Prof. Fredericq's observations led him to believe that the data upon which Bohr's conclusions were founded, might be more or less incomplete owing to the time allowed for the contact between the blood and the air of the aerotonometer being too short in Bohr's apparatus for the correct determination of the tension of the O and CO_2 in that liquid. Fredericq's apparatus allowed of a long time, two hours, for the determination, and he had never obtained as low a tension of CO_2, nor as high a tension of O, in the blood as

Loewy had found. He therefore concluded that the diffusion hypothesis was adequate to account for the interchange. Dr. Haldane, replying to the above, pointed out that the criticism did not affect those experiments of Bohr's in which the ærotonometer CO_2 tension, although made initially higher than that in the pulmonary air, yet fell in the course of an experiment to a value much below the latter.

Mr. L. Cobbett and Mr. Melsome brought before the Section the results of an investigation on the production of local immunity through a localised specific inflammatory condition. It appeared from the authors' experiments that an attack of erysipelas localised to the ear of the rabbit conferred upon that organ an immunity against subsequent inoculation by the erysipelas organism so long as there was any indication of the inflammatory thickening occasioned by the first attack, and that the only consequence of this subsequent inoculation was a localised non-specific inflammation. The authors regarded this inflammation as the reaction of the affected tissues against the specific poison of the disease, since the absence of the specific *streptococci* indicated that this secondary effect was not due to the invasion of the tissues by the microbes. This view was confirmed by the fact that it was found possible to obtain similar inflammatory effects when the organisms themselves having been destroyed by heat the concentrated filtered culture was injected into the ear. Finally, since the parts which had previously suffered from erysipelas reacted more quickly and vigorously to the subsequent injection of the poison, it seemed probable that this non-specific inflammation was due to some adaptation of the tissues enabling them to respond with greater vigour, and thus more effectively, so that, as Metchnikoff and others have affirmed, the inflammatory process is from one aspect a truly protective one.

Mr. Lorrain Smith and Mr. Trevithick brought forward a research in many respects similar to the foregoing, but with one important difference, since the initial protective inflammatory process was brought about by a simple irritant. A sterilised liquid containing fine glass particles was injected into one pleural cavity of the rabbit and guinea-pig. The injection was followed by hyperæmia of the lung and by inflammatory exudation into the pleural cavity and the subjacent pulmonary alveoli. The subsequent injection of the *Bacillus pyocyaneus* was found to be inoperative as long as the injection was limited to the parts which were the seat of this primary inflammatory process; thus the inflammatory region was rendered immune, the localised immunity produced by the glass lasting as long as twenty-eight days.

Dr. Mann showed a series of microscopic specimens and microphotographs in which changes could be observed in various nerve cells as the result of their functional activity. The cells in question were those of the spinal cord, cerebellum, &c., particularly those associated with the functional activity of the retina, whilst the chief alterations were in the size and chromatin distribution of the cell nuclei. By bandaging one eye of an animal and then exposing it to light, Dr. Mann was able to distinguish an alteration in the size and staining of the cells upon the two sides in the following situations: the outer nuclear layer of the retina, the pyramidal cells of the occipital cortex, and the cells of the external geniculate body. The changes were most conspicuously shown both in the specimens and in the photographs.

At the meeting of the Physiological Society, held on Saturday afternoon, the following communications were made:—Dr. L. Hill showed the effect of gravity in altering the mammalian blood pressure, as illustrated by the remarkable rise in carotid pressure which occurs when the animal is changed from a horizontal to a vertical position with the head down, and the corresponding fall when the animal is similarly placed with the head up. Mr Kent showed an organism which he believed might turn out to be the specific organism of vaccinia. Dr. Pavy showed a sugar of low reducing power which was obtained from the urine of an animal after the administration of large quantities of dextrose. Dr. Mott showed microphotographs of the medulla, cord, &c., after section of the gracile and cuneate nuclei of the monkey on one side of the medulla. The sections showed the degenerated arcuate fibres sweeping over to the opposite side of the medulla, and the degeneration in the fillet of the opposite side above the lesion. A remarkable point in connection with the changes was that the degenerated fibres could be traced up to the optic thalamus, but no farther, there being none in the internal capsule. He also showed microphotographs taken from sections of a cord in which a longitudinal section had been made in the lumbar region, the section being in the middle line. The sections showed degenerated fibres in both antero-lateral columns.

Monday.—Dr. Starling gave an account of the experiments which led him to believe that the flow of lymph from the thoracic duct was dependent upon the amount of the blood-pressure in the liver capillaries, and hence that the old mechanical theory of lymph formation was correct as regards this source of the lymph flow. He showed that obstruction of the inferior vena cava must raise the pressure in the portal capillaries, and that a similar result follows obstruction of the abdominal aorta. The flow of lymph which Heidenhain observed after these operations was not therefore necessarily due to secretory activity, but must occur in consequence of the pressure even if the permeability of the portal capillary walls remained unaltered. Similarly the injection of a large quantity of saline into the circulation (hydræmia) caused an increased flow in consequence of the purely mechanical rise of pressure in the liver capillaries, this rise being ascertained by taking simultaneous tracings of the blood pressure in the portal vein and the inferior vena cava. Many lymphagogues act by causing hydræmia, and in these the flow of lymph must be directly caused by the increase in the portal capillary pressure. That the lymph under these circumstances comes from the liver is shown by the absence of the flow from the thoracic duct when the lymphatics of the liver are ligatured. Some lymphagogues, the action of which was especially noted by Heidenhain (such as crayfish muscle extract), stimulate the flow of lymph without giving any evidence of increased pressure in the portal capillaries. The effect of these lymphagogues disappears after long continued obstruction of the aorta, and on this ground, since the liver lymph still flows, the author concludes that lymphagogues of this class act on other lymph sources than the liver, and probably in the main upon those present in the intestines.

Dr. Lazarus Barlow followed with some experiments upon the flow of lymph from the hind limbs. He found no increase in the flow when considerable though incomplete venous obstruction was maintained for one hour, whilst the specific gravity of the blood, muscles, and skin showed no evidence of any increased exudation. Such increased flow and exudation occurred, however, when, after thus damming up the katabolic products, the tissues under observation were supplied with blood through actively dilated arterioles. The dilatation, when caused by section of the sciatic nerve, led to no such increased exudation: hence he concluded that the demands of the tissue are an effective factor in lymph formation. When the arteries are actively dilated, the amount of exudation varies directly as that of the venous pressure; so that lymph formation, though not a purely mechanical process, is nevertheless simpler than a pure secretion, such, for instance, as exists in the salivary glands.

Messrs. Bayliss and Starling communicated the results of an experimental inquiry into the innervation of the portal vein. The method consisted in reading the pressure in the portal end of the cut splenic vein, which thus formed a side branch of the portal system. They found that the pressure rose when certain definite anterior roots were stimulated, these extending in the lower dorsal region from about the seventh to the tenth dorsal nerves; these, therefore, contain vaso-constrictor nerves for the portal system.

Mr. Bayliss gave a further communication upon vaso-dilator nerves. He showed that the fall of blood pressure which follows the excitation of the central end of the depressor nerve was accompanied by vaso-dilatation, this being evidenced in the case of the kidney by the simultaneous expansion of that organ, and in the case of the lower limbs by their increase of volume as indicated by the plethysmograph. As the vaso-constrictors leave the spinal cord by the lower lumbar roots, the section of the cord in the dorso-lumbar region will cut off the vaso-constrictors, and since, under these circumstances, the stimulation of the depressor still causes an increase in the volume of the limb, he was led to conclude (*a*) that the dilatation was really due to the increased activity of vaso-dilator centres, and not to the diminished activity of vaso-constrictor centres; (*b*) that the anterior roots by which the vaso-dilator nerves of the lower limbs leave the cord, extend higher into the dorsal region than is the case with the constrictor nerves. Corroborative experiments were carried out in which the cord was left intact, whilst the sympathetic, in which the vaso-dilators run, was divided. Under these circumstances no increase in the volume of the limb accompanied the depressor excitation because the dilator supply was cut off.

Prof. Waymouth Reid gave an account of the alteration in the mucous membrane of the lateral pouches of the pigeon's crop, which were associated with the breeding season of the bird, and resulted in the formation of masses of fat-holding material constituting the so-called *pigeon's milk*. The secretion of this material is in its histological features analogous to the formation of sebum in the sebaceous glands, the fat being contained in cells which are cast off in masses from the mucous surface. The material is used for feeding the young pigeon, and when analysed is found to contain from 7 to 9 per cent of fat and 12 to 15 per cent. of proteids, the chief of which is a nucleo-albumin; unlike true milk it contains no sugar, but among its proteids is a caseinogen which clots with rennet with or without the addition of calcic chloride.

Prof. Dubois read a paper on the production of heat in hybernating animals, and brought forward the results of experiments made on the marmot in order to ascertain what circumstances influence the change which takes place at the end of hybernation. Section of the cord at the level of the fourth cervical nerve interferes with the waking from winter sleep, the delay thus caused being only partially due to the muscular paralysis and consequent inability to produce heat, since it appears that the integrity of the sympathetic system is an essential factor in the process. Further experiments seemed to indicate that the nervous control of the circulation was necessary for the waking up, and that the most important part of the circulation was that through the liver, which under the conditions produced by the section was inadequate for the supply of that organ. In consequence of this inadequate circulation the author believed that the proper functions of the liver were very much interfered with, and that in the normal animal these functions were at the moment of waking very actively carried on, particularly those by which glycogen is converted into sugar.

Prof. Haycraft showed some micro-photographs of collodion casts of muscle fibres in which the transverse striæ of the fibres were displayed. This communication was followed by one from Prof. Rutherford, who exhibited on the screen micro-photographs of muscle fibres both at rest and in contraction. 14, Aug

Tuesday.—A combined meeting of the Physical and Physiological Sections was held in the large theatre of the museum, when Prof. Lodge showed a number of experiments upon the reflection, polarisation, and refraction of Hertz waves, using as a detector for the presence of the propagated electrical disturbance an extremely sensitive cohesion tube. This contained fine particles in imperfect contact, and consequently offering considerable resistance to the passage of an electric current. The surging in the particles of an electric disturbance causes a better contact to be established, and the resistance consequently to be enormously diminished. Prof. Lodge followed this demonstration with a suggestion as to the mode in which it was possible to conceive of a reaction of the retinal structures to light vibrations. If we assume that the retinal elements constitute an imperfect conductor, and that a constant electromotive source is present in the retinal tissues, then it is not improbable that the light waves would cause a sudden diminution in the resistance of the elements, and allow the passage of a previously masked current; this current might excite the nerve-endings, and thus start the necessary nerve impulses. He pointed out that the coherer was acted on not only by the sudden commencement, but also by the sudden cessation, of the Hertz waves, and drew attention to Hering's view that white and black are both positive sensations, and both caused by retinal excitation. He stated that as regards colour, mathematicians only demanded a triple starting-point, and that since in Hering's theory three such independent factors were postulated, no objections to this theory could be raised on that score. The Young-Helmholtz theory seemed to him difficult to reconcile with the facts described by physiologists and observed by himself.

A discussion followed, in which several physiologists took part, the general tendency of the tone being that the suggestion must be capable of being applied to all living electromotive structures which display electrical changes when called into activity. It was also pointed out that the histological appearances were not at any rate opposed to Prof. Lodge's suggestion.

Prof. Osborn described a modification of Golgi's method used by Mr. Strong, of New York, and showed beautiful photographs of nerve cells from various parts of the central nervous system treated in this way.

Dr. Haldane brought before the Section the evidence which had led him to the conclusion that in the recent colliery explosion in South Wales, and probably in most previous ones, the cause of death by suffocation was the deficiency of oxygen in the mine due to its displacement by the products of the explosion, *i.e.* after-damp. Suffocation by deficiency of oxygen occurs when the respired air contains less than 8 per cent. of O; it is ushered in by an extremely sudden attack of muscular paralysis, so that there is but little warning of the danger when air is inspired deficient in O, and little chance of escape owing to the muscular failure. Suffocation through excess of CO_2 is quite different, as it is preceded by gradual respiratory distress in which the neuro-muscular system is aroused to greater activity. In addition to the deficiency of O, the poisonous "after-damp" contains often at least two noxious gases in fatal percentage, these being CO and H_2S. The most effective method of fighting one's way through after-damp seemed therefore to be one which aimed at restoring to the inspired air an adequate quantity of oxygen, and this the author thought might be effectually done by suitable portable cylinders of this gas.

Mr. W. G. Smith brought forward some observations illustrating some of the mental conditions which influence the association of ideas, *i.e.* memory. Experiments were made as to the effect upon such association of contemporaneous nervous activities other than those which presumably were more or less directly involved. Thus the power of recollecting a given arrangement of letters which had been exposed before the eye for ten seconds was found to be modified by the person under observation having to carry out simultaneously any one of the following among other operations during the period of exposure: tapping rhythmically on the table with the forefinger; speaking a simple syllable over and over again; carrying out a simple sum in addition in an audible voice. In all cases the effect was to confuse the recollection, the degree of confusion being greatest in the last two described instances.

Wednesday Morning.—Profs. Gotch and Lodge demonstrated the method employed by them in order to study the physiological effects produced by rapidly alternating currents of high intensity. They first showed that a nerve muscle preparation from the frog, if held in the neighbourhood of a friction machine to the poles of which were attached Leyden jars, responded by a single contraction whenever a spark passed between the knobs of the machine. Since there was no connection, except an air one, between the preparation and the machine, it was evident that the response was due to the preparation being in the line of force which spreads out from the knobs, and that when the spark passed, the sudden equalisation of these effects must be accompanied by a surging to and fro in the exposed nerve; the sudden character of this excites the tissue. They then showed the following experiment:—

A looped circuit was arranged connecting the two Leyden jars together, but leaving them attached to the friction machine; the end of the loop was connected to the earth, this being essential to avoid all static effects. Two wires were joined, one to each side of the loop, and the ends placed so as to embrace the exposed nerve of a nerve muscle preparation midway between the central end and the muscle. The upper end of the nerve was now brought into contact by means of other separate electrodes with an induction apparatus, and was excited every four seconds by a minimal excitation. On working the friction machine, and passing the strong rapidly-oscillating currents of the Leyden jars through the preparation, it was observed that only when the spark of the friction machine was extremely intense did the preparation respond by a contraction to these rapidly alternating currents, and that the sole effect of rather feebler alternating currents was to so alter the nerve that it ceased for a brief period to transmit the nerve impulse evolved by the constant rhythmical stimulus at the central end. The passage of these currents thus seems to produce a temporary paralysis of the nerve without causing excitation, acting thus like pressure or cold.

Prof. Engelmann described a new kymograph and polyrheotome, and exhibited tracings obtained with the instrument, which showed the great accuracy of the apparatus. The recording surface was driven by means of a weight which was so contrived as to ensure that in each experiment the same velocity should be reached before the weight ceased to act, and the subsequent revolution rendered practically uniform.

Mr. G. J. Burch showed a series of photographs of the excursions of a very sensitive capillary electrometer when projected on to a rapidly travelling plate and actuated by speaking into a telephone placed in the circuit. The excursions formed the basis for calculations of the E.M.F. of such telephone currents as are produced by the sounds of ordinary conversation: this varied from ·05 to ·1 of a volt, but with louder sounds might be sufficient to produce electrolysis. Photographs were shown which demonstrated that the instrument used could respond to changes of potential difference when these occurred one after another at a rate of nearly 3000 double vibrations in one second. The effect of the sounds of certain vowels and consonants were shown, such as *ah*, *ee*, *z*, and . In each case the fundamental tone of the voice and some of its harmonics combined to give a characteristic electrometer excursion with higher rapid vibrations superimposed upon it. These in the case of *z* were just visible under a lens, and appeared to have a rate of 3000 in one second. Photographs were also shown of the characteristic excursion caused by the pronunciation of the words, "Pop, pop," and "Dod, dod," the difference between the labial and the dental being well marked. Finally another series of photographs was exhibited which demonstrated that when electrolysis occurs in the electrometer, and the evolution of the gas recorded on the travelling photographic plate, this evolution is seen to take place without any measurable delay the instant the electrolysing current commenced.

BRITISH ASSOCIATION CONFERENCES OF THE DELEGATES OF THE CORRESPONDING SOCIETIES.

THE meetings of the Conference of Delegates were held at the New Examination Schools. Forty-two societies nominated delegates to represent them at the Conference.

FIRST CONFERENCE, AUGUST 9.

The Corresponding Societies' Committee was represented by Prof. R. Meldola (chairman), Prof. T. G. Bonney, Sir John Evans, Sir Douglas Galton, Dr. Garson, Mr. Hopkinson, Mr. Cuthbert Peek, Sir Rawson Rawson, Mr. Symons, Mr. Topley, Mr. Whitaker, and Mr. T. V. Holmes (secretary).

The Chairman remarked that this was their tenth Conference. Hitherto the reports of these Conferences had always been a year behind, as regards their publication in the British Association volume; the report of the Conference held at Edinburgh in 1892, for example, appearing in the volume giving an account of the proceedings at Nottingham in 1893. Steps had been taken to prevent this delay in future. They had also taken a new departure in announcing beforehand that some special subject would be discussed at the Conference. On that occasion they had been fortunate enough to secure the attendance of Mr. Cuthbert Peek to open a discussion on Local Museums.

Mr. Cuthbert Peek dealt with the subject under the following headings:—

(1) Methods of registration and cataloguing.

(2) The protection of specimens from injury and dust.

(3) The circulation of specimens and type collections for educational purposes.

(4) Central referees for nomenclature and classification.

(5) The most satisfactory methods of making museums attractive.

(6) Museum lectures and demonstrations.

(7) The relations between museums and County Councils.

(1) For small museums he thought a card catalogue was the best. Sectional letters should distinguish the various classes of objects. Each specimen, when received, should have a number under the letter of the section assigned to it, painted on the specimen. It was a good thing to have the dimensions of the specimen, with a rough outline of it, on the back of the card.

(2) Every closed case was acted upon by changes in the pressure of the atmosphere, so that it drew in and gave out air and dust with every change of pressure. It was desirable to admit air into each case by means of an opening filled with cotton-wool, or some similar material, so that the air entering might be filtered.

(3) At Liverpool a system had been elaborated by which type collections were prepared and circulated among a large number of schools. Each collection contained some special class of objects, such as food products, woods, &c. Those wishing to organise a plan of this kind should consult a paper by Mr. J. Chard, in the Report of the Museums' Association for 1890.

(4) The average curator of a small museum was often in difficulties as to the correct names of certain specimens. An organisation of specialists who would, for a small fee, allow specimens to be forwarded to them for identification, would be of the greatest use.

(5) While there were many well-arranged and attractive museums, there were others dusty, with labels illegible or invisible, which were almost unvisited and unknown. The English as well as the Latin names of specimens should be given. Much might be done to exhibit the variations of structure in creatures of different families or genera. Thus, in the Natural History Museum, South Kensington, there had recently been placed the skeletons of a man and of a horse, both in the attitude of running, so that the relations of the two, bone for bone, could be distinctly seen. The surgical, ordinary, and veterinary names of the bones were added.

(6) It was extremely difficult to make a museum demonstration useful to more than about a dozen persons. One experienced demonstrator had suggested that a lecture should be given in an ordinary lecture-room, illustrated by specimens, &c., to the whole of a large gathering, and a case-demonstration afterwards to the few seeking further information. The demonstrator should be placed on a temporary stand, so that he might see, and be seen by, his audience.

(7) It had always appeared to him that demonstrations in museums should take a very prominent part in technical instruction, and he had been surprised that so little aid had been given by County Councils to museums. Having sent out a circular to County Council Technical Education Committees, he had found that local museums and free libraries had been assisted in only nine cases. From some counties no information had yet been received, but it would appear from the answers received that there was no insuperable obstacle to the application of money intended for technical education to the development of museums.

In conclusion, Mr. Peek drew attention to the magnificent museum founded at Oxford by General Pitt-Rivers, the arrangement of which was unique.

The Chairman thought they were greatly indebted to Mr. Peek, and invited discussion.

Sir John Evans said that Mr. Peek had left but little for any one to add. He approved of the card catalogue, but thought that the American system of having a perforated card through which a wire passed might perhaps be preferable. He would be glad to know the best way of keeping a cabinet free from dust. He had tried a lining of cotton wool, but did not think the result perfectly satisfactory. As regards referees for nomenclature and classification, he would suggest the keepers of the various departments of the British Museum, who would always give prompt and valuable assistance.

The Rev. O. P. Cambridge, having a large collection in spirits of wine, had found that the best place for the labels was inside the glass jars, not outside. The writing should be with a pencil.

Sir Rawson Rawson had not always found pencil-marks indelible; and the Rev. O. P. Cambridge added that the pencil should be neither very hard nor very soft.

Dr. Garson could corroborate what had been said as to the advantages of using pencils in spirit preparations. Mr. Gray remarked that variation in the aspect of a museum constituted a most important element of attraction. The circulation of specimens tended, in itself, to make a museum attractive.

Mr. T. W. Shore hoped that Conference might do something towards obtaining aid for museums from County Councils. It was clear that grants could be made by County Councils to defray the expense of lectures and demonstrations in museums.

Mr. Sowerbutts remarked that though County Councils might be subject to the Government auditor, boroughs were not; and Mr. Kenward said that at Birmingham the Corporation had established a museum and art gallery without any help from the County Council.

Mr. T. V. Holmes had in his hands a letter from Mr. W. Cole, secretary to the Essex Field Club, who was most intimately acquainted with technical education as it existed in Essex. Mr. Cole's experience had given him a very low notion of the efficacy of mere lecturing. A lecturer brought specimens with him, but with the departure of the lecturer the specimens also departed. What was wanted was (Mr. Cole thought) a permanent central museum continually sending forth loan collections to the remoter districts, the collections being allowed to remain a certain time after the lectures illustrated by them had been given. He did not think County Councils should have the entire control of museums, as that would greatly diminish the interest taken in them by the naturalists and field clubs to whom they usually owed their existence. But a grant from the County Council would give a permanence to a museum which would immensely increase its efficiency in every way.

After some discussion, in which Dr. Brett, Sir Douglas Galton, Mr. Gray, Sir John Evans, Mr. Cushing and Mr. Whitaker took part, the following resolution was proposed by Sir Douglas Galton, and seconded by Dr. Brett :—

"That in the opinion of this Conference it is desirable that local natural history societies, and those in charge of local museums, should place themselves in communication with the Technical Instruction Committee of the county or borough in which they are placed, with the view of obtaining pecuniary grants towards extending technical knowledge by means of lectures or by demonstrations in museums."

Mr. Coates stated that at Perth they were building a large addition to their museum, and had obtained a grant from the County Council on condition that they provided specimens suitable for agricultural teaching.

Mr. Elworthy said that a difficulty felt by many had not been touched upon. They needed the services of an expert who would visit a museum and pronounce with authority, "this is rubbish," in the case of worthless specimens. A secretary would seldom venture to get rid of rubbish on his own responsibility.

Sir John Evans thought the opinion of the secretary should be deemed sufficient.

The Chairman then put the resolution to the meeting, and it was unanimously adopted. On asking if any delegates had any other remarks to make,

Mr. Seward, of Cardiff, was anxious to know, if possible, what things bought for a museum in order to make it more useful and attractive to the poorer classes might be legally purchased under the Act.

Sir John Evans said that it seemed to him that the last resource in these cases was the Science and Art Department at South Kensington.

The Chairman thought the Conference could not possibly attempt to decide the point raised by Mr. Seward. He felt sure that all present were most grateful to Mr. Peek for having opened this discussion on museums, which, he believed, would lead to most useful results.

SECOND CONFERENCE, AUGUST 14.

The Corresponding Societies' Committee was represented by Prof. R. Meldola (chairman), Dr. Garson, Mr. Hopkinson, Sir Rawson Rawson, Mr. Symons, Rev. Canon Tristram, Mr. Whitaker, and Mr. T. V. Holmes (secretary).

The Chairman hoped that delegates would do their best to further the resolution passed at their last meeting, with regard to local museums.

SECTION A.

Meteorological Photography.—Mr. Clayden stated that a sufficient collection of photographs had been received, except that he would be glad of photographs of lightning showing anything abnormal. Sometimes he read of the remarkable effects of a whirlwind in some district when it was too late to obtain photographs of its results. In such cases he would be glad if the secretary of some local society could get photographs taken at once, and send them to him before it was too late. In reply to Sir Rawson Rawson, he said that he had seen the photographs of storms and lightning exhibited by the Royal Society, and believed he had many of them.

Mr. Symons remarked that much help could be given by local societies if they were to send reports in.

Earth-tremors.—Mr. Davison said that in the last report of the Earth-tremors Committee there was a description of a bifilar pendulum invented by Mr. Horace Darwin. It had also been described in NATURE for July 12. It was especially desirable that instruments for registering earth-tremors should be placed along the course of great lines of fault (dislocations of the strata).

Mr. Horace Darwin then explained the construction of his bifilar pendulum for registering earth-tremors. It was not, he said, affected by the rapid, complicated movements which took place during an earthquake, nor by the slight tremors caused by passing carts or trains. But extremely slight movements of the kind which would make a factory chimney lean to one side would be registered.

Mr. Symons, as chairman of the Earth-tremors Committee, explained how the work of the Committee had grown, and in what respect it needed additional help. A series of pulsations which had been recorded by an instrument placed at the bottom of one of the deepest mines in the district of Newcastle-on-Tyne had been traced to two causes—the gradual settlement of the ground in consequence of the removal of the coal, and the beating of the waves on the coast. They had since been looking for traces of earthquake tremors. Mr. Davison on one occasion watched his instrument for some time, as he found pulsations were taking place. They turned out to have been produced by the earthquake then going on in Greece. They wanted information as to the changes going on in connection with the faults in geological strata, and, if possible, to get records of the alterations in the earth's crust caused by tidal waves. The work was then going on at Birmingham under Mr. Davison, but they were anxious to have instruments established in other parts of the British Isles. In answer to Mr. Tiddeman, Mr. Symons said that an instrument could be placed on the floor of a cellar. Mr. Horace Darwin had kindly undertaken to explain its mechanism at the close of the Conference.

The Chairman hoped that some of the corresponding societies would have something to report on this question next year.

SECTION B.

Pollution of Air in Towns.—Dr. G. H. Bailey said that for three or four years they had been engaged in Manchester, in connection with the Manchester Field Naturalists, in examining the air of towns. The amount of pollution and the amount of the death-rate varied together. They had almost perfected a method for determining the amount of sulphur compounds in the air, and one for measuring the amount of sunlight in towns. Their work had been chronicled in the *Journal* of the Manchester Field Naturalists for 1893.

Mr. Slater made a few remarks on the effects of smoke on plants, and the Chairman added that cryptogams and lichens were once common on trees in Epping Forest. London had now approached too near for them to flourish.

SECTION C.

Mr. Whitaker (representing Section C) said that he would first refer to coast-erosion. The final report on this subject would be made, he hoped, next year. The subject would then be handed over to the local societies, and those which had coast borders could continue the work by recording changes on six in maps. As regards the Committee on the Circulation of Underground Waters, its final report would also be made next year. In this case, also, the local societies could continue the investigation. It had been suggested that the twenty reports should have their contents arranged topographically, and that if then published, as a volume of 250 to 300 pages, many local societies might be glad to purchase it.

Erratic Blocks.—Mr. Murdoch regretted that the labours of the Erratic Blocks Committee were confined to England and Ireland. The work in Scotland had not been so nearly finished as was commonly supposed. Mr. Gray said that in Ireland they had issued their first Report on Erratic Blocks.

Prof. J. F. Blake stated that he was engaged in examining the microzoa of clays, especially of Jurassic clays, and would be glad if members of the corresponding societies could send him samples. He would gladly report to senders on the general character of these clays and their microzoa. He might take that opportunity of telling the delegates that unless he could obtain more support for the *Annals of British Geology* he could no longer afford to publish it.

Mr. Whitaker hoped that Mr. Blake's remarks would prevent the cessation of that most useful work.

Geological Photographs.—Mr. Jeffs said that the committee had received 1055 photographs, and had passed a resolution recommending the Council of the British Association, whose property the collection was, to deposit it in the Museum of Practical Geology, Jermyn Street, London.

SECTION E.

Mr. Sowerbutts said that the Manchester Geographical Society had come to the conclusion that geography would never be taught satisfactorily in primary schools unless it was made a compulsory subject. Progress had been made in some primary schools by the institution of school-museums. It was a singular fact that at an examination in geography of the primary schools of Cheshire, Lancashire, and Yorkshire, the girls had won all the prizes in Yorkshire, and the boys in Lancashire. His Society had for the last two or three years published an analysis of the chief geographical papers which had appeared in English and foreign journals.

SECTION H.

Ethnographical Survey.—Mr. Brabrook remarked that during the past year their list of suitable villages had been considerably increased, and now numbered 367. At Ipswich a sub-committee had been formed to assist them, and at Liverpool the keeper of the museum had given most valuable help. In Wales their sub-committee had met and had done good work, and the same remark might be made of Ireland. In Scotland they had a promise of assistance from the Glasgow Archæological Society. They had been told that their instructions about photographing were too minute, but they had been drawn up by Mr. Francis Galton with reference to his system of composite photographs, and any departure from them would make the application of that system comparatively difficult.

Mr. Sowerbutts stated that old people in his district objected to be photographed and measured.

Dr. Garson said that as regards photographs it was not necessary to get all the appliances Mr. Galton had mentioned. It was desirable to have a seat which could be raised or lowered like a piano-stool, so that each person might have his head in the same place, whatever his height might be. It was well, also, to have chalk lines on the floor at right angles to each other, the sitter being directed to look along either one line or the other. They did not want measurements of people more than fifty years old.

Mr. Brabrook added that a set of instruments for measurements might be had for £1 6*s.*, and a more expensive set for £3 3*s.* And Dr. Garson remarked that the cheaper set was quite good enough.

A vote of thanks to the chairman closed the proceedings.

SCIENTIFIC SERIALS.

Proceedings of the Edinburgh Mathematical Society, vol. xii. (Williams and Norgate, 1894)—The geometrography of Euclid's problems, by Dr. J. S. Mackay, is a modification of M. E. Lemoine's La Géométrographie ou l'art des constructions Géométriques (the subject of two memoirs read at the Oran (1888) and Pau (1892) meetings of the French Association for the Advancement of the Sciences), and an application of it to the problems in the first six books of Euclid's "Elements." The restrictions are those of Euclid, viz. that the constructions should be effected by means of the straight-edge and compasses only. It is an interesting introduction of M. Lemoine's methods to English readers. The same author contributes formulæ connected with the radii of the incircle and the excircles of a triangle. This is on the lines of the work we recently noticed by the same writer (vol. i. *Edin. Math. Soc. Proceedings*). It is founded upon a table given in the *Lady's and Gentleman's Diary* for 1871. Nearly all of the eighty formulæ are assigned to the authors who first published them: possibly those unassigned are due to Dr. Mackay himself. M. Paul Aubert, in his "Coordonnées Tangentielles," applies them to the discussion of a number of general problems relating to surfaces of the second order.—Dr. Sprague writes on the geometrical interpretation of i^i; his investigation was suggested by a result given in Hayward's "Vector Algebra and Trigonometry."—Mr. G. A. Gibson, in a proof of the uniform convergence of the Fourier Series, with notes on the differentiation of the series, discusses a point which has not, apparently, been considered in the English text-books.—In addition to the above papers there are several short notes: Prof. Crum Brown gives an abstract of a paper (to appear) in the *Transactions* of the Royal Society of Edinburgh, on the division of a parallelepiped into tetrahedra; notes on factoring, J. W. Butters; on a problem in tangency, G. E. Crawford; on certain maxima and minima, G. Duthie; on solutions of certain differential equations, F. H. Jackson; on E. Carpenter's proof of Taylor's theorem, R. F. Muirhead; notes on the number of numbers less than a given number and prime to it, and on the pedal triangle, Prof. Steggall; five notes, viz. two circular notes, geometrical note (ii.), two triplets of circum-hyperbolas, three parabolas connected with a plane triangle, and notes on an orthocentric triangle, R. Tucker; and a note, by W. Wallace, on a third mode of section of the straight line. Of the other communications that were made to the Society during the session the titles only are given. A list of members and of the presents made to the library close the volume, which contains a good deal of matter of interest to mathematical teachers.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 7.—"On the Recurrent Images following Visual Impressions." By Shelford Bidwell, F.R.S.

The earliest recorded observation of a certain curious phenomenon associated with optical after-images is that of Prof. C. A. Young, who published a note on the subject in the year 1872, and proposed that the phenomena should be called "recurrent vision." (*Phil. Mag.* vol. xliii. 1872, p. 343). He noticed that when a powerful Leyden jar discharge took place in a darkened room, any conspicuous object was seen twice at least, with an interval of a little less than a quarter of a second; often it was seen a third time, and sometimes even a fourth.

A few months later an account of two experiments on the same subject was published by Mr. A. S. Davis. (*Phil. Mag.* vol. xliv. 1872, p. 526). In the first, a piece of charcoal, one end of which was red-hot, was waved about so as to describe an ellipse or circle a few inches in diameter. A blue image of the burning end was seen following the charcoal at a short distance behind it, the space between the charcoal and its image being absolutely dark. The other experiment was made with a piece of apparatus resembling a photographic instantaneous shutter. The shutter was interposed between the observer's eye and the sky, and was covered with pieces of coloured glass, through which momentary flashes of light were allowed to pass. It was found that each flash was, after a short interval, generally succeeded by a recurrent image, the colour of which was nearly complementary to that of the glass.

In 1885 the author called attention to a very simple and effective method of exhibiting a recurrent image (NATURE, vol. xxxii. 1885, p. 30). If an ordinary vacuum tube, illuminated by an induction coil discharge, is made to rotate slowly upon a horizontal axis fixed at right angles to the middle of the tube, the tube is seen to be followed at a distance of a few degrees by a ghost-like image of itself, the ghost exactly imitating the original in form, but having a uniform steel grey colour. In the same paper the following observation is noted:—"The vacuum tube being at rest in a feebly lighted room, I concentrated my gaze upon a certain small portion of it while the discharge was passing. The current was then interrupted, and the luminous image was almost instantly replaced by a corresponding image which appeared to be intensely black upon a less dark background. After a period, which I estimated at from a quarter to half a second, the black image again became luminous; this luminous impression lasted but for a small fraction of a second, and the series of phenomena terminated with its disappearance . . . . It was also found desirable to make the preliminary illumination as short as possible, a single flash being generally sufficient to produce the phenomena." The following comment was added:—"The series of phenomena seem to be due to an affection of the optic nerve which is of an oscillatory character. Abnormal darkness follows as a reaction after the luminosity, and again after abnormal darkness there is a rebound into feebler luminosity."

The subject has recently attracted much attention in connection with the experiments of M. Aug. Charpentier. The account of them given by M. Charpentier in a paper on "Retinal Oscillations"[1] is briefly as follows:—If a black disk having a white sector is illuminated by a strong light, and slowly turned round while the observer's eye is fixed upon its

[1] "Oscillations rétiniennes," *Comptes Rendus*, vol. cxiii. 1891, p. 147. See also "Réaction oscillatoire de la Rétine," *Arch. de Physiologie*, 1892, p. 541.

centre, there appears upon the white sector, near to its leading edge, a well-defined dark band, which is separated from the black ground of the disk by a similar white band. The angular extension of the dark band increases with the speed of rotation, so that it always takes the same time to pass over a fixed point on the retina; it begins about one-sixty-fifth or one-seventieth of a second after the first passage of the white, and lasts sensibly the same time. He goes on:—"The dark band is in fact only a kind of reaction of the retina after the luminous excitation, a reaction which can be demonstrated in a totally different manner. I have found that if an instantaneous luminous excitation is produced in complete darkness the sensation appears to be reduplicated; shortly after its first generation it seems to disappear, and then manifest itself again. This is the case, for example, when a single discharge from a Ruhmkorff coil is passed through a Crookes or Geissler vacuum tube, or simply, but less obviously, through the air. . . . . There is, then, in this last experiment, as in the first, a negative reaction of the retina under the influence of excitation. . . . . It would be difficult, and in any case premature, to indicate the cause of this phenomenon, but it may fairly be characterised as the result of a retinal oscillation set up under the influence of the beginning of the luminous excitation."

The present paper deals partly with the colours of recurrent images under different conditions, and partly with the reaction attending the early stages of a luminous impression as noticed by Charpentier.

In the observation of the recurrent images set up by the action of light of different colours, the author began, like Mr. Davis, by using coloured glasses.

A metal disk, about 8 cm. in diameter, was arranged so as to rotate slowly and steadily about its centre in front of the condenser of a projection lantern. Near the edge of the disk was a circular aperture about 0·5 cm. in diameter, the image of which was focussed upon a distant screen. A plate of coloured glass was placed before the projecting lens, and thus was obtained a small coloured disk of light, which described a circular path upon the screen. The coloured disk was, in most cases, seen to be followed at an interval of a few degrees by a ghost of the same size and shape, but of feebler luminosity, and of a hue which varied more or less with the colour of the glass employed. With white electric light the colour of the ghost was violet.

This method of experimenting was, however, found to be unsuited for the purpose in view, and it is mentioned only on account of the facility which it affords for exhibiting the phenomenon to a large number of persons. To obtain results of any value, it was necessary to employ the simple colours of the spectrum.

In the arrangement finally adopted, light from a selected portion of a spectrum was projected upon a small mirror, to the back of which was attached a horizontal arm, not quite perpendicular to the mirror: the arm was rotated by clockwork, and the reflected beam of light was received upon a white screen, forming a coloured disk about 1·5 cm. in diameter, which revolved in a circular path having a diameter of 30 cm.

When the mirror turned once in 1½ seconds the ghost or recurrent image appeared about 50° behind the coloured disk, the corresponding time interval being one-fifth of a second. The ghost appeared to be circular in form, its diameter being generally rather less than that of the original. The colours of the recurrent images, as specified below, have all been observed by several persons, and, except as to those at the extreme limits of visibility, all the observations were in agreement.

Spectrum colours.	Recurrent colours.
Extreme violet... ...	No perceptible image.
Middle violet	A pale image, variously described as grey, yellow, and greenish-yellow.
Dark blue	Feeble violet.
Light blue	Brighter violet.
Middle green	Bright violet. The image is more conspicuous with green light than with any other.
Greenish-yellow ...	Blue.
Orange-yellow... ...	Bluish-green.
Orange	Dark bluish-green.
Orange-red	Very dark bluish-green.
Red	No image at all, however bright the red was made.

A complete small spectrum, revolving parallel to itself in a circle about 1 metre in diameter, was followed by a ghost which corresponded to the portion of the spectrum comprised between the orange and the beginning of the violet. The *whole* of this ghost was of a violet hue: no trace whatever of yellow or greenish-yellow could be detected at the more refrangible end, nor of blue or bluish-green at the other.

From other experiments it appeared probable that the blue and bluish-green recurrent colours apparently observed when the yellow and orange portions of the spectrum are tested separately are due merely to an effect of mental judgment, and not to any cause of a physiological nature.

Four independent facts are consistent with the conclusion that luminous recurrent images are due to a reaction of the *violet* nerve fibres only.

(*a*) With white light the recurrent colour is violet.

(*b*) In the recurrent image of the complete spectrum no colour but violet can be detected.

(*c*) A pure red light, however intense, gives no recurrent image. (It is generally supposed by the supporters of the Young-Helmholtz theory that red light has no action upon the violet nerve-fibres.)

(*d*) The apparently blue colour of the ghost of simple spectrum yellow is just as well produced by a compound yellow consisting of green and red, the latter of which is inert when tested separately.

The path of the revolving spot of light is generally marked by a phosphorescent track, which, when the rate of revolution is not less than one turn in 1½ seconds, often forms a complete circle. The trail is due to the usually feeble continuation of the after-image, of which the bright initial stage constitutes the recurrent image.

In the experiment next to be described, the Charpentier effect and the recurrent image are made to exhibit themselves simultaneously.

Two blackened zinc disks, 15 cm. in diameter, from each of which two opposite quadrants were cut out, were mounted in contact with each other on a horizontal axis, driven by clockwork, and making one turn in 1½ seconds. By slipping the disks over one another round their centres, opposite open sectors might be obtained, of any aperture from 0° to 90°. The apparatus was set up opposite a box containing a 32-candle power incandescent lamp, with a variable resistance in the circuit, the side of the box between the lamp and the disks being covered with a sheet of ground glass.

The sectors being in the first place opened as widely as possible, Charpentier's dark band was easily seen upon the illuminated background.

The sectors were then gradually closed up, until the posterior edge of the dark band approximately coincided with that of the sector. When this was accomplished, it was found that the arc of the open sector was equal to about $\frac{1}{52}$ part of the whole circumference. The dark reaction, therefore, ceased in ($\frac{1}{52}$ of 1½ seconds =) $\frac{1}{35}$ second after the first impact of the light upon the eye.

For more readily demonstrating the succeeding phenomena, it was found convenient to again open the sectors a little, so that they covered an angle of about 10° or 12°. Resuming the observation, it was seen that the posterior edge of the open sector was bordered by a luminous fringe due to persistence. A little beyond the termination of the fringe there appeared an intensely black radial band, estimated to cover a space of from 3° to 4°, and distinguishable even upon the black ground of the metal disk, though it is shown far more conspicuously upon a translucent disk made of stout writing-paper with a sector cut out. Lastly, after another interval of perhaps 35° or 40°, came the luminous recurrent image, which, with the yellowish light of the incandescent lamp, appeared to be of a blue colour.

This method of observation revealed one other point of interest, which seems hitherto to have escaped notice, though it is evident enough with a Charpentier disk, when once attention has been directed to it. The average illumination of the bright band intervening between the dark band and the leading edge of the sector is much more intense than that of the other portion of the sector. Moreover, it is not uniform, but increases, gradually at first, and very rapidly at last, from the leading edge up to the dark band. In fact when the light used is not strong, the luminous margin of the bright band is a far more conspicuous object than the dark band itself: it appears to glow almost like a white-hot wire.

Charpentier states that, under favourable conditions, he has been able to detect the existence of a second, and even of a third, dark band of greatly diminished intensity, though he adds that the observation is a very difficult one. What is probably the same effect in a different form can, however, be shown quite easily in the following manner :—

In a blackened zinc disk 15 cm. in diameter, there were cut two opposite radial slits, about 0·5 mm. in width. The disk was rotated at the rate of one turn per second in front of a sheet of ground glass, behind which was an incandescent lamp. The glass was covered with opaque paper, in which a circular opening was made of slightly less diameter than the disk. The disk was placed opposite this opening, and no light reached the eye except such as passed through the two slits. When the disk was observed from a distance of about $1\frac{1}{2}$ metres, the eye being fixed upon its centre, each slit appeared to give four (or possibly five) luminous images, arranged like the ribs of a partly opened fan. The images were distinctly separated by dark intervals near the circumference, but overlapped one another towards the centre. The leading image was naturally the brightest, each consecutive image being considerably weaker than its precursor. All had the same tone of colour, namely, that of the yellowish-light given by the electric lamp. The usual blue recurrent image could also be seen following the images of the radial slits, at an angle of about 80°.

It appears, then, that when the retina is exposed to the action of light for a limited time, the complete order of visual phenomena is as follows :—

(1) Immediately upon the impact of the light there is experienced a sensation of luminosity, the intensity of which increases for about one-sixtieth of a second : more rapidly towards the end of that period than at first.

(2) Then ensues a sudden reaction, lasting also for about one-sixtieth of a second, in virtue of which the retina becomes partially insensible to renewed or continued luminous impressions. These two effects may be repeated in a diminished degree, as often as three or four times.

(3) The stage of fluctuation is succeeded by a sensation of steady luminosity, the intensity of which is, however, considerably below the mean of that experienced during the first one-sixtieth of a second.

(4) After the external light has been shut off, a sensation of diminishing luminosity continues for a short time, and is succeeded by a brief interval of darkness.

(5) Then follows a sudden and clearly-defined sensation of what may be called abnormal darkness—darker than common darkness—which lasts for about one-sixtieth of a second, and is followed by another interval of ordinary darkness.

(6) Finally, in about a fifth of a second after the extinction of the external light, there occurs another transient impression of luminosity, generally violet coloured, after which the uniformity of the darkness remains undisturbed.

No account has been taken of the comparatively feeble after-image, to which the phosphorescent trail before referred to is due, and which may last for two seconds or more.

In an addendum to the paper reference is made to the recent experiments of Dr. Carl Hess ("Pfluger's Archiv fur Physiologie," vol. xlix. p. 190).

PARIS.

Academy of Sciences, August 27.—M. Lœwy in the chair.—On the variations of the apparent signs of lines and angles, in direct vision and in vision by movements of the eyes and head, by M. Ch. Henry. Formulæ and tables are given embodying the results of the consideration of a great number of cases and enabling apparent sizes to be calculated.—On the transformation of *équations canoniques* in the problem of three bodies, by M. Paul Vernier.—On the possibility of replacing the indeterminate problem given by the generalisation of Pascal's theorem by a determinate problem, by M. Paul Serret.—Researches on the movements of the solar atmosphere, by M. H. Deslandres. An examination of many photographs of spectra of the sun reveals interesting phenomena in connection with a bright line occurring within the wide dark lines H and K of calcium. This line may be resolved into two bright lines enclosing a dark line; the bright lines correspond to the lower layers of the chromosphere, while the dark line belongs to the higher layers. These bright lines often show dissymmetry, sometimes one and sometimes the other becoming the narrower. Spectra of the faculæ do not usually show this dissymmetry, but it is a common condition over the remainder of the surface, and is more pronounced near the equator than in the neighbourhood of the poles. Near spots the observed dissymmetry is often in the opposite direction on opposite sides, and the narrowing of the line is sometimes irregular. These phenomena can be explained on the hypothesis of a continual circulation of the sun's atmosphere, but it is worth noting that a less marked dissymmetry has been obtained in the calcium spectrum produced by the induction spark. Resemblances are pointed out between these phenomena and those observed in the spectrum of Nova Aurigæ.—A remarkable thunderstorm, by M. Ch. V. Zenger.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Fabrication de la Fonte : E. de Billy (Paris, Gauthier-Villars).—City and Guilds of London Institute, Programme of Technological Examinations, &c., Session 1894-95 (Whittaker).—Review of Mineral Production in India for 1893 (Calcutta).—Sach-und Orts-Verzeichnis zu den Mineralogischen und Geologischen Arbeiten von Gerhard vom Rath : W. Bruhns and K. Busz (Leipzig, Engelmann).—Katalog der Bibliothek der Kaiserlichen Leopoldinisch Carolinischen Deutschen Akademie der Naturforscher, Fünfte Liefg. Band 2 : O. Grulich (Halle, Blochmann).—The Country Month by Month, September, Owen and Boulger (Bliss).

PAMPHLETS.—Tellustria : B. G. Jenkins (Norwood, Morgan).—Manchester Microscopical Society Transactions and Annual Report, 1893 (Manchester).

SERIALS.—Zeitschrift für Wissenschaftliche Zoologie, lviii. Band, 1 and 2 Heft (Leipzig, Engelmann).—Natural History of Plants, Part 5 : Kerner and Oliver (Blackie).—Contemporary Review, September (Isbister).—Scribner's Magazine, September (S. Low).—Journal of the Chemical Society, September (Gurney).—National Review, September (Allen).—Journal of the Asiatic Society of Bengal, Vol. lxiii. Part 2, No. 1 : Part 3, No. 1 (Calcutta).—Himmel und Erde, September (Berlin).—Fortnightly Review, September (Chapman).

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THURSDAY, SEPTEMBER 13, 1894.

BACTERIA IN WATER.

Micro-Organisms in Water; their Significance, Identification, and Removal. By Prof. Percy Frankland and Mrs. Percy Frankland. (London: Longmans, Green, and Co., 1894.)

On perusing this volume, there can be left no doubt in the mind of anyone who has paid attention to the enormous progress in the knowledge of micro-organisms in water, that the authors have succeeded in producing a work which testifies to a full and accurate survey of the subject, and to a large amount of original observations carried out by the modern approved methods. For these reasons we venture to say that this volume will occupy the position of a valuable text-book and standard work on the subject of micro-organisms in water. The views which the authors, in common with modern sanitarians, hold as to the relative value of the chemical and biological examination of potable waters, deserves special attention on behalf of some distinguished chemists, on whose mind the whole progress of bacteriological science seems to have as yet made but little impression; in this connection we quote, from p. 117, chapter v., the authors' statement which, being those of a distinguished chemist, it is to be hoped will have the desired effect:—"If water which is known to have received sewage matters (and the *entire* exclusion of such from supplies drawn from rivers is practically impossible) is to be supplied for dietetic use, and if this water, as is so often the case, is not objectionable on account of the absolute quantity of organic matter, as revealed by chemical analysis, which it contains, but only of the suspicious origin of a part of this organic matter, then it is evident that in the purification of such water the point to be taken primarily into consideration is how the organic life it contains can be reduced to a minimum." The authors might have further added that the chemical analysis only of such waters is for sanitary purposes of little practical use, since a water may contain less than the recognised amount of organic matter, and yet be dangerous for drinking purposes on account of the presence in it of some undesired pathogenic microbes. The amount of organic matter and the presence of these latter in water need not, and in some cases (*e.g.* the well-known outbreak of typhoid fever at Caterham) do not bear a constant or a definite relation to one another. As a more recent illustration of this kind, the well-known instance of the cholera in Hamburg and Altona in 1892 may be quoted.

As is well known, Hamburg and Altona (p. 152) "are dependent upon the river Elbe for their water supply, but whereas in the case of Hamburg the intake is situated *above* the city, the supply for Altona is abstracted below Hamburg after it has received the sewage of a population of close upon 800,000 persons. The Hamburg water was therefore, to start with, relatively pure when compared with that destined for the use of Altona. But what was the fate of these two towns as regards cholera? Situated side by side, absolutely contiguous in fact, with nothing in their surroundings or in the nature of their population to especially distinguish them, in the one (Hamburg) cholera swept away thousands, whilst in the other (Altona) the scourge was scarcely felt." . . . "The Hamburg water, to start with, was relatively pure when compared with the foul liquid abstracted from the Elbe by Altona; but whereas in the one case the water was submitted to careful filtration through sand before delivery, in Hamburg the Elbe was distributed in its raw condition as taken from the river." Here we have water coming originally from the same source, which was yet widely different in biological respects for the two sets of consumers:—

(*a*) Hamburg water, chemically comparatively pure.

(*b*) Altona water, chemically foul, owing to great sewage pollution; yet the Hamburg water proved deadly because rich in cholera germs, while the Altona water, from which most of these germs had been removed by careful filtration, but chemically still impure, did little harm.

Prof. Percy Frankland, when before the Royal Commission on Metropolitan Water Supply, seemed to have resented a statement made by myself before that Commission as to the comparatively small value that sanitarians attribute to a purely chemical analysis of water; inasmuch as he (Prof. Frankland) quoted the very water of Hamburg as proving the importance of chemical analysis. He said that the Hamburg water which he had examined for the editor of the *British Medical Journal*, would already, on chemical grounds, have been condemned as unwholesome water. But he was immediately after this answer confronted with the information not then known to him (Prof. Frankland), given to him by one of the Commissioners, viz. that the population of Altona drank with comparative immunity the same water, only chemically more polluted, the difference between the two waters being that the Hamburg water was consumed unfiltered, while the Altona water was filtered before delivery. From what we have quoted above, it is satisfactory to find that Prof. P. Frankland, in common with others, does not attribute great value to chemical analysis alone.

The subject of preparation of culture media for bacterioscopic water-analysis, and of the methods of isolation of micro-organisms from water, are treated in a fairly exhaustive manner in chapter i. We miss, however, the description of the methods of making agar plates, probably because the authors as a rule used only gelatine plates. Chapter ii. gives a detailed description of the methods of staining bacteria. It is not quite clear where, in the examination of micro-organisms in water, the staining of sections of tubercle, leprous, and other pathological tissues comes in; at any rate, if quoted, it might as well have been quoted more perfectly. Chapter iii. deals with the examination of water for micro-organisms; chapter iv. with the bacterial contents of various waters, of rivers, lakes, wells, springs, sea-water, ice, hail, rain, &c.; chapter v. with the purification of water for drinking purposes by the various filters in use on large and small scales, sterilisation by heat, subsidence, chemical treatment, &c.; and chapter vi. on the multiplication of the micro-organisms in water. All these subjects are treated in great detail, both on account of the large amount of bibliography, as also on account of a considerable amount of work contributed by the authors themselves. There are, however, two subjects on which it is necessary to make some comment. The first refers to a passage on p. 119: they say: "In the year 1885 Koch's gelatine process of water examination was first introduced into this country by one of us."

I am quite sure that Prof. P. Frankland hereby quite unintentionally omitted to state the fact that Dr. Angus Smith (*The Sanitary Record*, 1883) was the first to apply the gelatine test for showing the relative number and the different characters of the colonies of the microbes present in water.

The second point refers to the factors which determine the efficient character of sand filters. From p. 119 to p. 142 we have a detailed account, with numerous tables, of the results of the bacteriological examination of London waters "by one of us," yet no mention is made and no indication is given of one of the most important factors (*cæteris paribus*) in efficient sand filtration, viz. the formation in the superficial layers of the filter bed of a slime (Schlamm); it is precisely after the formation of this "slime" that the filter becomes efficient, it is inefficient before the "slime" is formed. The authors have had abundant indications as to the importance of this "slime"; they quote on p. 158 researches by Piefke, who demonstrated already in 1887 that (p. 159) "it is the slime deposit on the sand which constitutes the real filtering material in the water-works' filter." Further indication of the importance of this "slime" was given to the authors by Prof. Lankester's extremely valuable evidence before the Royal Commission on Metropolitan Water Supply, November 1892, and lastly by Koch's paper on water filtration in the *Zeitschr. f. Hygiene und Infektions*, vol. xiv. Koch clearly shows that the sooner this slime is formed—water which initially contains a greater amount of impurity would form it sooner than water initially pure—the sooner the filtration becomes efficient; further, that on renewal (by scraping) of the surface of the filter this protective slime is removed, and therefore the filter for the time becomes inefficient; then the influence of frost on this slimy layer, and a variety of other important points connected with this slime. All these and others are of the utmost importance as regards the real understanding of the working of sand filters; *e.g.* the exact nature of the slime, the conditions affecting its formation, the differences of its formation in the filter-beds of the various London Water Companies, and at various periods, &c. All these points require elucidation, and one must regret that the authors have missed a valuable opportunity to treat of these in the book; since the researches "by one of us" made of the London waters in 1886, which are quoted in full in the work, no real progress appears to have been made. One thing, however, is brought out by the observations not only of Fraenkel and of Piefke, but of all that have worked on the question of purification of drinking-water by filtration, and that is (p. 157) that "even under the most favourable conditions of working the sand filters do not form a complete obstacle to the passage of micro-organisms."

Chapter vii., on the detection of pathogenic bacteria in water, gives an extensive bibliography and the most reliable methods for the detection of bacteria, the typhoid bacilli, and Koch's comma bacillus receiving a not undeservedly large share of attention. With regard to the differentiation of bacillus coli and typhoid bacillus by the presence or absence of gas-bubbles in gelatine cultures, the authors state (p. 269): "This distinction has been shown by one of us to be available in an extremely simple form for the differentiation of the two organisms," viz. the bacillus coli forming gas-bubbles in gelatine shake cultures already after twenty-four hours' incubation at ordinary temperature, while the bacillus of typhoid does not do so. I am able to confirm this, and to state that this characteristic formation of gas-bubbles by bacillus coli in gelatine shake cultures has been known and practised in my laboratory for more than two years, and is described by me in the Reports of the Medical Officer for the Local Government Board, 1892–1893; also in the *Journal of Pathology and Bacteriology* November 1893; and in the *Centralblatt für Backt. und Parasit.* vol. xv. Nos. 8 and 9.

There is one further subject to be mentioned, viz. on p. 272 and p. 273. The authors in using Parietti's method, in order to detect the typhoid bacillus in water, recommend adding to the cultivating medium "1 to 10 drops of the water under investigation"; if, as is almost invariably the case, the typhoid bacillus is present in the water in a highly diluted state, *i.e.* few examples in a large bulk of water, how the authors can under these conditions hope to recover the typhoid bacillus by using 1 to 10 drops of the water, is difficult to see. True, later on, on p. 285, an important addition *in small print* is made in the shape of a note at the end of chapter vii., to the effect that in "examining water for the typhoid bacillus it is advisable to pass a considerable volume, 250 c.c. or upwards" (this sounds rather different from 1 to 10 drops) "through a sterile porcelain or infusorial earth filter, and then to transfer this deposit on the surface of the cylinder by means of a sterile brush into a small quantity of sterile water"; this is then used for cultivation. This is the identical method which was used by me with success in the summer of 1893 in detecting the typhoid bacillus in the Worthing water, and soon after in the water from a polluted well in Rotherham.[1]

For the means by which Koch's cholera vibrio can be differentiated from other vibrios that have been hitherto found in water, the authors (on p. 270) mention Koch's conclusion that the absence of indol reaction, as well as the absence of any pathogenic effects on guinea-pigs, sufficiently distinguish the non-cholera vibrio from Koch's comma bacillus. This conclusion is definitely contradicted by a number of more recent observations made by independent workers, amongst them notably R. Pfeiffer (*Archiv. f. Hyg. und Infekt.* vol. xvii.).

Chapter viii. treats of the vitality of particular pathogenic bacteria in different waters; a large amount of bibliography with tabulated results by the various authors are given *in extenso*. Turning to the vitality of the typhoid bacillus, we find one observer (p. 290), Braem, gives the vitality of this bacillus in distilled water 188

[1] A similar remark may be made to a passage on p. 2[illegible]3. The authors in describing the detection of anthrax spores in water, state—"A method has been devised by one of us (1[illegible]3) suitable for the detection of anthrax spores when present along with other micro-organisms in water." This consists in killing by heat the non-spore-bearing forms, while the spores, being more resisting, survive. This method "one of us" might have found described in Klein's "Micro-organism and Disease," 3rd edition, 1886, p. 1[illegible]6.

days; Hochstetter, on the other hand, not exceeding five days; Meade Boulton, from two to three and ten to fourteen days; Wolffhügel and Riedel, thirty-two days. Similarly as regards the vitality of Koch's cholera vibrio in distilled water, Percy Frankland states that none were discoverable on the second day (the vibrio was initially in a weakened condition); Hochstetter, twenty-four hours to seven days; Nicati and Rietch, more than twenty days; Slater, five hours; Strauss and Dubarry, fourteen days. These differences are extremely perplexing and materially interfere with the value of the statements. As all these observers used distilled water, the differences as to the vitality must be due to the microbes themselves; the readiest explanation is this, that the different observers used the microbes in different states of resistance. It is perfectly well known that a variety of conditions, such as the nature of the nutritive medium in which the organisms had been growing, the age and the pedigree of the culture used, determine the resistance and vitality; unless, therefore, in all cases the best and most favourable cultures are used, the observations are of small value, and the authors justly (see pp. 331 and 334) lay stress on similar points.

One conclusion proceeds with clearness from the recorded observations, viz. that (p. 261) "a number of bacteria, possessing pathogenic properties of the most pronounced character, have been detected in natural waters from time to time," and it is therefore not quite correct to assume, as is generally done, that typhoid and cholera are the only diseases whose germs are distributed by water, nor is it justifiable to limit our attention to these two species only, because the whole subject of the identification of specific bacteria in water is practically still in its initial phase.

Chapter ix. and last, on the action of light on micro-organisms, is extremely well written and gives a detailed account of this important and ever-widening field of research; the history of the whole subject and the very valuable results obtained by the authors (or rather "by one of us"[1]) are described in a thorough and readable manner. It is to be regretted that the beautiful and well-known researches of Prof. Marshall Ward on the fundamental difference of action of the red and blue part of the spectrum should have been passed over.

In an appendix a valuable and up-to-date systematic description is given of the micro-organisms that have been hitherto found in water, by which their identification is greatly facilitated. We only wish the authors had not ventured to classify them into pathogenic and non-pathogenic bacteria, the former indicated by being printed in red letters, the latter in black. The authors do not accurately define, for obvious reasons, what is and what is not a pathogenic micro-organism, but give a list of "those microbes which have been found to be pathogenic to man or animals." The classification in the appendix is both incorrect and misleading. It is incorrect because a great many of the microbes mentioned here as non-pathogenic, produce disease and death in the guinea-pig if injected in sufficiently large doses into the peritoneal cavity; it is misleading because microbes are mentioned here as pathogenic, *e.g.* the *Bacillus coli*, the *Proteus vulgaris*, the *Proteus mirabilis*, which have no greater claim to such a designation than the *Bacillus prodigiosus* or the *Bacillus subtilis*; for it has been conclusively established, by a number of independent observers, that these latter act in the same way pathogenetically when injected into the guinea-pig's peritoneum as the *Bacillus coli*, the vibrio of Koch, or the bacillus of typhoid fever.

In conclusion, we have no hesitation in saying that, short of the omissions that we have pointed out, the book will take a prominent place amongst the standard works on micro-organisms in water. E. Klein.

[1] This expression occurs over thirty times.

RITTER'S "ASIA," RUSSIAN ADDENDA.

East Siberia. Part i., *being the Sayan Highlands in the Government of Irkutsk, in the South of the great Siberian Highway, up to the South-western Extremity of Lake Baikal.* By P. P. Semenoff, I. D. Chersky, and G. G. von Petz. (St. Petersburg, 1894.)

This volume belongs to the great undertaking of the Russian Geographical Society, which was begun many years ago with the intention of publishing addenda to those parts of Ritter's "Asia" which deal with regions of the great continent belonging to Russia, or touching its frontiers. The large number of geographical researches which have been made since the year 1832, when Ritter's great work had been published, and the difficulty of treating them with the same details as Ritter had treated the scanty information available sixty years ago, have resulted in many delays in the appearance of the promised volumes, and even this last one comes out as the work of three different persons—P. P. Semenoff taking it up when Chersky had met with an untimely death in the far north of Siberia. But in the hands of P. P. Semenoff, the volume we now have before us bears no traces of an incomplete posthumous publication. On the contrary, it is a well-finished work, worthy to take one of the first places among the several excellent volumes of "Russian Addenda" previously published.

Not only the great lines of Ritter's classical work and its spirit could be fully maintained, but the many explorations which have been made in this region during the last sixty years, have only confirmed the correctness of the conceptions of the great geographer. The Sayan mountains appear, indeed, as a huge border-wall of the great massive upheaval of North-west Mongolia, and as a part of the immense border-ridges which fringe the high plateau of East Central Asia. And in the Alpine regions beyond it there is no trace of the chains which Humboldt wanted to run along the parallels, and the meridians. There is, in the Tunka, the Kitoi, and the Byelaya Alps, simply a succession of chains running roughly parallel to the border-ridge.

In the huge border-ridge lies the 11,500 feet high Munku Sardyk, the highest mountain of East Siberia, which till lately was supposed to be the only one snow-clad peak in that part of Asia. Its glaciers and its summit had already been visited and described by Radde in 1856, but the present volume contains also the most interesting observations of Captain Bobyr, who has re-visited the peak, and from whom we learn that four more peaks rise above the snow-line in the same part of the

Sayans. One of them, situated further west and named Peak Middendorff, gives origin to mighty glaciers, visited by M. Yachevsky. The same expedition has fully confirmed the fact which was much contested five-and-twenty years ago, namely, that the highlands lying in the south of the Sayans are a plateau, 3000 to 4000 feet high, belonging to the great plateau of East Asia.

However, much remains to be done to explore the border-wall of this plateau, for, apart from the exploration of the Munku Sardyk and the plateau in the south of it, by Captain Bobyr, little has been added to what was known thirty years ago from the rapid excursions of Radde, Polyakoff, and the writer of these lines. The ridge offers, however, a good deal of interest in more than one aspect. It gave rise, probably, in the early Quatenary period, to mighty flows of lava, which spread down the valleys of its northern slope, reaching the valley of the Irkut; and, in the valley of one of the tributaries of the Upper Oka, the Junbulak, two small craters of ejection, 400 feet high, were described in 1864. Unhappily, these formations, so interesting in the very heart of Asia, at an altitude of about 6200 feet, have not been revisited since, and all we know about them is what could be gathered during a rapid excursion.

The beautiful valley of the Irkut, between the Sayans in the south, and the wild stony wall of the Tunka Alps in the north, is described next, and a masterly perusal of the available documents gives a very lively picture of that broad valley, covered with lacustrine deposits, and, about the Tunka village, with sheets of lava. But with the mountains in the north of this valley one enters again in a field nearly quite unbroken by the explorer. Happily enough, Chersky has crossed it in at least one direction, and some of the most interesting parts of the present volume are those given to the description of these mountains, among which the Munku Sagan Khardyk—snow-clad, as its very name shows—reaches to the unsuspected height of nearly 10,000 feet. The description is the more interesting, as it is based upon Chersky's unpublished MS. notes, and it is sufficiently detailed to give a good idea of that part of the immense Alpine region stretching in the north of the Irkut. Further west, the footpath which leads to the long since abandoned graphite mines of Mount Alibert, and which has been followed by several geographers, as also further east, this grand mountain region, rising to 7000 and up to 9000 feet above the sea-level, continues to remain totally unknown. Even the river valleys of the Kitoi and the Byelaya are only mapped in their lower courses.

The 1500 to 2000 feet high plains which lie in the north of this Alpine region, and which will soon be intersected by the great Siberian railway, come next. These fertile plains are well explored by this time, and their climate, soil, and flora are fully described; especially the flora, for which we have the excellent works of MM. Agapitoff, Prein, and J. Freyn (plants gathered by Ferd. Karo), so that we not only possess lists of plants, but know their distribution and subdivision into vegetable "formations," the whole making a capital addition to the classical work of Turchaninoff.

And, finally, the volume contains a full geographical and statistical description of the regions occupied by both the Russian and the Buryate settlements on the high plains along and on both sides of the present Siberian highway.

In the appendix the description of the Nizhneudinsk caves, explored by Chersky, is especially interesting for the naturalist; the more so as Chersky's report had only been published in Russian, in the little-known publications of the East Siberian Geographical Society, and his collection of bones was destroyed during the great Irkutsk conflagration. These caves, situated in limestones 700 feet above the level of the Uda River, and attaining a total length of 1525 feet, contain immense quantities of relics of all sorts of mammals, 17 feet thick at certain places. Moreover, in consequence of the low temperature which prevails in the caves, the bones of the animals are sometimes found with perfectly well-preserved pieces of cartilages, muscles, and skin attached to them. The species discovered by Chersky were:—*Vespertilio borealis* and another still living species of bat; *Sorex vulgaris*; *Canis Nischneudinensis*, a species of wild dog, analogous to, but separate from, the *Canis alpinus*, which may still exist in the mountains of the above Alpine region; the Arctic fox (*Canis lagopus*) and the common fox (*C. vulpes*): the common bear, the *Gulo borealis*, and the sable; a species of *Spermophilus*, different from both the *S. Eversmanii* and the *S. Perryi* which exist in north-east Siberia (its samples have perished during the Irkutsk conflagration); several *Arvicolæ*; the lemming, probably *Myodes obensis*, various soft parts of the head and fore-feet being well preserved with the bones; *Lepus variabilis*, *Lagomys hyperboreus*, *Cervus tarandus*, and *Antilope saiga* (named *Antilope borealis* by Chersky); an undetermined species of *Capra*, the horse, and, what was most striking, a piece of the skin of a rhinoceros. This find was so extraordinary that Chersky hesitated to consider it as a rhinoceros skin, and mentioned it in his report as *Sus?* And so it appears also in Count Uvaroff's "Anthropology." But this piece had happily been sent to St. Petersburg before the conflagration took place, and on nearer examination it at once was recognised as having belonged to a rhinoceros, on account of its characteristic oval pits filled with clusters of seven to ten, and even thirty-three hairs in each cluster. The mixed fauna of the caves proves that they have been filled with animal remains since the Glacial period, and possibly it also points out (through the *Saiga* remains) to a relatively warm post-Glacial period. It is evident, at any rate, that a new exploration of the Nizhneudinsk caves would prove of great utility for post-Glacial palæontology.

The foregoing rapid sketch gives an idea of the interesting contents of this volume. The very name of P. P. Semenoff is itself a guarantee for a thoroughly scientific and good all-round use having been made of all the available materials, without falling into the lengths and repetitions which one would readily excuse in a work of this kind, if they existed. The whole is a lively description of the region, with a view to the grand lines of structure, combined with minutest accuracy in even small details. It would certainly be a great regret if this volume, like the preceding ones of the Russian addenda to Ritter's "Asia" (Amur, East Turkestan, West Sayans) were to remain accessible to Russian geographers only.

P. K.

ELEMENTS OF COMETARY ORBITS.

Verzeichniss der Elemente der bisher berechneten Cometenbahnen. By Prof. Dr. J. G. Galle. (Leipzig: Wilhelm Engelmann, 1894.)

THE volume which we have before us contains, as its title indicates, a list of the orbits of all those comets which have up to the present time been calculated. As our readers may already be aware, this is not the first "Verzeichniss" with which Prof. Galle has presented us, for one has only to refer to the second edition of "Olber's Methode zür Berechnung der Cometenbahnen," by Encke, where will be found a collection of the orbits of comets which had appeared up to the year 1847. In the following or third edition, which came out in 1864, the list was expanded, revised, and brought up to date. The present "Verzeichniss" has, however, assumed larger proportions than its predecessors, containing as it does over 300 pages, and so is published as a separate work.

In the introduction the author sums up in a few words the chief points about the numerous lists of cometary orbits which have been published from time to time, referring chiefly to the different ways in which they have been arranged and compiled.

Several changes from preceding lists have been adopted in the book before us, and we will chiefly restrict ourselves to a brief statement of the same. It may be mentioned here that the order of the elements of the same comet has been so chosen that the less accurate elements precede those which have been considered more correct, so that the last elements in every case are those which approach nearest to the truth.

Two important alterations concern the removal of the distinction between direct and retrograde moving comets, and the way of representing the inclinations of orbits from $0°$ to $180°$. Instead of the Longitude of Perihelion (π) being adopted, Prof. Galle employs the angle between the node and the perihelion point, that is, he introduces an angle ω, which equals the Longitude of Perihelion minus the node, so the relation may be represented by $\omega = \pi - \Omega$. The arc ω has been termed the "Argument of Perihelion," and is somewhat analogous to the "Argument of Latitude" ($u = v + \pi - \Omega$), so that ω is the Argument of Latitude for $v = 0$, or is Perihelion point.

To pass from the "Argument of Perihelion" ω, to the "Longitude of Perihelion" π, without distinguishing between direct and retrograde movement, the simple relation $\pi = \Omega + \omega$ is used. On the other band, if, after the old style in the case of retrograde moving comets, the Longitude of Perihelion is denoted by the difference $\Omega - \omega$ and represents this by π', and if also i' denotes the value of the inclination in this case only as far as $90°$, then the relation for the reduction is as follows:

$$\pi + \pi' = 2\Omega. \quad i + i' = 180°.$$

Following the columns dealing with the position of Perihelion, the Node, and the Inclination, are others giving the logarithms of the Perihelion distance, and the eccentricity, concluding with the names of the computers of each of the orbits and the references in every case.

In addition to the above, we have no less than 160 pages of remarks and literature references, which will be found invaluable by those searching for special information about any particular comet. Perhaps a brief note will best serve to give the reader some idea of the style in which the author has brought together the information. The subjoined note, picked out at random, is typical of the method followed.

No. 356. 1883 II. Discovered 1884. January 7, by Ross in Elsternwick, at Melbourne, observed only for a few days in the southern hemisphere and in Madras, by Ellery in Melbourne until February 4, still approaching February 7 and February 19. At first visible with the naked eye, then afterwards dimmed quickly and difficult to observe—*A.N.* cviii., cix. *M.N.* xliv., xlv. *Observatory* vii. NATURE xxix.—*Tebbutt's* elements are computed from the observations made on January 19, 23, 28. *Tennant's* from those of January 17, 26, 30. *Bryant's* from three normal positions January 19, 25, February 2. *Ellery's* from those of January 12, 18, 28. Oppenheim's from those of January 12, 18, 28, 29, February 4. Three computed ellipses, one by Tennant and the other two by Bryant, in *M.N.* xlv. and xlvii., have been omitted, so also an approximate orbit by Hind in NATURE xxix.—All the above-mentioned orbits are referred to the M.E. 1884, 0.

As a rule the notes are much longer than the above, some, such as those which relate to comets 1880 I., 1881 III., 1882 I., 1882 II., 1889 V., &c., extending over a page or more.

In the compilation of this work, the thoroughness with which it has been done is a striking feature throughout, and Prof. Galle deserves the thanks of all astronomers for the completion of this volume. The information is brought up to the beginning of this year, thus making the book, besides the best, the most recent of all other lists.

W. J. L.

OUR BOOK SHELF.

Primary Geography. By A. E. Frye. Pp. 128. (Boston U.S.A.: Ginn and Co., 1894.)

WE have never seen a class-book of geography more profusely and admirably illustrated than the one under review. Our only regret is that the book, being written for schools in the United States, possesses the eccentric or reformed orthography that obtains there. This, in conjunction with the fact that the British Isles are dismissed in less than a page of text, renders the volume unsuitable for use in our schools. We hasten to remark, however, that the author has not merely concerned himself with the interests of the United States, as a brief statement of the various sections in his work will show.

The book opens with what is called "Home Geography," which section deals with elementary facts of physical geography observable at any place. The earth is next studied from an astronomical point of view; and then follow descriptions of the slopes of the earth. After describing the surface features of the different continents, the author passes to an account of the peoples of the earth, and then to meteorological phenomena. This is followed by sections on plants and animals, and finally commercial geography is treated, the continents being taken in succession. The book has so many excellent points that we can only mention a few of them. One is that the text on people refers to child-life, and must therefore appeal to children more than references to cheek-bones and the texture of hair. Plants and animals are studied in their relations to climate and physical features, and thus a clear idea as to the causes affecting distribution is obtained. Another good point is that each of the great divisions of the earth's surface is shown in its relation to the whole; in other words, the earth is the unit throughout the book. But it is in the matter of illustrations that the work excels all others of its kind. The hundreds of pictures and maps are really works of art, and the author does not claim too much when he expresses the thought that they are superior to those in any similar school book. They are true to nature, most of them having been engraved from photographs; they well illustrate and supplement the text, and they present typical forms. Only in two or three cases can any fault be found. In some of the relief maps showing hemispheres of the earth, the parts of continents extending beyond the hemispheres are, as it were, lifted from the other side, and drawn in outside the containing circle. We are sure that this will lead to misconception, for children will get the idea that the continents are surfaces lying on the earth instead of portions of the earth itself above sea-level. But this is a small matter, and one easily remedied. The book is both attractive and instructive; it reflects great credit upon the author for his originality, and upon the publishers for their enterprise. We should be glad to see a similar work produced on this side of the Atlantic.

Theoretical Mechanics. Vol. i., *Solids.* Vol. ii., *Fluids.* By J. Edward Taylor, M.A., B.Sc. (London: Longmans, Green, and Co., 1894.)

When Solomon delivered himself of the sage remark that "there is no new thing under the sun," his prophetic eye may have been looking up the corridors of time, and seen the "soul-destroying text-books" (as Dr. Armstrong terms examinational literature) of the present day. It is only rarely that a text-book writer goes beyond his brief. He designs his book to meet the requirements of a particular examination, and feels that he has performed his task successfully if future questions set by the examiners are more or less anticipated in the text. Such a writer has little scope for originality. If he departs much from the lines laid down in the examiners' syllabuses, his production fails in its object, and if he keeps the contents within the examiners' bounds, he incurs the censure of the reviewer. Thus it is that text-books are often mere summaries, and that there is a family likeness between those covering the same ground.

The volumes which Mr. Taylor has put together cannot, by the greatest stretch of imagination, be termed interesting. They are little more than collections of exercises and examples. We do not, however, raise any objection to this. Theoretical mechanics, like arithmetic, can only be learned by steadily working at exercises, and of these there is an abundance. The examples are also numerous, and they are so clear that the most obtuse student cannot fail to understand them. There is nothing remarkable about the illustrations except their familiarity. Most of them are very old, and many have done duty time after time.

The Animal as a Machine and a Prime Motor, and the Laws of Energetics. By R. H. Thurston. Pp. 97. (New York: John Wiley and Sons. London: Kegan Paul and Co., 1894.)

Prof. Thurston, the head of Sibley College, Cornell University, ranks very high among American engineers. He is well known as the author of several widely-used text-books and of numerous important papers on engineering matters. The volume just published runs into less than one hundred pages; but in that space, energy and its transformations, and the relations between matter, force, and energy are skilfully described. The chapter which deals with the animal as a prime motor will be found attractive from many points of view, and should be read by all who have to do with the muscular work of men and animals. Among the many matters with which it is concerned are the processes of vital machines, the efficiency of the animal system, effective methods of application of power, intensity of muscular effort, dietaries, and the draught of vehicles. To a large extent the book is made up of reprints from magazines, and selections from various works; nevertheless, it contains many original and valuable points, and will add to the author's already high reputation.

The Aborigines of Western Australia. By Albert F. Calvert. Pp. 55. (London: Simpkin, Marshall, Hamilton, Kent, and Co., 1894.)

Captain William Dampier, the first Englishman known to have made the acquaintance of the Australian natives, referred to them as "The poor winking people of New Holland . . . the miserablest people in the world." Mr. Calvert, who has had a little experience with the natives, looks upon their imperfections with a more lenient eye than the plain-spoken buccaneer, who visited Western Australia in 1688. He gives descriptions of a few of their habits and rites, the information being drawn in some cases from journals in the British Museum, while in others it is based upon his own recollections. Their marriage laws are curious. Children of either sex always take their mother's family name, but a man may not marry a woman of his own family name. Interesting descriptions are given of aboriginal funeral ceremonies, and these, with one or two other matters of interest to anthropologists, render the book worth reading, if a little discretion is used.

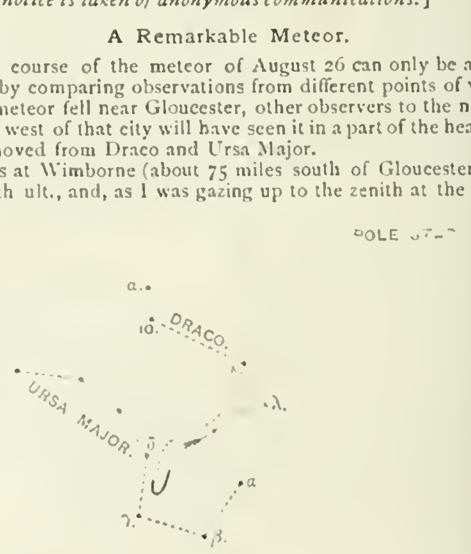
LETTERS TO THE EDITOR.

[*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.*]

A Remarkable Meteor.

The course of the meteor of August 26 can only be ascertained by comparing observations from different points of view. If the meteor fell near Gloucester, other observers to the north, east, or west of that city will have seen it in a part of the heavens far removed from Draco and Ursa Major.

I was at Wimborne (about 75 miles south of Gloucester) on the 26th ult., and, as I was gazing up to the zenith at the time



This figure accompanied Mr. Earle's letter last week. To it a × has been added to show the position of nebulous remains of meteor as seen from Wimborne.

the meteor fell, I missed its descent, but attracted by the vivid glow, I was just in time to catch sight of a brilliant light, which seemed to me two or three times as bright as Venus at its brightest. Any elongated trail disappeared quickly, but a nebular light remained at the lowest point reached by the meteor, which assumed a vague oval shape and imperceptibly faded away. For four minutes the nebular light was easily watched; then I ceased to note the time, and after two or three minutes more I failed to distinguish it.

The position of the nebulous remains of the meteor appeared to me vertically beneath β Ursæ Majoris, at a distance from it rather more than one-third the distance of α from β. I did not notice any motion, but if the apparent upward movement of the nebulous light were due to a north-north-west current of air drifting the light incandescent ash of the meteor to the south-south-west, the motion would be imperceptible to a distant observer who was nearly in the same line up or down the direction of the wind. EDWARD F. LINTON.

Bournemouth, September 8.

IN case it may prove of interest, I write to say that I noticed the meteor mentioned in your last number by Mr. John Earle, as having been seen on the night of August 26. I was walking in the country that evening, and not long after 10 p.m. I saw the landscape lighted up as by a vivid flash of lightning from behind me—my back being towards the north at the time. On turning round, I just caught sight of the meteor as it disappeared, leaving a bright track behind it, about two degrees of arc in length. This track, as seen from where I stood, lay half-way, or nearly so, between the last star in the tail of Ursa Major and Alpha Canum Venaticorum, and in a line connecting the above two stars. It lasted several minutes, as far as I could judge, gradually fading away, and curled up at the lower end, after the manner described by Mr. Earle; but I did not detect any change of position. It seemed to remain about half-way between the end of the tail of Ursa Major and Alpha Canum Venaticorum all the time it was visible to me. I regret that, not having matches with me, I was unable to read my watch and take the exact time of the phenomenon. T. B CARTWRIGHT.

Brackley House, Brackley, September 7,

THE meteor of August 26, referred to by Mr. Earle, was seen at Northwich by me, and noted as remarkable owing to the long continuance of the brilliant light in the sky. We had had thunder and lightning in the afternoon, but the clouds had cleared away, and the stars were visible through a faint haze. On entering my garden shortly after 10 p.m., I saw a most brilliant flash of what I took to be lightning. Not hearing any thunder, I looked to see from whence the flash had proceeded. I then saw, almost in the zenith, but a little to the west, a brilliant streak of light. This remained nearly stationary for perhaps half a minute, and then one end bent till the light assumed the shape of the letter J, or, according to a note made at the time, the shape of a hockey stick. Whilst this was taking place there was a manifest movement of the whole, as I thought, towards the west. In the space of two or three minutes the light faded away. The whole time, from the brilliant flash till the fading away of the phosphorescent light, could not have been more than three minutes. Perhaps the slight haze hid the light here sooner than at Gloucester.

Northwich, September 9. THOS. WARD.

Drought at Antigua.

[MR. THISELTON-DYER has kindly sent us the following interesting note received by him from the Superintendent of Agriculture, St. John's, Antigua.—ED. NATURE.]

We are suffering from a terrible drought here. I thought you might like to look at the accompanying average prepared for H.E. the Administrator. The *Bryophyllum calycinum* weeds are drying up, and in some parts the Opuntias are dying! No single fall of under 1 inch is of any use to us.

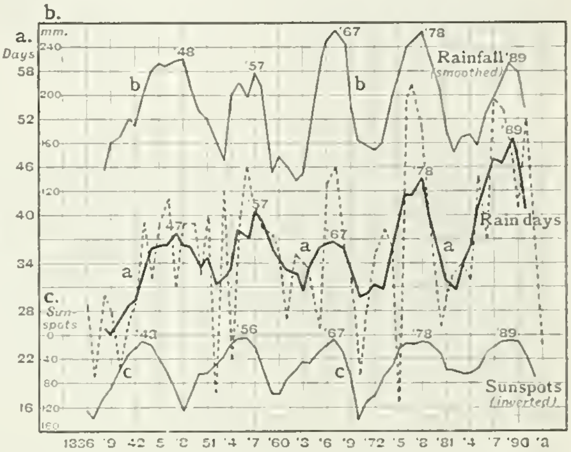
	Jan.	Feb.	March.	April.	May.	June.	July.	
1891	3·74	2·24	0·33	2·82	1·87	4·02	10·04	=25·06
1892	5·81	0·83	0·88	1·18	2·39	3·28	3·15	=17·72
1893	1·77	1·48	2·64	2·14	2·02	2·19	4·63	=16·87
1894	2·02	1·06	1·31	2·84	2·86	1·54	1·73	=13·36
					in.			

NOTE.—1891 was a fair year with annual fall 3·83 over that for last 20 yrs.
1892 „ very dry „ „ 7·24 below „ „
1893 „ „ „ „ 6·73 „ „ „
1894 promises to be worse than any

Antigua, West Indies, August 13. C. A. BARBER.

On Spring Rains in Geneva.

THE variation of rain at Geneva Observatory in spring (March to May), through a long series of years, appears to have been subject to a certain periodicity, to which it might be well to draw attention, even if its (considerable) similarity to that of the sun-spot curve should prove to be merely of a fortuitous nature. In the accompanying diagram, I have dealt with both rainfall and rain days (rain *hours* would have been better than rain *days*, but these extend back only to 1861). The dotted-line curve shows the actual variation in the annual number of rain days, and the continuous curve with it is the result of smoothing with averages of five. Above is a similarly smoothed curve of the spring rainfall, which is very similar (the actual variations are not given). Below is the *inverted* sun-spot curve.



The letters a, b, c, connect the curves with their respective vertical scales on the left. It will be seen that, the sun-spot *minima* occurring in 1843, 1856, 1867, 1878, and 1889, we have in the smoothed rain curves, *maxima* in 1847 or 1848 (but note that the curves rise nearly as high in 1844), in 1857, in 1867, in 1878, and in 1889. In the case of the sun-spot *maxima* (the earlier at least) there seems to be more "lag."

It would be interesting to know what happens in other parts of Europe in this respect. The Paris curve is, I think, like the Geneva one; but Bremen and Berlin present some important differences. A. B. M.

Interesting Marine Animals.

TWO rare and interesting animals, which we have had alive and under observation for a week past in the aquarium of the Port Erin Biological Station, are probably worthy of record in the pages of NATURE. The one is the yellow variety (?) of *Sarcodictyon* (*Rhizoxenia catenata*. This was first found by Forbes and Goodsir in the Hebrides, and has been described since by myself from specimens dredged in Loch Fyne in 1883. We have now found it here, off the west side of the Calf Island, in 25 fathoms, and have at present several colonies alive with the polypes expanded. The commoner red form of *Sarcodictyon* is rarely seen expanded, and I do not know that the yellow one has ever been seen in this condition. The polypes are of a beautiful transparent white, and glisten in the light like frosted silver.

The other interesting animal is the Polynoid worm *Panthalis oerstedi*. We dredge in the deep water near here large muddy sausage-like tubes, which sometimes contain *Panthalis*, but are frequently empty. Some doubt has been felt, however, as to whether the *Panthalis* really builds the tubes, and it is therefore satisfactory to have had the matter definitely settled by the formation of a new tube before our eyes by a living *Panthalis* in the aquarium during the last few days. Mr. Arnold Watson, of Sheffield, who has been studying the formation of Polychæte tubes for some years, after examining our preserved specimens, became anxious to settle the *Panthalis* question, and came here on my suggestion to get living material. I was fortunately able to take a steamer to the ground on the 25th inst., and amongst the tubes brought up in the dredge, from over 50 fathoms, one contained a fine living *Panthalis* which was successfully transferred to a small tank provided with a supply of the fine mud in which the animal lives. This worm has been kept under the closest observation by Mr. Watson and his son during the whole daytime and part of the night for the past week, and their care and enthusiasm have been rewarded by the collection of a number of drawings, photographs, and notes of the appearance and movements of the animal. During that time the *Panthalis* has deserted its old tube, and has formed a new one in the mud, fortunately using the glass of the tank for part of one side, so that the processes of scooping out the mud and of putting on the lining of mucous threads, and the various movements of the animal, have been readily enough seen—if one does not mind the inconvenience of lying for hours in a cramped position on the damp concrete floor of the aquarium room. The worm, and Mr. Watson, are still alive and at work, and we may expect a detailed account of their mutual labours from the latter when his observations are completed. W. A. Herdman.

Port Erin, August 31.

Symmetry of "Aurelia aurita."

During the last few months I have seen countless thousands of living specimens of *Aurelia aurita*, and have paid special attention to abnormal varieties. I have found not only such as have throughout the five-fold symmetry, seen by Mr. Unthank at Brightlingsea, as named in Nature for August 22, but have with me on the *Glimpse* specimens stained and mounted as lantern slides having entire three-fold and entire six-fold symmetry, and one in which it is partially two-fold. I think it may be said that in Suffolk and Essex, a few such abnormal varieties occur per thousand of the normal. An imperfect four-fold symmetry is much more common. H. C. Sorby.

Yacht *Glimpse*, Burnham, Essex, August 31.

MARS AS HE NOW APPEARS.

Statistics are looked upon, as a rule, as hateful things, but nevertheless it would be interesting to know how many people out of the millions who walk this globe will turn at this period a telescope, however small it may be, in the direction of the planet Mars, which is shining so brilliantly in our eastern heavens. Times there were, no doubt, as for instance in the early Babylonian and Egyptian civilisation, when Mars was more generally the subject of scrutiny than to-day, but then the appearance of this intermittent and gradually brightening object made far different impressions on the minds of those early observers. Early it was that the peculiar coloured rays cast by his shining surface on this earth were first remarked. He was known to the Greeks and Hebrews as the fiery planet, and in Sanskrit he was referred to as like "burning coal."

To-day, however, the case is quite different. Many there are who may happen to notice an object more brilliant than usual in the heavens, and make some brief allusion to the fact, and trouble himself or herself no more about it, but it is to the increasing few that his appearance is of the greatest interest. To those who have once made use of even a small telescope to observe the planets, the fact that the nearest, and, it may be added, the most interesting, of them, namely Mars, is approaching us day by day, will be certain to raise a strong desire to catch another glimpse of his disc under such favourable conditions.

So much has been written about the markings of his surface, which represent huge areas of water and land, to say nothing of the most curious network of canals, that reference only to the very recent work on them will here be dealt with.

A few brief remarks, before proceeding, as to the position of the planet in the heavens, and to the approaching opposition.

Firstly, as to position. At the present time Mars is moving easterly in the heavens, situated at the southernmost corner of the constellation of Aries. By September 15 he will have reached his most eastern point, and from that time he will turn in his loop, and continue his apparent journey in the westward direction, passing into the neighbouring constellation of the Fish.

The following table will perhaps be useful to those who have not the data at hand. The times referred to are Greenwich mean time.

Date.		R.A. Noon.	Decln. Noon	Diam.	Rises.	Transit.	Sets.
		h. m. s.	° ′	″	h. m.	h m.	h. m.
Sept. 8	...	2 14 36	9 37 N	21·8	8 6	14 59	21 52
18	...	2 15 48	9 49	23·4	7 30	14 24	21 18
28	...	2 11 15	9 42	24·9	6 46	13 40	20 34
Oct. 8	...	2 1 30	9 16	25·6	5 59	12 50	19 41
18	...	1 48 38	8 41	25·7	5 10	11 58	18 46
28	...	1 35 38	8 9	24·6	4 21	11 6	17 51
Nov. 7	...	1 25 29	7 51	22·8	3 29	10 16	16 55

The fact of Mars being the first superior planet reckoning from the sun, his opposition, or in other words, the position in which he is to be found in his orbit when on the same side of the sun as the earth, with all three bodies in a straight line, affords us a good opportunity for studying his surface features. Owing, however, to the non-concentricity of planetary orbits, his distance from the earth at these times is always varying, and this explains why some oppositions are more favourable for observation than others. The nearest approach of Mars to the earth may be approximately given as 35,000,000 miles, his distance at the coming opposition exceeding this number by about 5,500,000 miles.

In consequence of these varying distances, the apparent size of his disc is undergoing changes; thus the conditions at each succeeding opposition are rarely the same.

That the coming opposition is a very favourable one, can be seen from the table given below, and that it will be more favourable than that of 1892 for observers on the northern hemisphere is due to the planet's more northern declination at this period, bringing him above the mists which spoil good seeing near the horizon.

Date of Opposition.		Semi-diameter.
		″
1862 October 5	... ...	10·8
1869 February 13	... ...	8·2
1873 April 27 ...	... ...	9·7
1877 September 5	... ...	14·7
1881 December 26	... ...	9·2
1884 January 31	... ...	8·3
1888 April 10 ..	... ...	9·2
1892 August 13	... ...	14·7
1894 October 20	... ...	12·9

Let us turn our attention now to the observations that have been made up to the present time, and see what has as yet been learnt from a study of the Martian surface. The work to which we are now about to refer hails from the Lowell Observatory, Flagstaff, Arizona, and the observations have been and are continually being made by its founder, Mr. Percival Lowell, who has set his observatory on this spot for the single purpose of carefully studying the surface of Mars during this period of opposition. The old saying that the early bird gets the first worm, can be applied with some force to Mr. Lowell, for he has been rewarded with ample satisfaction for commencing his observations at such an early date. Indeed, perhaps the great value of this series of observations which he is making will be in its very length, for is he not, from a study of his own observations, watching attentively the various stages of a vast aquatic display which becomes more and more distinct the nearer the earth is approached, and therefore must be continually and for a long period observed?

At the commencement of the observations (May 31) the planet was 98,000,000 miles away, and his south pole was directed towards the earth at about 23½°, reaching a maximum dip of 24° on June 22, the disc appearing gibbous to the extent of about one-sixth.

Such being the conditions of seeing, one could look on the planet, so to speak, rotating under one, watching the snowy pole whirling, as a boy might look at his colour-striped top. The observations were thus limited more or less to the southern hemisphere, but occasional glimpses carried one up as far as latitude 40° north. The regions most referred to in the observations were the Syrtis Major, all the region of the north pole, that about Solis Lacus, Lacus Phœnicis, and that a little more north of Mare Sirenum and Mare Cimmerium.

The rapid diminishing of the huge snow-cap, which at this period of the planet's summer has been taking place very rapidly, has perhaps been the most prominent feature of this series of observations. Mr. Lowell has noticed a decrease in its diameter of about 7° in as few as fifteen or sixteen days, by no means a small diminution considering the length of the period.

A further very prominent feature of this polar cap is the apparently perfectly elliptical outer edge, which means that the boundary is in reality circular. The narrow dark streak girdling it, and of nearly a uniform breadth, is "clearly water at the edge of the melting snow, a polar sea in short."

On the snow-cap itself, in the region of the great bay situated south, Hellas and Chersonesus, several extremely brilliant parts have been observed, the appearance and behaviour of which have led to the conclusion that we are here dealing with mountains. These at present are accounted for by supposing that the rotation of the planet brings them into such positions that the sun's light can be reflected by them in the direction of the earth, just as a beam of sunlight can be thrown by means of an ordinary mirror. What has led us to believe them to be mountains is the constancy of the positions in which they are, for not only have they been several times observed at this period of opposition, but Mitchell in 1845, in a drawing made at Cincinnati on August 30, and Green in 1877, have both recorded them and in the same position.

Another marking on this polar cap, referred to as "the great rift," seems to be a very conspicuous object. The best time for observing it is when it is, so to speak, end on, or on the central meridian of the planetary disc. Mr. Lowell has likened it to "a huge cart-track coming down to one over the snow," and he has estimated its size as 220 miles broad and 1200 miles in length.

An observation, which is of more importance than one is at first likely to admit, is that concerning the *indefinite* characters of all the markings between the sharp boundary of the snow-cap and the *definite* characters of the continental coast-line. The coast-line was "most salient and clear cut on the western side of the Hour-Glass Sea (Syrtis Major or Mer du Sablier). To the eastward the coast lay in general direction straight, approaching the pole as it stretched eastward. It was indented by numerous bays, but destitute of those comet-tail peninsulas so generally observed connecting it to the chain of islands south. All of these islands, Hellas, Ausonia, and the rest, were vague, without definite contours, and lapsed imperceptibly into the surrounding seas. Even in colour they were less decided than, though of much the same tint, as the continental areas."

With such facts before us, it is hard to believe that we are not observers of a great inundation, which obliterates, or nearly so for a time, all landmarks lying anywhere in the region 20° or more south of the equator. The source of this flood would of course be the rapidly melting snow, and the great volume of water now liberated from the solid form, and forming at the boundary of the cap the dark narrow belt, would be ample to account for the disappearance of islands, blurring of coastlines, and suchlike phenomena. Certain are we that these landmarks are *there*, and the only justifiable cause of their dimness of outline and colour is the hypothesis of their partial and sometimes total submersion.

An observation of great interest may be mentioned here, as it deals directly with the great variation of surface markings we have referred to above. The most conspicuous object on the planet's surface at the present time is the large black gulf bounding the melting snow, and situated due south of the Hour-Glass Sea, or Syrtis Minor. This, as Mr. Lowell has previously described it, is clearly water at the edge of the melting snow, or, in other words, a polar sea. On June 4 the polariscope was brought to bear on this gulf by Prof. Pickering, with the result that it was declared to be water, just as the canal in the same region, running north from it, was concluded to be of this substance. This observation simply verified what had previously been thought to be the case from its general appearance and colour; but another examination, at a later date, represented the matter in quite a different light. On July 9 "no trace of the polarisation in the dark spot could be detected," and a more minute examination of the colour of this region showed it to be of a "rich chocolate-brown tint, differing entirely in colour from the bluish-grey regions to the north of it." This reads somewhat different from Lowell's observation on July 9: "Bay a deep blue, looks just as deep water does." Prof. Pickering is of opinion that as the colour of the grey regions does not, he thinks, represent water, he is led to conclude, as far as his observations at present go, that the "permanent water area on Mars, if it exists at all, is extremely limited in its dimensions." This favours to a considerable extent the hypothesis of an inundation.

Let us consider for a moment the observations relating to the appearance of the channels at this time. These, at this season of the Martian southern hemisphere, are generally not so easy of observation, but Mr. Lowell has been able to make out several of them. Those most generally seen were Cerberus to the north of Mare Cimmerium (on June 9 glimpsed as double), Eumenides, Gigas, Titan, Gorgon and Sirenius, all of which lie just to the north of the Mare Sirenum, and at a later date he has seen some in the region of the Lake of the Sun (Solis Lacus), namely Phasis, Eumenides, and Agathodæmon. These channels, including one or two others which we have not mentioned in the above list, have, we may say, the greatest southern latitude, or lie nearest to the south pole, a fact which may or may not be insignificant.

Of course the great inclination of the pole of Mars towards us, renders those on the northern hemisphere more difficult of observation, so that our information is to a great extent restricted. Nevertheless, one is inclined, from Mr. Lowell's drawings, to look upon the channels simply as the watercourses caused by the inundation of the sea on to the land, commencing naturally at the lowest levels, and of course at the water's edge. Out of the nine drawings which he gives, illustrating the positions of the canals observed, eight of them show the majority of the canals in connection with the southern seas, while there is only one instance of a channel not so connected, and that a very short one. This is as it should be if the channels are, so to speak, overflow courses, and accounts also for the invisibility, or at any rate the difficulty of observation of the channels, as a whole, about this time. As the polar cap ceases to melt, the channels should then be at their fullest, and therefore easily visible. The absence of cloud on the planetary surface about this time shows that the aqueous circulation is almost totally brought about by this flood season.

Whatever may be the cause of these channels and their duplicity at times, cannot be dwelt on here: but that they are the results of a great inundation, seems to be the conclusion which is most compatible with recent observation.

A further fact which has recently attracted particular attention is the frequent observation of bright projections on the terminator of the planet's disc. It may be here simply mentioned that the observations as yet seem to point to the presence of high mountains as the cause of these bright markings.

A discussion of this question will be dealt with, however, in a future article, which will contain a detailed account of the work up to the present time.

Such, then, are some of the facts which have been brought before us by the Arizona observations. Observations at other observatories, such as that of Juvisy, &c., are also at hand, but the weather seems to have been hard on these eager watchers, so the observations are very few. The surface of Mars is still a puzzle to be unravelled, and there are many who are employed in the fascinating work of solving it. One may repeat, what has often been stated before, that in the study of planetary details, the aperture or the size of object-glass is not the most important function for good observations. A keen and patient observer sitting at the eye-piece of a comparatively small equatorially-mounted telescope, if he makes his observations carefully and with due regard to atmospheric conditions for good seeing, can do more useful and valuable work than one who has a large aperture at his disposal, and employs it indifferently. For Martian detail, Mr. Lowell puts the observer first, then the atmosphere, and lastly, the instrument, as the order of weights to be given as factors of a good observation. W. J. LOCKYER.

Note. In my article on "The Discs of Jupiter's Satellites," which appeared in a previous number of this journal (August 2, p. 320), the table, giving the measurements of the position angle of the 1st satellite, requires a slight alteration, owing to a printer's error in that number of *Astronomy and Astrophysics* from which the table was taken. In the column indicating the initials of the observers, the following measures, 1, 3, 5, 7, 9, 11, ought to be attributed to Prof. Pickering, and the rest to Mr. Douglas. This alteration makes no change in the text necessary, as it was only stated that there was "a mean personal correction of about 7°·1," which, in the light of the revised column, still holds good. The correction, with one exception, simply reverses the names of the observers in each case. W. J. L.

THE ARCHOPLASM AND ATTRACTION SPHERE.

PLATNER in 1886, when dealing with the spermatocytes of helix, showed that the great "nebenkern" in these elements was derived after each division from a coalescence of the spindle-fibres. At the same time he pointed out in the interior of the structure bright refractive points answering in every way to what was then known about the centrosomes. Some time afterwards F. Hermann, in an exquisite description of the karyokinetic process in the spermatocytes of salamander, successfully homologised the great "archoplasm" (as he termed the nebenkern of these cells), on the one hand with Platner's nebenkern, and with the sphere-attractive and archoplasm of Van Beneden and Boheri on the other. I subsequently drew attention to the fact that this archoplasm in the salamander arose by a collection of the spindle-fibres precisely in the same manner as that of helix, *i.e.* these structures (attraction-spheres) in widely separated groups present precisely similar constituents, and arise in a precisely similar way.

The clear appreciation of the mutual equivalence of these bodies is of considerable value, as it paves a way towards the systematic splitting up of a whole group of structures present in reproductive cells, which had all previously been loosely grouped under the head of nebenkerns. Nevertheless, if we accept it, a certain difficulty arises, to which I referred briefly at the time, and to which Dr. Neves has since called my attention in an interesting letter from Kiel:—If the archoplasm of the spermatocytes with its inner constituents is the homologue *in toto* of the attraction-sphere when at rest (Fig. 3), or during the initial phases of mitosis, what is to be said of it in the later phases of this process?

In the attraction-sphere as first described and ordinarily understood in ascaris, the centrosomes, with their light-surrounding zone, occupy the middle of an extended archoplasm which divides with the centrosomes during the course of the mitotic change, but in the case of salamander the archoplasm remains undivided as a rule: and its whole mass is used up in the construction of the spindle, the centrosomes appearing at the apices of the figure related to a radiation of the non-archoplasmic and external protoplasm. Now when the karyokinesis is completed, and the daughter nuclei formed, the centrosomes can be found at the remote sides of the nuclei (as in Fig. 4, *c*, one-half of a dividing spermatocyte of a rat), but the two new archoplasmic masses are being regenerated on each side of the division plane (as in the rat, Fig. 4, *b*). These masses become completely formed, but in consequence of their position are destitute of centrosomes, which must acquire a secondary connection with them; so that at this phase the sphere is divided into two parts in each cell, that which attracts (centrosomes) being at one side of the nucleus, that which is regarded as primarily attractive (the archoplasmic portion of the kytoplasm) on the other. In salamander these anomalous conditions eventually become righted by the centrosomes wandering round the nuclei into the archoplasm.

Turning, however, to a still higher type of vertebrates, the Mammalia, a short time ago I found in the spermatocytes of various forms, besides other and well-known accessory bodies, a great lightly staining nebenkern (archoplasm), which can be determined as arising during the spermatogenesis by a coalescence of the spindle-fibres (Figs. 1, 2, *a*), so that we must regard this body as having the same value as the nebenkern in Amphibia, in Helix, in Echinoderms, or that it is the archoplasmic portion of the attraction-sphere; but at no time, either at rest or during active mitosis, does it contain within its mass the centrosomes! In the resting spermatocytes of the rat (Fig. 2) these bodies lie quite outside the archoplasm (Fig. 2, *c*), they become duplicated, and enter into the formation of a spindle without any connection with the archoplasm (Fig. 1, *c*), which passes further away, and ultimately degenerates (Fig. 1, *a*). The spindle-fibres are constructed anew out of the kyto- and superficial nuclear-plasm, and the mass of substance thus utilised is collected on either side the division plane as the archoplasmic bodies of the daughter cells.

The archoplasm, then, has no permanent existence in these cells, and is of no immediate consequence in the formation of the spindle. The fact, however, that the transitory body formed in mammals from each new crop of spindle-fibres, after each division (Fig. 4) rapidly dissolves and reincorporates itself into the surrounding kytoplasm, is distinctly favourable to the view now gaining ground, that the spindle has a kytoplasmic origin.

From all this it will be seen that we cannot regard the archoplasmic portion of the sphere as a permanent organ of the cell any more than the ripples wind produces are the permanent features of the surface of a pond.

On the other hand, all the more recent investigations concerning normal or karyokinetic propagation of cells, whenever sufficient pains have been taken to insure good results, show that the centrosomes retain their individuality through every change. Couple with these facts the discovery by Dr. Field of the entry of the centrosomes into the spermatozoa of the echinoderms, and a quite similar state of things I have found to occur in mammals, and there seems much evidence that the centrosomes, unlike the other constituents of the sphere, retain their individuality during successive mitoses, and are incorporated as an essential constituent of the spermatozoa.

Further, the well-known observations of Fol, and more recently those of Fick, show clearly that these bodies assume their old functions as dominants of the attractive process in the initial steps of fertilisation. Their identity through successive generations being thus maintained, the

Fig. 4.

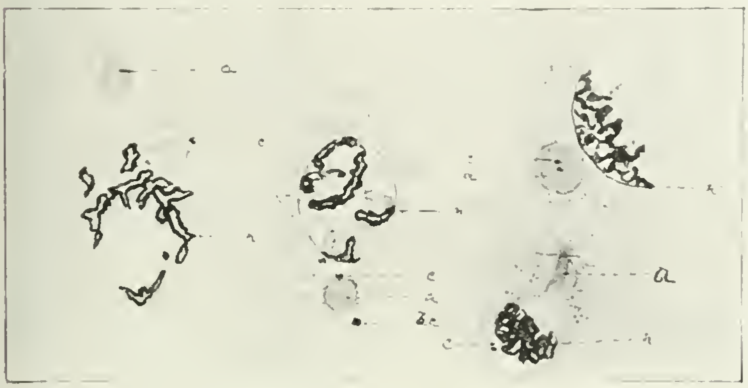


Fig. 1. Fig. 2. Fig. 3.

important functions they perform in the division process itself necessitates our regarding them, with Van Beneden, as organs of the cell, although, when viewed in such a light, they will have to be disrobed of their more conspicuous radial and archoplasmic vestments. With respect to these latter, in whatever degree they may be present, it seems an unavoidable conclusion that they can only be regarded as the effect produced by the inconstant action of polarity or whatever power is exercised by the centrosomes on the surrounding kytoplasm.

J. E. S. Moore.

HERMANN VON HELMHOLTZ.

Honoured and mourned by all, Prof. von Helmholtz, one of the most brilliant men who have devoted their lives to science, passed away at Charlottenburg, on Sunday last. Shortly before his death, the Empress Frederick sent a telegram of inquiry as to his condition, and upon hearing of his decease messages of sympathy were sent to the sorrowing relatives by the Emperor and herself. This fact is a significant indication of the regard in which the representatives of science are held in Germany.

Hermann Ludwig Ferdinand Helmholtz was born August 31, 1821, at Potsdam, where his father, Ferdinand Helmholtz, was Professor in the Gymnasium, his mother, Caroline Penn, being of an English family. While but a schoolboy he developed a love for science, and studied all the books on physics which his father's library contained. They were very old-fashioned; phlogiston still held sway, and electricity had not grown beyond the voltaic pile. When the class was reading Cicero or Virgil, he was finding the paths of the rays in a telescope, or developing optical theorems not usually met with in text-books. At that time there was little possibility of making a living out of physics, so, acting on the advice of his father, Helmholtz took up the study of medicine. He entered the Army Medical School, the Friedrich Wilhelms Institut, and while there came under the influence of a profound teacher—Johannes Müller. He eventually became a military surgeon, and continued in that position till the end of 1848, when he was appointed Assistant of the Anatomical Museum of Berlin, and Teacher of Anatomy at the Academy of Arts.

In 1847, that is, during his career as an army surgeon, Helmholtz's essay, "Ueber die Erhaltung der Kraft," was published. In this, the principle of the conservation of energy was developed. About Joule's researches on the same subject, he knew at that time but little, and nothing at all of those of Robert Mayer. He was led to write the essay by an examination of Stahl's theory, adopted by most physiologists, which accorded to every living body the nature of a *perpetuum mobile*. The essay contained the results of a critical investigation of the question whether any relations existed between the various kinds of natural forces for perpetual motion to be possible. It was written for the benefit of physiologists, but, to Helmholtz's surprise, the physicists took up the doctrine of the conservation of energy, which some of these were inclined to treat as a fantastic speculation. Jacobi, the mathematician, recognised the connection between the line of thought in the essay, and the principles investigated by Daniell, Bernouilli, d'Alembert, and other mathematicians of last century, and soon the members of the then young Physical Society of Berlin accepted Helmholtz's results. It is unnecessary for us to dwell upon the marvellous influence that these results have had upon physical science during the last half-century. The principle of the conservation of energy has long passed through the debatable stage, and some of the greatest discoveries in thermodynamics and other branches of modern physics have been deduced from it.

In 1849 Helmholtz went to Königsberg as a Professor of General Pathology and Physiology; seven years later he accepted a similar position at Bonn University. While at the former University he designed the ophthalmoscope for the diagnosis of diseases of the inner parts of the eye—a discovery which shows the great importance to the physiologist and physician of a thorough knowledge of physical principles. The year 1859 saw him occupying the chair of Anatomy and Physiology at Heidelberg; and in 1871 he was appointed Professor of Natural Philosophy in the University of Berlin, a post which he held until his death.

The two great works of Helmholtz on "Physiological Optics" and on the "Sensations of Tone," are splendid examples of the application of methods of analysis to the two kinds of sensation which furnish the largest proportion of the raw material for thought. In the first of these works, the colour-sensation is investigated, and shown to depend upon three variables or elementary sensations. The study of the eye and vision is made to illustrate the conditions of sensation and voluntary motion. In the work on the "Sensation of Tone as a Physiological Basis for the Theory of Music," the conditions under which our senses are trained are illustrated in a yet clearer manner. His researches threw a flood of light upon what may be termed the mechanical, physical, physiological, and psychological processes involved in seeing and hearing.

No good end would be served by enumerating Helmholtz's contributions to knowledge. The versatility of his genius is well known among all workers in the realm of nature. Mathematics, physics, physiology, and psychology are but a few of the branches of knowledge which have been enriched by his investigations. His acquaintance with science was not only extensive but thorough, and, as Clerk Maxwell said in these columns in 1877 (vol. xv. p. 389), the thoroughness was that which of itself demands the mastery of many sciences, and in doing so makes its mark on each. He solved problems with which great mathematicians, since the time of Euler, had occupied themselves in vain. Questions as to vortex motion and the discontinuity of motion in liquids, and the vibrations of sound at the open ends of organ pipes, belong to this class of subjects elucidated by him. In his numerous papers on thermodynamics, he reduced to an intelligible and systematic form the labours and intricate investigations of several independent theorists, so as to compare them with each other and with experiment. Other subjects investigated by him are electrodynamics, stereoscopic vision, galvanic polarisation, the theory of anomalous dispersion, the origin and meaning of geometrical axioms, the mechanical conditions governing the movements of the atmosphere, the production of waves, &c. But even the circle of natural and physical sciences does not embrace all the subjects which he benefited by his keen insight and strenuous energy. He was an acute logician and an accomplished metaphysician. His investigations on perception and observation of the senses led him to study the theory of cognition. The principal conclusion he came to after an examination of the subject, was that the impressions of the senses are only signs for the constitution of the external world, the interpretation of which must be learned by experience.

In 1891, when Helmholtz reached his seventieth birthday, the event was made the occasion of an international celebration. In honour of the anniversary, a marble bust was prepared, and numerous marks of respect were bestowed upon him by his admirers, both in and out of his own country. The German Emperor raised him to the highest rank in the Civil Service; the Kings of Sweden and of Italy, the Grand Duke of Baden, and the President of the French Republic conferred Grand Crosses upon him; many academies, not only of science, but also of the fine arts, faculties, and learned societies representing all parts of the world, sent him diplomas and richly illuminated addresses, expressing their recognition of his scientific labours, and their thanks for his work. His native town, Potsdam, conferred its freedom upon him, and countless individuals sent their congratulations. It was on the occasion of this jubilee that Helmholtz delivered the autobiographical sketch published in the second volume of his "Scientific Lectures," and which has furnished us with some of the particulars contained in the foregoing. He was made a Foreign Member of the Royal Society in 1860, and received the Copley Medal in 1873. He was also one of the Associés Étrangers of the Paris Academy of Sciences, and a correspondent of most important scientific academies and societies all over the world.

Science has had few investigators who have furthered her interests more than Helmholtz. He was constantly exploring new fields of research, or bringing his keen intellect to bear upon old ones. With his contributions he helped to raise science to a higher level. And, while he did as much as anyone to render scientific discoveries understandable to the whole intellectual world, he always recognised that he was in the service of something that should be held everlastingly sacred, a feeling which kept him from playing to the gallery either in his popular works or in his lectures. Many years ago, it was written—

"A wise man instructeth his people, and the fruits of his understanding fail not."

"A wise man shall inherit glory among his people, and his name shall be perpetual."

To no one could these words be more appropriately applied than to the eminent investigator whose loss we now deplore.

NOTES.

We note with deep regret that Prof. H. K. Brugsch, the distinguished philologist and Egyptologist, died on Sunday last, at the age of sixty-seven.

The Deputy-Mastership of the Mint, vacated by the resignation of Sir C. Fremantle, K.C.B., will be filled at once by the appointment of a distinguished official, Mr. Horace Seymour, Deputy-Chairman of the Board of Customs. If the post had been destined for a scientific man, it would doubtless have been given to Prof. Roberts-Austen, C.B., but his acceptance of it would have involved his resignation of his chair at the Royal College of Science. The due discharge of the duties of the Deputy-Mastership would, moreover, have left him far less opportunity for research than he has in his present office at the Mint, which he has made such an important one for science. Sir Charles Fremantle has always encouraged original research in his Department, and we wish him much happiness in his well-earned retirement.

The death of the Comte de Paris recalls the fact that he was a Fellow of the Royal Society. He was elected by ballot on April 27, 1865, and signed the charter book on May 18 of the same year. Under the statutes which were then in force, any foreign sovereign prince or the son of a sovereign prince could be proposed for immediate ballot if he wished to enter the Society. In the case of the Comte de Paris it was found that, according to the strict letter of the statutes, the head and representative of a Royal house might be inadmissible by privileged election, whilst members of the same family of inferior rank were entitled to it. Although he was the hereditary representative of the then late King of the French, yet inasmuch as his father had not been a "sovereign prince," the Society was precluded from extending the courtesy of election, and therefore took steps to amend the statute, and upon being advised that Court usage would accord, introduced words establishing the privilege to "any foreign prince who is received by her Majesty as Imperial Highness, or Royal Highness." It was under such an amended statute that the unanimous election of the Comte de Paris occurred.

The death of Prof. Josiah Parsons Cooke, LL.D., which took place in Boston, Massachusetts, on Tuesday, is, says the *Times*, not simply a loss to Harvard University, where he has laboured for more than forty-four years, but to the scientific world at large. His work on "The New Chemistry" is well known and highly esteemed, and has been translated into nearly every language of Europe. Born in 1827, he graduated from Harvard in 1848. In the following year he became tutor in mathematics, afterwards instructor in chemistry, and in 1850 Erving Professor of Chemistry and Mineralogy at Harvard. Under his direction the course in chemistry was greatly developed. He was the first in America to introduce laboratory instruction into the undergraduate course. In addition to his duties at Harvard, it was his practice to give courses of popular lectures on chemistry in the cities of Baltimore, Brooklyn, Washington, Lowell, and Worcester, besides his regular lectures at the Lowell Institute in Boston. As director of the chemical laboratory at Harvard he has published numerous contributions to chemical science, most of which have been collected and published in a volume entitled "Chemical and Physical Researches." In 1872 he was elected an honorary Fellow of the Chemical Society, sharing that distinction with only one other American; and in 1882 he was granted the degree of LL.D. by Cambridge University.

The death is announced of Sir Edward Augustus Inglefield, K.C.B., F.R.S., at the age of seventy-four. The following particulars as to his scientific work are extracted from an obituary notice in the *Times*:—After seeing a large amount of active service, and earning for himself a high reputation, he was appointed to the command of the yacht *Isabel* in a private expedition which was sent in search of Sir John Franklin to Smith's and Jones's Sound—an experience which partly suggested the interesting story he published under the title of "A Summer Search for Sir John Franklin." Although it failed in its main object, his plucky mission on that occasion enabled him to record the discovery of an open polar sea and a coastline 800 miles in length, while he also had the pleasure of carrying mails to the Government Arctic Expedition at Beechey Island. For these services he received the gold medal of the Royal Geographical Society of London, the large silver medal of Paris, and a much-treasured diamond snuff-box from the Emperor of the French. He was at the same time elected a Fellow of the Royal Society. His first Arctic experience brought him a second like command in 1853, when he went out by order of the Admiralty with three ships, especially despatched to the relief of Sir Edward Belcher's expedition. One of the three vessels was crushed in the ice, and foundered, but he was able to bring home an officer bearing the news of the discovery of the North-West passage. In the following year he received the command of another expedition, consisting of the *Phœnix*, the *Talbot*, and a transport with stores, sent out to afford further relief to Sir Edward Belcher, and this time he brought back the officers and crews of five ships which were abandoned in the ice. For these services he was awarded the Arctic medal, and the honour was signally confirmed by the Queen in 1887, when he was knighted on the occasion of the celebration of the completion of the fiftieth year of her Majesty's reign. To his skill and daring as a seaman Sir Edward Inglefield added a technical ingenuity which has bequeathed to naval engineering the hydraulic steering apparatus fitted in the *Achilles* and the *Minotaur*, the screw-turning engine of the *Monarch*, and the anchor bearing his name, which was supplied to the *Dreadnought*, *Sans Pareil*, *Renown*, *Inflexible*, and other ships. He was a graceful writer and a vigorous speaker, and, beside the book recounting his Arctic researches, was the author of pamphlets on "Maritime Warfare," "Naval Tactics," and "Terrestrial Magnetism."

THE thirty-ninth exhibition of the Royal Photographic Society will open to the public on Monday, September 24. The exhibition will be held, as on former occasions, in the Gallery of the Royal Society of Painters in Water Colours, at 5A Pall Mall East, and will remain open until November 14.

THE Royal Commission appointed last year to inquire into the mode of identification of habitual criminals having reported favourably on the Bertillon system, the Commissioners of Prisons have decided to adopt the anthropometrical system of measurement of criminals. The system will be worked in connection with the present system of identification. From various prisons officers have been already ordered to attend at her Majesty's Prison, Pentonville, to receive instructions from Dr. Garson.

REUTER reports that the members of the Arctic excursion party, organised by Dr. Cook, and noted in NATURE of August 30 (p. 429), have returned to North Sydney, Cape Breton, in the Gloucester fishing schooner *Rigel*. The steamer *Miranda*, by which the party travelled, grounded and sprang a leak on the coast of Greenland. After they had remained on the disabled vessel for some time, the party were taken off by the *Rigel*. The *Miranda* was floated and taken in tow, but foundered on her way home.

A MONUMENT, erected in honour of Armand de Quatrefages, was unveiled at Vallerangue, his native town, at the end of last month. M. Darboux presided over the distinguished company that took part in the ceremony. The scientific labours of the renowned investigator were extolled by MM. Milne-Edwards, Hamy, Geoffroy Saint Hilaire, and Brongniart. Prof. Hamy referred to Quatrefages as the creator of the science of anthropology. The monument is five metres in height, and consists of a bronze bust of the deceased on a stone pedestal, having on its principal face a figure holding in one hand a scientific work, while the other is presenting a crown to the eminent naturalist.

WE learn from the New York *Nation* that the Marine Biological Laboratory at Wood's Holl, Mass., has concluded its seventh summer session, the most successsful in its history. The number of students and investigators in attendance was 133, representing seventy colleges and high schools. Courses of instruction in zoology and botany were offered, a new building for the accommodation of the students in the latter course having been erected. The important part played by the Laboratory in the development of the biological sciences in this country is evidenced by the fact that no less than fifty-eight of those in attendance were carrying on research in zoology, botany, or physiology, and that several important investigations were completed during the summer. A number of the lectures delivered at the Laboratory during the session will as in former years, be published in book form.

MR. H. GARNETT informs us that while boating with a friend on the River Avon, just above Evesham, on August 11, he had a good view of a white swallow flying amongst a flock of others very near the ground. Its companions were apparently persecuting it. Finally it flew across the river close over the observers' heads, and this view was sufficient to convince them that it was the common swallow, and not one of the martins. Curiously, it was not a snow-white, but apparently a very pale uniform cream colour. In connection with Mr. Garnett's observation, it is worth remark that the current number of *Science Gossip* contains a note on a white variety of the common sparrow, shot at Ripley on August 13; and Mr. E. W. Atkinson, writing to the *Zoologist*, says that he recently saw a white swallow at Harswell, in the East Riding of Yorkshire.

OF all the sciences, meteorology is probably the farthest from perfection. Many dabble in it, but few seriously attempt to reduce the abundance of observations to law and order. One of the reasons for this state of things is that, so far as we can remember, none of our educational institutions include systematic courses of meteorology in their curricula. There is practically no field for professional meteorologists, and therefore no training-school exists. For the sake of the science we are glad to note, however, that the Board of Regents of the University of California has decided to establish a course in meteorology in that University. Through the course of study and investigation which the students of meteorology will prosecute at the University, valuable additions to knowledge may be expected.

M. DE FONVIELLE calls our attention to one of Roger Bacon's essays, published in 1618, in which some of the possibilities of steam are vaguely foreshadowed, and aerial navigation is declared to be a thing of the future. We quote from a translation with which he has furnished us, and which reads like Mother Shipton's prophecies. "Instruments may be made for navigating without any men pulling the oars, with a single man governing, and going quicker than if they were full of pulling men. Waggons also can be made so that without any horse they should be moved with such a velocity that it is impossible to measure it. . . . It is possible also to devise instruments for flying, such that a man being in the centre if revolving something by which artificial wings are made to beat the air in the fashion of the birds. . . . It is also possible to devise instruments which will permit persons to walk on the bottom of the sea. . . . All these things have been done in old times and in our times, except the instrument for flying, which I have not seen, and I have not known any man who saw it done."

THE portion of Lord Salisbury's address which refers to the periodic law was not delivered in exactly the same form that it was printed in the official copy. A correspondent of the *Chemical News* points out that in the printed report (see NATURE, August 9, p. 340) the following passage occurs:—"In the last few years the same enigma has been approached from another point of view by Prof. Mendeléeff. The periodic law which he has discovered reflects on him all the honour that can be earned by ingenious, laborious, and successful research." Before the address was delivered, Lord Salisbury became aware of the claim of Newlands as the first discoverer of the periodic law, and the words actually spoken in the Sheldonian Theatre were:—"In the last few years the same enigma has been approached from another point of view by our own countryman Newlands and by Prof. Mendeléeff. The periodic law which they have discovered, &c." Unfortunately, the address was already printed and distributed to the press before the alteration was made. The claim of Mr. Newlands is secured to him by the award of the Davy Medal in 1887 by the Council of the Royal Society.

WRITING from Table Cape, Tasmania, Mr. H. S. Dove says that a fine aurora was witnessed there early on the morning of July 21, from about 12.30 until a few minutes after 1. The whole of the western, southern, and a good deal of the eastern heavens was illuminated by a strong red glow, paling to a delicate pink at the edges. The glow was brightest about half-way between the horizon and zenith, but was discernible over the whole space between those two boundaries, and when it paled and faded in the west would spread and become very vivid towards the east. The broad vertical white stripes which usually accompany these auroræ were also noticeable, but the most uncommon feature of the phenomenon was the presence of brilliant white flashes which shot upwards in rapid succession, spreading out into a fan-shape as they rose, and instantly disappearing. These were principally seen about the Southern Cross, where the vertical stripes were also brightest, the region about that constellation appearing to be the centre of a great electrical disturbance. A low bank of clouds lay along the horizon under the aurora, and a stream of white fleecy clouds sailed up from about west-north-west, but preserved almost a straight line on the edge next the phenomenon, as if something in the highly electrical state of the atmosphere there prevented their spreading in that direction. A note concerning the same aurora appeared in our issue of August 30.

A NEW department of the Pasteur Institute in Paris has recently been established, having for its special object the experimental study of means of defence against destructive insects. The new section—Station expérimentale de l'Institut Pasteur—as it is called, has (says the *Revue Scientifique*) been placed under the superintendence of M. Metchnikoff, with M. J. Danysz as assistant. The department will be concerned with the following points: (1) The collection and cultivation of all the pathogenic microbes of insects and animals destructive to crops; (2) the study of the conditions of development of these microbes in animals and on various media; (3) the direction of field-experiments; (4) the superintendence and control of practical applications of the results of laboratory work. The best means of applying these results will be discussed by a *Comité d'étude* consisting of naturalists, agriculturists, and some specialists in mycology, bacteriology, and agriculture, such as MM. Brocchi, Costantin, Grandeau, Millardet, Sauvageot, Schribeaux, A. Giard, J. Kunckel d'Herculis, A. Laboulbène, P. Marchal, and E. L. Ragonot, of the Société entomologique of France. A *Bulletin* will be published, containing notes and communications to the station and the committee, and the proceedings of meetings. It is also proposed to give monographs of destructive insects and pathogenic microbes; statistics concerning the damage done by harmful animals; and critical notes on all publications referring to these matters. In connection with the Laboratoire de Parasitologie of the Bourse de Commerce and the entomological station of Paris, the new section of the Pasteur Institute will render excellent service to French agriculture.

WE have received from the *Deutsche Seewarte* its report for the year 1893; it is issued as an appendix to the *Annalen der Hydrographie*, from which useful publication we have frequently had occasion to quote. The report shows that much good work is being done, but to which we can now only briefly refer. In the department of maritime meterology, great activity is shown in the collection and utilisation of observations made on board ships of both services, the number of co-operators during the year amounting to 430 for the mercantile marine alone. The results are published in tables for one-degree squares of the North Atlantic, in the daily synoptic charts issued in connection with the Danish Meteorological Institute, and in the preparation of atlases for different oceans, the one now in hand being for the Pacific. Similar activity is also shown in the department for weather prediction, and the daily weather reports issued by it are among the most complete that are published; they contain full particulars of the weather twice or thrice daily, at about 100 stations all over Europe, in addition to the usual weather charts and summary of existing conditions.

IN a paper read before the Asiatic Society of Bengal, Dr. R. Havelock Charles calls attention to the incomparability of nasal indices derived from measurements of the living head with those deduced from observation of dry skulls. The author carefully measured the nasal diameters of sixty-two "subjects," of various castes, and then having removed the integuments, &c., and cleared the naso-frontal suture and anterior nasal aperture, he again measured the diameters. The results are certainly somewhat startling. The height of the nose taken on the undissected head is almost invariably less than the long diameter of the nose measured on the skull of the same head, the difference amounting, in one case, to as much as 16 mm. The higher the caste the greater the discrepancy, but it may be reckoned to be upon an average about 4 mm. in the higher races. The transverse diameter of the anterior nasal aperture, taken on the skull, is less than the breadth of the nose taken on the head of the same subject. The difference is usually 7 mm., and in the lower castes it may be as much as 9 mm. or even 11 mm. Also, other things being equal, the older the individual the greater is the difference between these measurements. Hence, we see that the nasal index deduced from observations on the skull must always be lower than the index calculated from measurements taken upon the head; and, therefore, the *skull* nasal index will place a race upon a higher platform than the *head* nasal index.

THE *Rendiconti del Reale Istituto Lombardo* contain a paper by Profs. Bartoli and Stracciati on the effect of a thin veil of cloud or mist upon the intensity of solar radiation. This effect was brought out in a striking manner by choosing from among some thousand pyrheliometer observations made at Catania and at Casa del Bosco, on Etna (4725 feet above sea-level), those which corresponded to the same altitude of the sun and to approximately the same hygrometric state of the atmosphere. It was found that a stratum of cirrus clouds interposed in the path of the sun's rays was capable of intercepting up to 30 per cent. of the radiant energy. When the sky was of a light blue colour, but quite cloudless, the absorption was greater than in the case of a deep azure sky. The ratio of the amounts of heat transmitted ranged from 77 per cent. with an altitude of 10° above the horizon, to 96 per cent. at 50°. The effect of a slight mist equally distributed in every direction was somewhat undefined, since the ratio of the absorptions does not appear to vary regularly with the thickness of the stratum of air. In one pair of cases, with the sun at 45° 15′, the quantity of heat received during one second by 1 square cm. of the pyrheliometer surface was 0·0237 with a deep blue sky, and 0·0201 with a slight mist. With the sun at 9° 42′ the figures were 0·0161 and 0·0093 respectively. In general, the ratio varied between 58 and 92 per cent.

AT the Adelaide meeting of the Australasian Association for the Advancement of Science, the committee appointed to collect evidence as to glacial action in Australasia, in Tertiary or post-Tertiary time, presented their report. The conclusions arrived at are as follows :—At the time of their greatest extension the ancient glaciers of New Zealand were larger and descended lower the further they were south. The terminal moraines in North-West Nelson go to 2700 feet above the present sea-level ; Lake Rotoiti, in South Nelson, to 2000 feet ; Lake Sumner, probably a glacier lake, is 1700 feet above the sea. In South Canterbury the terminal moraines are 1000 feet, and in South Otago only 600 feet above the present sea-level. In Westland and in the West Coast Sounds the glaciers advanced to below the present sea-level. The glacier of Boulder River was four, and that of Lake Rotoiti about twelve miles in length ; the glacier at the head of the Waiau-ua or Dillon, fourteen miles ; that of the Rakaia, fifty-five miles ; the Wanaka glacier, sixty ; that of Wakatipu, eighty ; and that of Te Anau, sixty-five miles in length. There is, therefore, a considerable difference in relative proportion between the ancient glaciers and their present representatives. At present they reach their maximum in South Canterbury, and get smaller both to the north and to the south ; while in ancient times their maximum was in Central Otago. The committee had little biological evidence to report upon, but what there is indicates that the ocean round New Zealand has not been much colder than at present ever since the Miocene period.

THE Glasgow and West of Scotland Technical College has issued its Calendar for the session 1894-95. Another Calendar just received refers to the Mining School at Houghton, Michigan, and contains information concerning the institution and its courses of instruction.

THE current number of the *Quarterly Journal of the Royal Meteorological Society* contains a portrait of Luke Howard, the author of the system of cloud nomenclature in general use, together with a biographical notice of him. The papers in the *Journal* include one by Mr. W. H. Dines, on the duration and lateral extent of gusts of wind, and the measurement of their intensity ; and another, by the same author, on the relation between the mean quarterly temperature and the death-rate. The calculation of photographic cloud measurements is described by Dr. G. K. Olsson, and Mr. Inwards' address on phenomena of the upper air, delivered before the Society in April last, is printed in full.

A CALENDAR of the Evening Classes to be held at the People's Palace, Mile End Road, during the Session 1894-95, has been sent to us. Under the direction of Mr. J. L. S. Hatton, the number of these classes has been largely increased. In addition to the usual scientific and technological subjects, instruction is offered in astronomy, brass-work, bookbinding, instrument making, differential and integral calculus, determinants, trilinear co-ordinates and advanced co-ordinate geometry of three dimensions, and practical physics. The Drapers' Company have voted the sum of £5000 for the erection of new engineering workshops, and several new laboratories have been constructed. More than 8000 class-tickets were issued last session, and there is every prospect of this number being increased during the coming one.

To the current number of *Science Progress*, Prof. W. Halliburton, F.R.S., contributes a paper in which he emphasises the importance of further study of blood coagulation and the poisonous proteids secreted by snakes. Mr. A. C. Seward shows that algæ have a much greater claim to the attention of geologists as possible agents of rock construction than has generally been admitted. Fossil algæ is also the subject of a paper by Mr. George Murray. Dr. George A. Buckmaster describes the biological characters of *Bacillus typhosus* (Eberth) and *Bacterium coli commune* (Escherich). In a paper on ancient volcanic rocks, Mr. Alfred Harker compares the views of continental petrologists, who hold that there is a fundamental distinction between the "older" (that is, pre-Tertiary) volcanic rocks and the "younger" (Tertiary and Recent), with the conviction of English students, that the supposed differences are due to the fact that the former are, as a rule, more affected than the latter by the changes which come with lapse of time. Mr. E. H. Griffiths writes on the measurement of temperature, and shows that mercury thermometers are hardly comparable in point of accuracy with the platinum thermometer.

AN account of the striking changes which the great lava lake in Kilauea has undergone this year, appears in the *Hawaiian Gazette* for July 24, a copy of which the Hon. Rollo Russell has sent us. The lava steadily rose after the last great breakdown of the floor of the crater in March 1891, when an area of 2500 feet long, by 2000 feet wide, fell more than five hundred feet in one night. Towards the end of last year, the rising and overflowing of the lake filled the pit thus produced. Since that time the activity of the lake has been intense, as many as twenty-three overflows of liquid lava having taken place in a single day, and the walls surrounding the lake have been rapidly raised by continual overflows. Accurate measurements of the lake were made by Mr. F. E. Dodge, of the Survey Department, in August 1892 and March 1894. From his observations it appears that in August 1892 the outer rim surrounding the lake was 282 feet below the level of the Volcano House. The surface of the lake was 240 feet below this line. In March, 1894, the surface of the lake was 207 feet above this line, making a rise of 447 feet in nineteen months. But the most interesting observations relate to the breaking down of the lake, witnessed by a number of persons in July last. On July 11 the lava began to sink steadily, falling at the rate of about twenty feet an hour. This subsidence caused the banks to give way. We quote from the *Gazette* :—"From about noon until eight in the evening there was scarcely a moment when the crash of the falling banks was not going on. As the level of the lake sank, the greater and greater height of the banks caused a constantly increasing commotion in the lake as the banks struck the surface of the molten lava in their fall. A number of times a section of the bank from 200 to 500 feet long, 150 to 200 feet high, and 20 to 30 feet thick, would split off from the adjoining rocks, and with a tremendous roar, amid a blinding cloud of steam and dust, fall with an appalling down-plunge into the boiling lake, causing great waves to dash into the air, and a mighty 'ground swell' to sweep across the lake, dashing against the opposite cliffs like storm waves upon a lee shore. Most of the falling rocks were immediately swallowed up by the lake, but when one of the great downfalls referred to occurred, it would not immediately sink, but would float off across the lake, a great floating island of rock. At about three o'clock an island of this character was formed estimated to be about 125 feet long, 25 feet wide, and rising 10 to 15 feet above the surface of the lake. Shortly after, another great fall took place, the rock plunging out of sight beneath the lava. Within a few moments, however, a portion of it approximately 30 feet in diameter, rose up to an elevation of from 5 to 10 feet above the surface of the lake, the molten lava streaming from its surface, quickly cooling, and looking like a great rose-coloured robe, changing to black. These two islands, in the course of an hour, floated out to the centre, and then to the opposite bank. At eight in the evening they had changed their appearance but slightly, but the next morning they had disappeared." It was observed that, as the falls occurred, the exposed surface, sometimes more than 100 feet across, was left red-hot. Sometimes a great mass would fall forward like a wall; at others it would simply collapse and slide down, and again enormous boulders, as big as a house, singly and in groups, would break from their fastenings, and, all aglow, leap far out into the lake. It is believed that this is the first break-down of Kilauea that has taken place in the presence of observers, those prior to 1868 being before the establishment of the Volcano House, and those of 1868, 1886, and 1891, and several minor ones, all having occurred at night when no one was present.

THE additions to the Zoological Society's Gardens during the past week include a Slender Loris (*Loris gracilis*) from Ceylon, presented by Miss Grace Thomson; two Wild Swine (*Sus* sp.?) from Turkish Arabia, presented by Mr. F. G. Beville, H.B.M. Consul; three Agoutis (*Dasyprocta* sp.?) and two Orange-winged Amazons (*Chrysotis amazonica*) from the Island of Tobago, presented by the Hon. W. Low; a Raven (*Corvus corax*), European, presented by Mr. Ogilvie Grant; a Green Turtle (*Chelone viridis*) from the West Indies, presented by Mr. E. Leach; a Japanese Teal (*Querquedula formosa*) from North-eastern Asia, purchased; a collection of Marine Fishes, purchased; two Shamas (*Cittocincla macrura*) from India, received in exchange; a Brazilian Blue Grosbeak (*Guiraca cyanea*), and a Red-headed Marsh Bird (*Agelaeus ruficapillus*) from Brazil, received in exchange; and a Diana Monkey (*Cercopithecus diana*) from West Africa, deposited.

OUR ASTRONOMICAL COLUMN.

THE HARVEST MOON.—This year's Harvest Moon will be exceptionally conspicuous. On the day of full moon, September 14, the ascending node of our satellite's orbit will be only 1° 35' from the vernal equinox. The inclination of the orbit to the horizon will therefore be very nearly the same as if the node were exactly at the equinox. Owing to this, the moon is longer above the horizon than she is at other times of the year. On the average, the moon rises fifty-one minutes later every night; but for a few evenings before and after the coming full moon, the average interval is only about ten minutes.

ECLIPSE OF THE MOON.—A partial eclipse of the moon, partly visible at Greenwich, will occur early on Saturday morning. The first contact with the penumbra takes place at two o'clock in the morning, the first contact with the shadow at 3h. 36m., and the middle of the eclipse happens at 4h. 32m. The last contact with the shadow will occur at 5h. 27m. As the moon sets shortly after, the last contact with the penumbra will not be observable. Taking the moon's apparent diameter as equal to 1, the magnitude of the eclipse = 0·225.

M. TISSERAND ON SATELLITE ORBITS.—M. Tisserand's recent investigations on the satellite of Neptune have already been referred to in these columns (vol. xlix. p. 543). He has shown that the equatorial protuberance of Neptune causes the direction of the major axis of the orbit of the satellite to change, and that the reaction of the satellite itself modifies the position of the plane of the planet's equator. As the mass of the satellite is comparatively small, the latter effect can be neglected for a considerable period of time. But when the difference of mass between a primary and its companion is not great, the case is altered. In the *Bulletin Astronomique* for August, M. Tisserand investigates the various conditions affecting the secular displacements of the equator of a planet and the satellite-orbit. He cites the Algol system as a case in which the two members—that is, the luminous star and the dark companion revolving round it—have comparable masses. The distance separating the pair is also commensurate with their dimensions. Under these conditions, the variations of the equator, and those of the orbit of the satellite, can be treated at the same time. The secular inequalities undergone by the equator and the orbit doubtless cause the proportion of the bright star's disc eclipsed by the dark companion to vary with the lapse of ages. A secular change in the range of variability must result from this. Observations extending over a long interval of time should also show changes in the periods of variables like Algol. M. Tisserand considers cases of this kind and develops the formulæ relating to them. The discussion of the formulæ is reserved for a future communication.

THE DISTRIBUTION OF NEBULÆ AND STAR-CLUSTERS.—Mr. Sidney Waters has mapped the positions of the nebulæ and star-clusters—7840, in all—contained in the New General Catalogue, and two excellent lithographed charts, given in the number of *Monthly Notices*, R.A.S., just issued (vol. liv. No. 8), show the results of his labours. The Milky Way is drawn upon the charts, the portion for the northern heavens being taken from Dr. Boeddicker's fine maps, while that in the southern heavens is copied from the *Uranometria Argentina*. Mr. Waters designed the maps with two objects. First, to study the distribution of nebulæ and clusters of stars, and, secondly, to guide astronomers engaged upon the observation of nebulæ to fields of research. Clusters are shown upon the charts by means of red crosses, resolvable nebulæ by red dots, and irresolvable ones by black dots. The distribution of these objects is thus taken in at a glance. Whether, in the light of recent research, it was desirable to continue to recognise this difference between nebulæ is a matter of opinion; one point in favour of the distinction is that it was followed in similar maps drawn by Mr. Waters and laid before the Royal Astronomical Society in 1873, so that the two sets are easily comparable. The present charts show very clearly the peculiarities of the distribution of clusters and nebulæ. Referring to the former, Mr. Waters says: "It is striking to note the fidelity with which they follow not only the main track of the Milky Way but also its convolutions and streams. They appear in many parts to seek out the denser regions, and to avoid with an equal persistence the dark spaces." As to nebulæ, we read (and the maps bear out the remarks): "A proportionate scattering of resolvable nebulæ follow the others throughout the charts, showing that they are probably intermixed, and that the resolvability of many of them must not necessarily be regarded as a criterion of their distance. The remarkable avoidance of the nebulæ of the galaxy, although in some points reaching up to and encroaching upon its edges, is equally significant with the coincidence of the clusters with its main track." It is pointed out that the exceeding nearness to one another of very many of the nebulæ suggests the probability of physical connection analogous to that of double stars, hence long-continued observations may lead to the detection of similar orbital motions. Other fields of research are suggested by the charts, and by exploring them new light will certainly be thrown upon the structure of the sidereal universe.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

A GENERAL account of the recent meeting of the American Association for the Advancement of Science was contributed to our last issue by Dr. W. H. Hale. We are now able to give a few extracts from presidential addresses, together with descriptions of some of the papers read before the different sections.

In the course of his reply to the address of welcome to

Brooklyn, Dr. Daniel G. Brinton, the President, thus expounded the aims of the Association.

"The influence of our Association is in the highest and best sense of the word educational. Its discussions are aimed to present the correct methods of scientific investigation and to be guided by the true spirit of scientific inquiry.

"The goal which we endeavour to attain is scientific truth, the one test of which is that it will bear untrammelled and unlimited investigation. Such truth must be not only verified, but always verifiable. It must welcome every test, it must recoil from no criticism, higher or lower, from no analysis and no scepticism. It challenges them all. It asks for no aid from faith; it appeals to no authority; it relies on the dictum of no master.

"The evidence, and the only evidence, to which it appeals or which it admits is that which it is in the power of every one to judge, that which is furnished directly by the senses. It deals with the actual world about us, its objective realities and present activities, and does not relegate the inquirer to dusty precedents or the mouldy maxims of commentators. The only conditions that it enjoins are that the imperfections of the senses shall be corrected as far as possible, and that their observations shall be interpreted by the laws of logical induction.

"Scientific truth has likewise this trait of its own: it is absolutely open to the world; it is as free as air, as visible as light. There is no such thing about it as an inner secret, a mysterious gnosis, shared by the favoured few, the select *illuminati*, concealed from the vulgar horde or masked to them under ambiguous terms. Wherever you find mystery, concealment, occultism, you may be sure that the spirit of science does not dwell, and what is more, that it would be an unwelcome intruder. Such pretensions belong to pseudo-science, to science falsely so called, shutting itself out of the light because it is afraid of the light.

"Again, that spirit of science which we cultivate and represent is at once modest in its own claims and liberal to the claims of others. The first lesson which every sound student learns is to follow his facts and not to lead them. New facts teach him new conclusions. His opinions of to-day must be modified by the learning of the morrow. He is at all times ready and willing to abandon a position when further investigation shows that it is probably incorrectly taken. He is in this the reverse of the opinionated man, the hobby rider and the dogmatist. The despair of a scientific assemblage is the member with a pet theory, with a fixed idea, which he is bound to obtrude and defend in the face of facts. Yet even towards him we are called upon to exercise our toleration and our charity, for the history of learning has repeatedly shown that from just such wayward enthusiasts solid knowledge has derived some of its richest contributions.

"All this prying into the objective, external aspect of things, this minute, painstaking study of phenomena, this reiterated revision and rejection of results, are with the single aim of discovering those absolute laws of motion and life and mind which are ubiquitous and eternal, which bear unimpeachable witness to the unity and the simplicity of the plan of the universe, and which reveal with sun-clear distinctness that unchangeable order which presides over all natural processes.

"This is the mission of science—noble, inspiring, consolatory, lifting the mind above the gross contacts of life, presenting aims which are at once practical, humanitarian, and spiritually elevating."

Mathematics and Astronomy.

The address of the vice-president of Section A (all the sectional presidents are termed vice-presidents) was summarised in our last number. In this section Prof. George E. Hale gave an interesting paper on "Some Attempts to Photograph the Solar Corona without an Eclipse."

C. W. Hough presented a method of control of the equatorial driving clock, based on a description published in the Transactions of the Albany Institute in 1871.

W. R. Warner, on "Requisites for Governing the Motion of Equatorial Telescopes," told of the differing resistance produced by weather, oil, or the lack of it, &c., which a driving clock must overcome in order to run accurately.

Prof. Doolittle exhibited a large diagram showing the results of the recent latitude determinations at the Sayre Observatory, of South Bethlehem, Pa. The Chandler theory and these observations differ so much that one can hardly be called an approximation of the other. Prof. Doolittle finds a diminution in the mean value of the latitude which is entirely unaccounted for.

Physics.

The subject of the presidential address to this section was "Obscure Heat as an Agent in producing Expansion in Metals under Air Contact." The address contained the results of a study of the forces under which the expansion and contraction of metals take place, under the conditions in which they are used in every-day experience. Among the papers communicated to the section was one by Miss Mary Noyes, on the influence of heat and electricity upon Young's modulus for a piano wire. It appears that the effect of heat is to make the modulus less. Magnetism has no effect. The passage of a current of electricity through the wire causes the modulus to diminish more than can be accounted for by the heating effect.

W. Hallock, of Columbia College, who has photographed sensitive flames, exhibited specimens.

Dr. Bedell presented a paper by Prof. Nichols and Miss Crehore, of Cornell University, giving studies of the lime-light. They have examined the light from the lime cylinder of the Drummond light, by means of a spectro-photometer.

In a paper upon aluminium violins, Mr. Springer discussed their merits. He said that soundboards made of aluminium differed from those made from other metals, and were analogous to those of wood. They did not produce secondary tones which were not in harmony with the prime tones. There were many difficultities to be overcome in the manufacture of violins from aluminium. The material could not be soldered satisfactorily, and had to be rivetted. As uneven thicknesses could not be secured for the belly and back, it was necessary to rib and arch the metal. In conclusion, he said: "My experiments incline me to believe that the real cause of the superiority of old wooden instruments over new ones is not so much in the elasticity of the wood or in the composition of the varnish, but in the peculiar warping of the wood to a higher arch, a buckling caused by the position of the F holes and sound-post. I have never seen a good old instrument which was not thus warped. Moreover, I believe if a new wooden instrument were immediately so constructed, while good at first, would deteriorate because further arching would produce rigidity and consequent veiling of tone. Time has no such effect on aluminium violins, as they remain practically unaltered; one which has been used daily for the last two years shows no signs of crystallisation. A perfect instrument would consequently retain all of its good qualities, and could easily be duplicated."

Two papers of considerable interest were read, one by A. McAdie, on some peculiar lightning flashes, and the other on a phonographic method of recording the change in alternating electric current, by C. J. Rollesson.

Mr. McAdie said that in the month of June, 1894, there were one hundred persons killed by lightning in the United States. It is, therefore, important to get accurate knowledge about lightning discharges, especially in reference to the length and form of the path of lightning, so as to discover its energy. Mr. McAdie has three cameras pointed at the top of the Washington Monument, in the city of Washington; one at the Capitol, a second at Fort Myer, and the third at the Weather Bureau. He wishes to obtain three simultaneous photographs of a lightning discharge, but though he has watched since May, he has not been successful.

Mr. Rollesson said that two operations were necessary to produce the alternating current curve by the aid of the phonograph: first, a record of the curve must be produced on the wax cylinder of the phonograph; second, the record produced in the second operation must be magnified by means of a suitable multiplying arrangement. The method described was especially adapted for the study of harmonics in the alternating current.

Chemistry.

The subject of Prof. T. H. Norton's address was "The Battle with Fire, or the Contributions of Chemistry to the Problem of Preventing Conflagration." We hope to be able to print this address in full in a future issue.

Among the papers read before the section was one upon observations regarding certain European water supplies, by William P. Mason. It was shown that the difference in the death-rate of various towns and cities in Europe, caused by improvement in the water supplies, varied from 2 to 13 per cent. "Fallacies of Post-mortem Tests for Morphine" was the title of a paper by David L. Davoll. Other papers before this section were on the behaviour of allylmalonic, allylacetic, and æthylidenpropionic acids when boiled with caustic soda solutions, John G. Spenzer; camphoric acid, W. A. Noyes; double halides of antimony and potassium, Charles H. Herty; some peculiar forms of iron, T. H. Norton; on the existence of ortho-silicic acid, T. H. Norton; volatility of certain salts, T. H. Norton; a new formula for specific and molecular refraction, W. F. Edwards; action of nitric acid upon the chlorides of zinc, bismuth, and cadmium, O. C. Johnson; and a convenient milk sampling tube, M. A. Scovell.

Mechanical Science and Engineering.

Dr. Mansfield Merriman delivered an address before Section D, on "the resistance of materials under impact." He pointed out that the science of the resistance of materials, as taught in text-books and used in the daily practice of every engineer, was mainly that of static conditions where external force is resisted by internal stress. The question of resistance to the impact of falling bodies, likely to occur in machinery, on bridges, and to a certain degree also in buildings, is recognised as important, but it is seldom reduced to computation or made the occasion of careful experiment. Even the fundamental principles and laws regarding it seem often not clearly understood. Dr. Merriman's address was an attempt to set forth the present state of knowledge concerning impact, and to reconcile some of the apparent paradoxes that often arise in the discussion and application of its principles.

The first paper before the section was on the crank curve, by J. H. Kinealy, secretary of the section. In this paper a simple graphical method was given for determining the velocity of the piston of a steam engine for a given positon of the crank. The next paper was on preliminary experiments on a new air pyrometer for measuring temperatures as high as the melting point of steel, by D. S. Jacobus. Experiments made at the Stearns Institute show that three pyrometers gave concordant results in measuring extremely high temperatures.

Another paper, by Prof Jacobus, was on improvements in methods of testing automatic fire sprinkler heads. Automatic fire heads for extinguishing fires have now come into common use. In these a valve is opened automatically in case of fire, by the melting of a fusible solder piece, and the water from this valve puts out the fire. The method of making tests on such heads was described in detail. A paper, by Prof J. E. Denton, was read on the ratio of the expansion of steam in multiple expansion marine engines for maximum economy in East River steamers. This was followed by a paper by Samuel Marsden, on experiments on the transverse strength of long-leaf yellow pine. The results of numerous experiments were presented. The last paper was by Elmo G. Harris, on the air lift pump.

Geology and Geography.

The president of this section, Samuel Calvin, took for his subject "Niobrara Chalk." The Niobrara stage of the Upper Cretaceous is well represented along the Missouri, from the mouth of the Niobrara River to the mouth of the Big Sioux. East of the Sioux, beds of the same stage are found at various points in Iowa as far eastward as Auburn in Sac country, while fossils distributed through the drift indicate the former existence of cretaceous strata at points many miles farther east than any locality where they are not known to occur in place. The general distribution of the Niobrara deposits covers an area reaching from Western Iowa to the Rocky Mountains, while north and south it stretches from Texas to Manitoba, and probably northward to the Arctic Ocean. The address was limited, however, to a description of some of the characteristics of the Niobrara chalk exhibited in the somewhat restricted region lying between the mouth of the river from which the formation takes its name, and the most eastern exposure of the beds at present known, near Auburn, Iowa.

Major J. W. Powell read a paper on the water resources of the United States. Mr. Powell said that the ultimate development of the United States rested largely upon the most thorough utilisation of the water resources. This was conspicuously true of the vast arid and sub-humid regions extending from the great plains to the Pacific coast. There the almost boundless extent of fertile land could not be utilised for agriculture without the artificial application of water. In all cases, whether in arid or in humid regions, the proper solution of the problem rested upon the correct knowledge of the distribution and fluctuation of the available water. This study had been begun by the United States Geological Survey, and was now being carried on.

Prof. W. J. McGee read a paper by F. H. Newell, on the Geological Atlas Folio issued by the United States Geological Survey. These folios are the final maps of the survey showing the topography, geology, and the mines of the areas covered by the sheets. Accompanying the maps are the descriptions of the same in popular rather than technical language, for the benefit of the people. The folios have involved a great expense, and represent probably the finest specimens of geological lithography that are known.

Mr. Joseph H. Hunt described briefly the minerals from Paterson, Upper Montclaire, N.J., and the Palisades, and exhibited excellent specimens, some of which showed in a beautiful manner the process of alteration of one mineral into another.

Dr. W. H. Dale, in a paper, entitled "Notes on the Atlantic Miocene," showed that the vast deposits of phosphate rock of South Carolina, which have yielded millions of dollars, are of Miocene age, like those of Florida.

Prof. Spencer read an interesting paper upon the age of Niagara Falls. He said that the first conjecture as to the age of Niagara Falls was made by Andrew Ellicott in 1790, who supposed the Falls to be 55,000 years old. About 1841 Lyall estimated the age of the Falls as 35,000 years. According to Prof. Spencer, the evolution of the Falls was as follows: A little stream draining the Erie basin only fell about 200 feet over the brow of the Niagara escarpment, and in magnitude was just about the size of the American Falls. This stream was not over one-fourth the present volume of the great cataract, and, consequently, was able to excavate the gorge at a much lower rate than at present. During this early history of the river the waters of the three upper lakes emptied through the Huron basin by way of the Ottawa River. The height of the Falls has advanced several times, and, owing to this change and the variation in the discharge of the water, retreat of the Falls has varied greatly during changing episodes. The computations of the age have been based upon these changing conditions of elevation and downfall of the river. The first episode, as before stated, represented a small river, with a total fall of 200 feet. This lasted about 11,000 years. Then fell another episode, where the height of the Falls was increased from 200 to 400 feet, succeeded by the entire drainage of all the upper Great Lakes. At the same time there were series of three cascades, the lower gaining on the upper, until finally they were all united in one great cataract, much higher than that of the present time. Subsequently the waters were raised at the head of Lake Ontario so as to bring about the present conditions after a lapse of 17,000 years from the end of the first episode. The last or modern episode has lasted 3000 years under nearly the present conditions. Thus we see that the age of the Falls is about 31,000 years, with another 1000 years added for an earlier condition not given. It is now 8000 years since Lake Huron emptied into Lake Erie for the first time. The land has risen about the outlet of Lake Erie, and if the present rate continues, in 5000 or 6000 years the waters of the four upper lakes will be turned into the Mississippi River drainage at Chicago.

Zoology and Botany.

Among the papers read before the section of Zoology were the question of spider bites, L. O. Howard; the pulmonary structures of the Ophidia, Edward D. Cope; photographing fishes and other aquatic animals under water by means of a vertical camera, Simon H. Gage; a migration of cockroaches, L. O. Howard; sexual characters in Scolytidæ, A. D. Hopkins; notes on the genus *Perigoninus*, Sars, Charles W. Hargett; the transformations of the lake and of the sea lamprey, S. H. Gage; on the above-ground buildings of the seventeenth year Cicada, J. A. Lintner.

Prof. L. O. Howard described an extraordinary migration of Croton bugs or German cockroaches, witnessed by him on the streets of Washington on a very dark day last summer. He found that the migrating army, which was composed of many thousands of individuals, consisted almost entirely of females carrying egg-sacs.

At a joint meeting of the sections of Botany and Zoology, Dr. Manly Miles read a paper on the limits of biological experiments. Among other things the speaker pointed out the futility of most feeding experiments. During the discussion which followed, Prof. Edward Cope remarked: "If Weissmann had been a better botanist he would never have promulgated his theory of the isolation of the germ plasm."

Prof. L. H. Bailey discussed the relation of the age of type to variability. He called attention to the wide range in variability of cultivated types, some of which, he said, vary so much and so quickly that specific types may be lost, yet the difference was not due to age or period, nor to geography or diversity of cultivation. Continuing, he said:

"Variability under cultivation must be ascribed to some original elasticity of the species, and this elasticity or flexibility is no doubt intimately associated with the phylogeny of the type. The common notion that man can modify any plant in given directions is not true. The newer the type the more readily does it vary. All this establishes an intimate relationship between development under cultivation and evolution under natural conditions. They are not two, but one, and the agriculture (*sic*) of man is but an extension of the agriculture of nature."

Prof. Bailey also read a paper on the struggle for existence under cultivation, and during the course of his remarks he said—

"It is commonly supposed that struggle for existence ceases under cultivation, and that man's endeavours and nature's are two. Here we have statistics. There are enough seeds in the United States to stock the world. It is observed that in cultivation there is less waste than in nature. Struggle is more intense than in nature. Not more than one in twenty or more which actually germinate are allowed to mature. But it is a struggle of few against few, rather than a struggle of few against many. This struggle, therefore, instead of fixing the specific type in a warfare against outsiders, sets up a divergence among individuals of the species itself. This, to my mind, is one of the reasons for the rapid development of garden plants."

Other papers read before the joint meeting were:—The numerical intensity of faunas, L. P. Gratacap; the growth of radishes as affected by the size and weight of the seed, B. T. Galloway; the work of the Indiana Biological Survey, A. W. Butler; the movement of gases in rhizomes, Katherine E. Golden; some interesting conditions in wood resulting from the attacks of insects and woodpeckers, A. D. Hopkins.

A paper on evidence as to the former existence of large trees on Nantucket Island, by Dr. Burt G. Wilder, was read before the section of Botany.

Dr. Byron D. Halstead, in a paper upon a root rot of beets, before the section of Botany, described a new disease of those plants.

Major J. Hotchkiss showed specimens of wood cut from trees that had been marked by surveyors 107 years ago. The presence of the injury was still manifest upon the surface of the trees. The growth per year was about one-twentieth of an inch.

Dr. E. F. Smith read a paper on watermelon disease in the south. Other papers read were:—The sugar maples of Central Michigan, W. J. Beal; some affinities among Cactaceæ, John M. Coulter; simplification and degeneration, Charles E. Bessey; regulatory growth of mechanical tissue, Frederick C. Newcombe; further studies in the relationship and arrangement of the flowering plants, Charles E. Bessey.

Anthropology.

Dr. Franz Boaz's address to this section was on human faculty as determined by race. He traced the history of civilisation from its dawn in the far East until now, showing how ideas and inventions were carried from one nation to another. He referred to the civilisations in ancient Peru and Central America, and showed that the general advancement was the same as in Asia and Europe. The only difference was one of time. One reached a certain stage 3000 or 4000 years earlier than the other. But this difference was insignificant compared with the age of the human race. Man had existed for a period to be measured by geological standards only. He showed that, in the past, nations brought into contact with civilisation easily assimilated it, and now they dwindled away before its approach. This was due to the fact that formerly races did not differ so widely as at present, and now disease devastated regions newly opened to white people. The conditions for assimilation in ancient Europe were much more favourable than in countries where primitive people now came in contact with civilisation. This conclusion was confirmed by other facts from the history of civilisation—Northern Africa and in China.

Dr. Boaz remarked: "Several races have developed a civilisation of a similar type to the one from which our own had its origin. A number of favourable conditions facilitated the rapid spread of this civilisation in Europe. Among these common physical appearances, contiguity of habitat and moderate differences in the modes of manufacture were the most potent. When, later on, civilisation began to spread over other continents the races with which the modern civilisation came into contact were not equally favourably situated. In short, historical factors appear to have been much more potent in leading races to civilisation than their faculty, and it follows that achievements of races do not warrant us to assume that one race is more highly gifted than another."

He also said: "After going over the field of anatomical differences, between races, so far as they have a bearing upon our question, our conclusion is that there are differences between the physical characters of races which make it probable that there may be differences of faculty. No unquestionable fact, however, has been found yet which would prove beyond a doubt that it will be impossible for certain races to attain a higher civilisation."

Dr. Boaz expressed the opinion that the probable effect of civilisation upon an evolution of human faculty has been much over-estimated. The psychical changes which are the immediate consequence of civilisation may be considerable. They are changes due to the influence of environment. It is doubtful, however, if any progressive changes or such as are transmitted by heredity have taken place. The number of generations subjected to this influence seems altogether too small. Besides, the tendency of human multiplication is such that the most highly cultured families tend to disappear, while others, who have been less subjected to the influences regulating the life of the most cultured classes, take their place. Therefore, it is much less likely that advance is hereditary than that it is transmitted by means of education.

In conclusion Dr. Boaz said: "The average faculty of the white race is found to the same degree in a large proportion of individuals of all other races, and although it is probable that some of these races may not produce as large a proportion of great men as our own race, there is no reason to suppose that they are unable to reach the level of civilisation represented by the bulk of our own people."

In the Anthropological Section, Dr. Daniel G. Brinton read a paper entitled "Variations in the human skeleton and their causes." The speaker called attention to a number of peculiarities in the human skeleton which had attracted the notice of anatomists, and which had frequently been interpreted as signs of reversion to an ape-like ancestry. He said that most of these variations can be explained by mechanical function, or excess or deficiency of nutrition; and when they can be so explained, this is the only interpretation they should receive. They could no longer be offered as evidence of the theory of evolution, nor considered as criteria or marks of the human races.

Mr. M. H. Saville read a paper on a comparative study of the Glyphs of Copan and Quirigua, in which he presented his conclusions on the hieroglyph "pax." In the discussion of Mr. Saville's paper, Dr. Brinton presented his conclusions, which he announced for the first time, based upon studies of vases in the museum of Pennsylvania, that the symbol pax was a representation of the sacred drum of the Aztecs, and that the hieroglyph stood in the codices for paxahs, "It is finished."

"Iroquois migration" was the subject of a brief paper by the Rev. Dr. Beauchamp, who said that one at least of the three great divisions of the Iroquois family had its centre near the south-western border of Lake Erie.

Mr. Frank Hamilton Cushing, ethnologist for the Bureau of American Ethnology at Washington, read a paper entitled "Salt in Savagery." He referred tot he universal liking for salt among the Indians of North America. The Zuni Indians believed that the first salt came from the sun. According to Indian mythology, there is a salt goddess who is the daughter of the ocean. Mr. Cushing related her genealogy, and then proceeded to discuss the influence of salt upon the culture of the Indians in the south-west. He stated that he believed that nothing led the cliff-dwellers down from their inaccessible dwellings to live in villages more than their desire for salt. Men's dispersion over the world, said Mr. Cushing, is largely influenced by salt. Coming down from his arboreal retreat, where he lived on nuts and fruit, he found the seashore and acquired a taste for a substance now universally used.

Mr. R. G. Haliburton read a paper on the dwarf races of the New World.

Rev. W. H. Beauchamp described the southern visit of the Eskimo, in which he declared that evidence of Eskimo contact with the Indians of Northern New York were to be found in certain stone knives found among them, specimens of which he exhibited.

Mr. Dorsey read a paper by William Sturtevant, in which Mr. Sturtevant described three ears of corn from prehistoric grains from localities in Peru, collected by Mr. Dorsey, the especial point of interest being that from a grave of undoubted antiquity in Iquique was found a kind of corn which was commonly supposed to be of a recent cultivated variety. Mr. Dorsey called attention to the great importance of collecting and preserving all varieties of corn from all prehistoric sources as a means of determining the original habitat of the maize, as well as furnishing an index of civilisation.

THE DISPLACEMENTS OF THE ROTATIONAL AXIS OF THE EARTH.[1]

DISPLACEMENTS of the rotational axis of the earth with reference to fixed directions in space have been observed since the earliest ages of astronomical measurement; for such displacements, visible in wanderings of the pole of the apparent diurnal rotation of the celestial sphere among the constellations of fixed stars, exist in such enormous amplitudes, that in their main features they could be detected by the aid of very simple apparatus and observations.

The true law and explanation of these wanderings of the pole remained, nevertheless, a deep mystery till Copernicus lifted the veil by showing that they were only the celestial image of real displacements of the rotational axis of the earth in space, and until Newton came and, combining his discovery of universal gravitation with his deduction of the ellipsoidal figure of the earth, proved that these displacements are due to the actions of the moon and the sun on the earth.

The mathematicians of the eighteenth century completed this explanation by profound researches embracing the full theory of free rotation of a solid system of masses, under the action of various disturbing influences, not only those acting from outwards on the rotating body (as in the case of the sun's and the moon's attractions on the earth), but also those depending upon the condition or changes within the rotating system itself.

Among several interesting results, these investigations pointed out an essential difference between the development of the disturbed rotation in the first and in the second case.

Upon the supposition, corresponding to the real terrestrial conditions of the problem, namely, that all the disturbing influences are relatively small in comparison with the amount of energy represented by the primary rotation of the earth itself, the following distinctions were demonstrated.

Exterior disturbing influences will mainly produce displacements of the axis in space, and corresponding wanderings of the pole among the stars, whilst the simultaneous displacements of the axis in the earth itself, in consequence of the particular conditions of their evolution, remain insensible.

On the contrary, interior conditions and disturbing influences, as those contained in the configurations of the masses, or in changes of the distribution of the masses composing the rotating system, will mainly produce displacements of the rotational axis in the rotating body itself, whilst in this case the simultaneous displacements of this axis in space and the corresponding variations of the position of the pole among the stars remain insensible.

Very soon after these deductions had been made from the theory, astronomers began to inquire if also effects of the latter type, that is to say, displacements of the rotational axis in the earth, really existed.

According to the theory, such displacements ought even then to exist when the distribution of the masses composing the earth is not in the slightest degree variable.

It is sufficient for producing such displacements that the position of the rotational axis of the earth is actually not in perfect coincidence with one of its principal axes of inertia, known as the principal axis.

The slightest deviation of the rotational axis from the principal axis has the consequence that the pole of the rotational axis begins and continues to describe a small circle around the pole of the principal axis.

The velocity of this movement depends upon the law of the figure and of the distribution of the masses composing the earth, and the best numerical data for this dependence had given the result that the displacement in question would probably have a period of nearly ten months.

Now all such displacements, possibly measurable with reference to fixed directions in the earth, and insensible with reference to fixed directions in space, could be found in the most favourable way by measuring as exactly and continuously as possible the distance of the pole from the zenith of the observer's station; in other words, by repeated determinations of the geographical latitudes. But, notwithstanding very long and refined determinations of the geographical latitudes at some of the principal observatories, beginning shortly before the middle of the present century, only very uncertain and discordant traces of the phenomena in question were found.

The reason for this want of success is now very clear. Astronomers had limited their researches too narrowly to the last-mentioned type, namely, to the supposed regular ten-monthly periodical movement of the pole of the rotational axis around the pole of the principal axis. Too easily it had been admitted that all the existing variations of the distribution of terrestrial masses were by far too small for altering sensibly the position of this principal axis itself.

It was Lord Kelvin, at the Glasgow meeting of the British Association (1874), who at first drew the attention of the scientific world to the consideration of the great natural transports of masses of air and water and various masses by the water, going on continuously and periodically in the form of currents and circulations of different kind, as well in the atmosphere as in oceans and rivers, for instance the enormous periodical sediments of snow and ice. He showed that these very considerable variations of the distribution of masses on the earth could not only produce sensible displacements of the principal axis of inertia, but that such displacements of this axis could have an amplifying effect on the total amount of displacements of the rotational axis.

For if the principal axis were itself not in a constant position, the theoretically required movement of the rotational axis around the principal axis would become a very complicated movement, differing entirely from the simple form which to that epoch had appeared in the researches of astronomers.

This epicyclic character of the movement of the pole of the rotational axis could considerably modify not only the length of the period, but also the whole geometrical character and amplitude of the curve in such a way, that in longer periods epochs of very small variations of latitude could alternate with epochs of considerably increased variations of latitudes. Possibly, as a further consequence of this complication of the displacements of the two axes, and as a consequence of the still existing plastic state of certain parts of the earth, as well as by the damping effects of the fluid parts, even *progressive*—though very slow and unsteady progressive—displacements of the rotational axis in the earth could still result.

The field of this research was thus decisively cleared by the veritably releasing ideas of Lord Kelvin. Finally, about four years ago, by the co-operation of some observatories with the International Geodetic Union, clear evidence was obtained, and in the last three years, with the aid of an expedition sent by the International Union to Honolulu, decisive proofs of such displacements have been found. I consider it a special honour and pleasure to be enabled to submit some of the newest results of this international co-operation to a meeting of the same Association which, twenty years ago, had been witness of the almost prophetic assertions of one of its most illustrious members regarding the real conditions of this important phenomenon.

I have prepared a diagram (Fig. 1, p. 489) showing these newest results. You see in this diagram a representation of the wanderings of the pole of the rotational axis of the earth on the surface of the latter during the last twenty months, from October 1892 to May 1894.

This sketch is founded on nearly 6000 single determinations of latitude made in the Observatory of Kasan (Eastern Russia), Strassburg (Elsass), and Bethlehem (Pennsylvania). The observations are condensed in twenty monthly mean results,

[1] A paper read by Prof. W. Foerster, Director of the Royal Observatory of Berlin, before the British Association.

numbered, as you see, from zero to nineteen. Every one of these resulting monthly positions of the pole indicated by the centres of the small circles is thus the mean result of about 300 single determinations.

The accompanying figure is drawn on a scale of two millimetres to one-hundredth of a second of arc, and the maximum amplitude of the curve is nearly 50-hundredths, or half a second. The amplitude of these movements of the pole on the surface of the earth is between 40 and 50 feet.

You see the general character of the movement quite in accordance with what has been mentioned concerning its complicated and somewhat spiral character. The sense of the motion is turning from west to east. The velocity is apparently very variable, and it seems as if we now approach an epoch in which the amplitude considerably diminishes. It is also evident that such

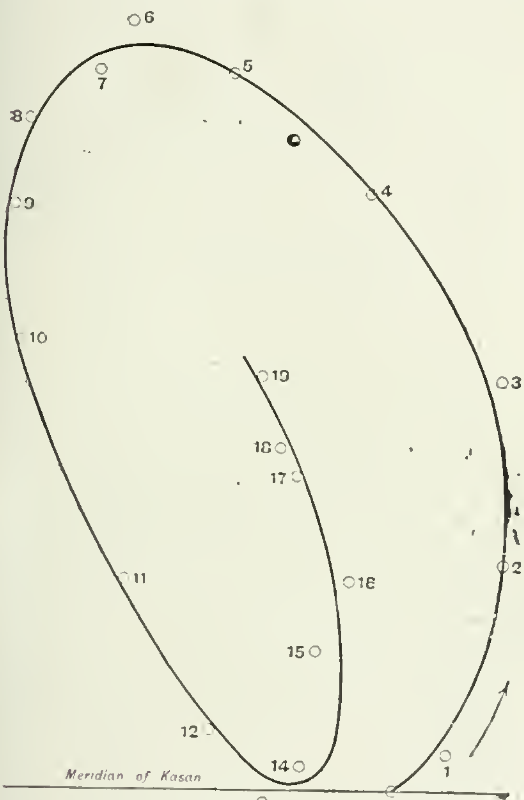


FIG. 1.—Movement of the North Pole of the rotational axis of the earth Derived from observations made at Bethlehem, Strassburg, and Kasan :—

0 = 1892 Oct 20	13 = 1893 Nov. 1.
1 = ,, Nov. 1.	14 = ,, Dec. 1.
2 = ,, Dec. 1.	15 = 1894 Jan. 1.
3 = 1893 Jan. 1.	. . . .
. . . .	. . . .
. . . . . .	19 = 1894 Mar. 30.

a character of movement can very easily produce slow progressive motions, and also from this reason the whole phenomenon wants to be watched incessantly and very carefully.

The astronomers and geodetists who are now associated in the International Geodetic Union, have invited the geologists to associate with them in this common research. Such an international organisation will be also useful and almost indispensable for a great part of the work of astronomical observatories.

It is to be hoped that Great Britain will now participate in this international union, embracing all other civilised nations. Such organisations, with their clear and reasonably limited aims, involve not only real economies and refinements of mental work, combined with diminutions of material expenses, but it is hoped that they will also have a great importance as slowly growing foundations of human and terrestrial solidarity.

SCIENCE IN THE MAGAZINES.

MR. HIRAM S. MAXIM gives, in the *National*, a brief description of his experiments on flying by means of aeroplanes. His flying machine, when finished and loaded with its water, its fuel, and three men, weighed very nearly 8000 lb., and the actual horse-power developed on the screws was 363 horse-power, with a screw-thrust of rather more than 2000 lb. The total width of the machine was over 200 feet. It was found that upon running the machine at thirty miles an hour very little load remained on the lower track, and at thirty-six miles an hour the whole machine was completely lifted.

The *Fortnightly* is remarkable this month for two critical articles by Prof. Karl Pearson and Mrs. Lynn Linton, respectively. Prof. Pearson assails Lord Salisbury's address to the British Association, and moans over the fact that Lord Kelvin courteously said that throughout it " there was the spirit of the student, the spirit of the man of science." Here is his opinion on it : "We find nothing in it which shows the spirit either of student or of man of science ; it teems with fallacious conclusions, and whatever may have been intended by the author, it can only serve as an appeal to that gallery which is occupied by the reconstructed theological party." Mrs. Lynn Linton outpours the vials of her wrath upon Prof. Henry Drummond and his "Ascent of Man." "He brings his subject," says she, "which only the educated can rightly understand, down to the level of the ignorant. He strips science of her divinity, and sends her out as a cottage-maid, or rather as a young priest, of whom no one need be afraid. But he lets slip truth in this endeavour to extract milk for babes out of the meat for men ; and his rendering of synthethic philosophy is both inadequate and shallow. Whatever is true is borrowed ; whatever is false, strained, and inconclusive, is his own. His sin is the sin of plagiarism, with the additional offence of distortion in the lifting." Surely a writer never received a more terrible flagellation than this.

Brief descriptions will suffice for other articles of more or less scientific interest in the magazines received by us. Sir Robert Ball contributes to *Good Words* a paper on Galileo. The *Century* contains a continuation of Messrs. Allen and Sachtleben's account of their journey across Asia on bicycles ; and a fine picture of an aurora, observed and sketched at Godthaab on September 3, 1892, by Mr. F. W. Stokes, one of the members of the Peary Relief Expedition. Dr. Carl Lumholtz describes in *Scribner* the life and costumes of the Tarahumaris, the inhabitants of the Sierra Madre. In *Chambers's Journal* we find a diversity of instructive articles. Among the subjects scientifically treated are "British Ring-Snakes," "Dynamite," "Sweet Lavender," and "Sources of Power in Nature." Lovers of nature will find pleasure in an article entitled "In a Rock Pool," contributed by the Rev. Theodore Wood to the *Sunday Magazine*, and geographers will be interested in a description of the inhabitants of the Andaman Islands. Under the title "Spirit and Matter," Emma Marie Caillard philosophises, in the *Contemporary*, on such psychical subjects as were touched upon by Prof. Oliver Lodge in his British Association address in 1891.

SCIENTIFIC SERIALS.

Bulletin de l'Académie Royale de Belgique, No. 7.—Comparative study of the isothermals observed by M. Amagat and the isothermals calculated from M. Van der Waals's formula, by MM. P. de Heen and F. V. Dwelshauvers-Dery. A comparison of the theoretical and experimental isothermals shows that the molecules which constitute carbonic anhydride expand regularly as the temperature increases. The coefficient of mean molecular expansion, for temperatures between 30° and 258°, is sensibly equal to 0·001, a number which closely approaches the coefficient of expansion of liquids in general. To this intramolecular dilatation corresponds the internal latent heat of dissociation, made evident by the variability of the specific heat of carbonic anhydride in the gaseous state. Since Van der Waals's equation furnishes fairly accurate values for the part of the isothermals situated to the right of the minimum, one might feel tempted to introduce another constant and to force the curve to pass through a supplementary point conveniently chosen to the left of that minimum. This would give much more satisfactory results, but they would have no value with regard to the theory.—On the motion of the satellites of the planets with respect to the sun, by P. Stroobant. The author points out that the moon alone, among all the satellites, always turns the concavity of its orbit towards the sun. This concavity is less at new than at full moon, but the attraction of the sun always outweighs that exerted by the earth. The author investigates theoretically the motions of the satellites round the sun, and introduces the attractions of their planets as perturbations. In order that the trajectory may be looped, the linear velocity of the satellite must be superior to that of the planet. The satellites I., II. and the new one of Jupiter, and Mimas, Enceladus, Tethys, and Dione of Saturn are the only satellites with looped orbits. The rest of the satellites follow a sinuous curve with points of inflexion. Those of Uranus are not taken into consideration. The author expects that if the moon is considered as revolving round the sun, subject to perturbations due to the earth, the lunar theory will be simplified, and successive approximations will be more convergent.

Bulletins de la Société d'Anthropologie de Paris, tome v. 4e serie), No. 3, March 1894; No. 4, April 1894.—Meeting of February 1, 1894.—Dr. P. Mauclaire and M. Bois contributed a note on Ectrodactyly and Syndactyly, in which they describe a very remarkable case, where the right foot and both hands have the appearance of a two-pronged fork. The authors had the opportunity of dissecting this subject, and give a most interesting account of the anatomy.—M. Paul Denjoy described a religious ceremony in Annam, celebrated at the commencement of the new year in honour of ancestors.—M. Ch. Letourneau read a paper on synthetic literature of the first ages, and M. F. Gaillard contributed a note on the sculptures of Gavr Inis.—On February 15, M. E. d'Acy made a communication on flint implements from the plateaus of Picardy and Normandy.—At the meeting of March 1, M. L. Lapicque exhibited some photographs of the inhabitants of the Mergui Islands (the Selungs), and made some anthropological and ethnographical observations on those people. The Mergui archipelago is situated off the coast of Tennasserim (long. 96° 20′ E.; lat. 13° to 9° N.). It is composed of lofty islands covered with ancient forests. The islands themselves may be said to be uninhabited, but in the straits and roadsteads of the Archipelago are to be found several tribes of nomadic fishermen who live entirely on their boats, except during the wet season, from May to September, when they come ashore and build temporary habitations for themselves on the coast. They are very wild, and hold little communication with the people on the mainland. The people seem to be of Malay origin, but there is evidently a considerable admixture of foreign blood of various kinds.—On March 15, M. G. Lagneau read a paper on the mortality from tuberculosis as affected by occupation and by residence.—M. O. Lambert offered some observations with regard to a recently observed case of the presternal muscle, in which he contended that the names *rectus thoracis* and *sternalis brutorum* as applied to this muscle are misleading, and that it ought to be regarded as a survival of a connection that once existed between the panniculi of the abdomen and of the neck.—Dr. Michaut contributed an account of the prehensile foot among the Japanese and Annamites.—M. A. Ponchon gave an account of the caves of Herleville, Canton of Chaulnes (Somme); and M. Octave Vauville read a paper on the enclosures, dwellings, and common pottery of the Gallic epoch. The conclusions at which M. Vauvillé arrives are (1) that the same forms of pottery were in use at the same time in different parts of the country; (2) that the pottery, at the close of the Gallic epoch, was generally made with a wheel; and (3) that it is evident that true artists existed amongst the potters of that period.

L'Anthropologie, tome v. No. 3, May-June 1894.—In an article on the inauguration of anthropology and human anatomy at the Jardin des Plantes, M. E.-T. Hamy gives a most interesting account of the work of Marin Cureau de la Chambre and Pierre Dionis, who lectured there during the years 1635-1680. Dr. R. Collignon contributes an anthropological study of the Basque race, in the form of a summary of a work published *in extenso* in the "Memoirs of the Anthropological Society of Paris." M. Salomon Reinach continues his exposition of sculpture in Europe anterior to Greco-Roman influences.

Tome v. No. 4, July-August, 1894.—This number opens with an interesting article, by Antony Jully, on funeral rites, graves, and honours paid to the dead in Madagascar. The worship of the dead is greatly developed in the different tribes that people the isle of Madagascar, and the ceremonies connected with it and the monuments that result from it are distinctive characters of that race, composed though it is in all probability of heterogeneous elements. The dead is honoured, not because his memory is dear to his relations, but because they fear to rouse his anger by neglect, and so to suffer from his vengeance. Careful attention is paid to the orientation of the graves, which are placed to the north-east of the house and in close proximity to it.—In a short paper on the remains of Elk and Lion, found in a prehistoric station at Saint Martory (Haute-Garonne), the author explains the reasons that have induced him to include these animals, together with the reindeer, in his list.—In an article on Mycenean Crete, M. Salomon Reinach gives an account of the important discoveries lately made in that island by Mr. Arthur Evans.—M. Eugène Toulouze describes the discovery of an interment of the neolithic period at the village of Saint Mammès (Seine et Marne). The sepulchral chamber measures 1·75m. in length by 0·90m. in width, and it is bounded by walls constructed of comparatively small stones. A vase, a polished axe, an arrow-head, and three other worked flints were found associated with the human remains, which were much damaged.—Prehistoric crania of Patagonia form the subject of a valuable article by Dr. R. Verneau. According to M. Moreno, it is possible to distinguish five or six distinct types amongst the known skulls of the ancient inhabitants of Patagonia. Dr. Verneau shows that all the crania have certain characters in common, such as great capacity, prominent glabella and superciliary ridges, sub-nasal prognathism, extroversion of the mandibular angles, large chin, and much-worn teeth.

SOCIETIES AND ACADEMIES.

London.

Royal Society, June 21.—"On Some Phenomena in Vacuum-tubes." By Sir David Salomons, Bart.

This paper deals with the phenomenon known as striæ, or bands, in vacuum tubes.

As far as the author could learn from the sources of information available to him, no one had previously discovered how to produce a predetermined number of bright and dark bands in a tube having an open or free path.

After a prolonged investigation he has succeeded in producing this result, and in the present paper he describes, first, the methods by which a definite number of bright and dark bands can be produced in a vacuum-tube; and, secondly, a number of interesting phenomena which have a bearing on the production of the bands in general.

Some of the conclusions drawn from the experiments are:—

That bands may be produced with greater facility in small tubes than in large, and that they become more accentuated probably on account of the inequality of the diameter of such tubes.

That for the production of bands, the glass of the tube itself appears to play a part, since the bands are difficult to produce unless they reach to the glass of the tube.

That an exceedingly minute current produces bands which to the eye, in most instances, disappear when the current is somewhat increased, and on further increasing the current they become visible again. The author believes that in all previous investigations it has been stated that the bands cannot be produced until a considerable current is passed. He refers to investigations by Messrs. Warren de la Rue, Gassiot, and others. His experiments, however, prove the contrary. The probable reason why these statements were made is due to the fact that with the apparatus employed at that time such small currents could not be easily produced. When the minute current is increased, and the bands seem to disappear, the author thinks this is due to an optical illusion: the bands are there, but too faint to be seen, perhaps in consequence of the dark bands being so narrow that they escape observation.

That, when an electric discharge takes place in a large tube in which is placed a partition pierced with a hole, "a forcing effect" frequently appears to be produced. Any bright bands being produced at the hole in the partition may give the appearance of being pushed through to the side of the tube which has the greater length. This phenomenon is mentioned because it is apt to mask many effects, unless the current is suitably adjusted.

That it is not impossible, after the first trace of light becomes visible in a tube when passing a very minute current, that the dark bands subsequent to this stage are illusory, and that they are really the bright bands; and what appear to be the bright bands consist of overlaps which produce double the brightness of the so-called dark bands. In reality, therefore, the bright bands indicate the position of the dark bands.

That by devices bands can be produced in a large tube occupying only a small portion of the cross sectional area, at any rate so far as the eye can discern.

That, when employing Prof. Crookes' tubes for illustrating experiments on radiant matter, if suitable conditions are observed, striæ are formed in these tubes.

That, in tubes having exceedingly small electrodes, and apparently not capable of producing striæ, these can be shown to exist if very minute currents are employed.

That the tube, when made to act as a condenser, permits more current to pass.

That from the above considerations it is not unlikely that a view, which has been held, in regard to the probable origin of the bands, that they consist of a series of discharges through the tube, is true; that the nature of such discharge can be varied by suitable devices placed within the tubes, and that the examination of the nature of the discharge can be best made with very minute currents, that is to say, currents so small that, if made any less, the tube would no longer show any sign of light.

"The Asymmetrical Probability-Cure." By Dr. F. Y. Edgeworth.

"On the Absorption Spectra of Dilute Solutions." By Thos. Ewan.

In order to measure the extinction coefficients of very dilute solutions, a new spectro-photometer was devised, in which a Lummer and Brodhun photometric prism was used, and the photometric measurements made by means of Abney's rotating sector.

The absorption spectra of dilute solutions of cupric sulphate, chloride, bromide, and nitrate were found to be identical. Solutions of cupric acetate absorb, for the same amount of copper, more light than those of the other salts used. The difference tends to disappear as the solutions become more dilute, and it is increased by the addition of acetic acid.

Measurements of the absorption spectra of a series of solutions of dinitrophenol in pure water were made, from which the amounts of the substance dissociated into ions were calculated, and found to be in very satisfactory agreement with those calculated from the electrical conductivity of the solutions.

The ferric hydroxide formed by the hydrolysis of ferric chloride in aqueous solutions containing less than 0·005 gramme molecules of $Fe\,Cl_3$ per litre, was found to contain no chlorine. The hydrolysis may therefore be represented most simply by the equation $FeCl_3 + 3H_2O \rightleftarrows Fe(OH)_3 + 3HCl$. The determinations of the quantity of colloid ferric hydroxide contained in these solutions (made partly by the spectro-photometer, partly by filtration through porous earthenware) showed that the equilibrium does not take place in accordance with the law of Guldberg and Waage, but agrees much better with the modified form of the law due to Arrhenius, in which account is taken of the electrolytic dissociation of the different substances.

PARIS.

Academy of Sciences, September 3.—M. Lœwy in the chair.—The marine laboratory of the museum at Tatihou I., near Saint-Vaast-la-Hougue (Manche), by M. Edmond Perrier. A description is given of the laboratory fittings and arrangements, and the work enabled to be done by its means.—On two methods for the study of currents in open circuits and of displacement currents in dielectrics and electrolytes. An abstract of a memoir given by the author, M. de Nicolaïeff. Discs or rings of dielectrics are, in the first method, supported by bifilar suspension between the two poles of an electromagnet so that the plane of the ring is at 45° to the axis of the electromagnet, and centrally situated between the poles. The difference in the displacements caused in constant and alternating fields of the same strength is due to a secondary field set up by displacement currents caused in alternating fields. Paraffin shows an augmentation of 12 per cent. for a period of 930 per minute, and 9 per cent. for 770 per minute. In the second method, displacement currents in the rings are caused by the iron in the magnet cores. The ring is suspended perpendicular to the axis of the cores; the polar faces are able to be brought nearer to or removed farther from the parallel faces of the ring. By this method, augmentations have been obtained of 15 per cent. for yellow wax, and 8·3 per cent. for paraffin. Electrolytes in annular glass tubes behave just like perfect dielectrics, sulphuric acid giving an augmentation of deviation of 15 per cent.—Assimilability of potash by the action of nitrates in poor siliceous soils, by M. P. Pichard. It is shown that, in presence of nitrates, a part of the potash combined with silica is capable of being assimilated by various plants, and hence that it is necessary to determine the total potash present in soils as well as that portion eliminated by acids or aqua regia when estimating the agricultural value of soils.—On the construction of the circle derived from seven right lines or defined by the equation $O = \Sigma_1^7 l_1 T_1^3 = X^2 + Y^2 - R^2$, by M. Paul Serret.—On a new gravimetric method for the estimation of glucose, by M. Fernand Gaud. Cuprous oxide is obtained in much the usual manner by reduction, but care is used to carry out the reduction below 100° by using a water-bath as source of heat. The reduced suboxide is then weighed by transferring the carefully-washed precipitate to a specific gravity bottle, and filling up with boiled water and weighing. The weight p of the precipitate is given by the formula

$$p = \frac{P - V_t d}{1 - \frac{d}{\Delta}},$$

where P is the weight of the water and precipitate, V_t is the volume of the flask at the temperature of experiment t, d is the specific gravity of water at the same temperature, and Δ is the specific gravity of dry cuprous oxide 5·881. The quantities of glucose corresponding to given amounts of cuprous oxide are as follows:—10 mg. of Cu_2O = 5·413 mg. of glucose; 20 = 9·761; 30 = 14·197; 50 = 23·036; 100 = 46·221; 200 = 91·047; 300 = 138·842; 400 = 188·928.—Phenomena following from the dialysis of the cells of the beer ferment, by M. E. Onimus. Yeast secretes a dialysable substance which inverts the sugar present before new cells are produced. The medium is modified by the zymase, and then only becomes able to support the production of new cells.—On the Constantinople earthquake of July 10, 1894, by M. D. Eginitis. The method of Dutton and Hayden gives the focus at a depth of 34 km. The speed with which the shock travelled to various places is as follows:—Paris, 3 km.; Pavlovsk, 3·5 km.; and Bucharest, 3·6 km. per second.

BERLIN.

Physiological Society, July 6.—Prof. Munk, President, in the chair.—Dr. J. Munk had tested the results of his experiments on fasting man by further new experiments on dogs, with the special object of investigating the excretion of chlorine, phosphorus, lime and magnesia, which he had found to be increased in man during hunger. During ten days of fasting he found all four of the above substances, but especially phosphorus and lime, in largely increased quantities in the urine, as compared with days of normal dieting. The fæces also during hunger, which closely resembled meconium both in appearance and composition, contained an increased amount of phosphorus, lime, and magnesia. By calculating, from the amount of nitrogen excreted, the amount of body-proteid metabolised during hunger, he found that only a portion of the excreted phosphorus could have come from the proteid; the remainder must have resulted from the metabolism of some constituent of the body rich in phosphorus and lime. The ratio of these to each other corresponded to a metabolism of bone-substance amounting to about 39 grms. in ten days of hunger. Dr. Munk further reported on experiments on dogs, in which he at one time administered a given amount of meat all at once, and at another time the same amount of meat distributed over three meals. In the latter case the excretion of nitrogen in the urine was greater than in the former, indicating a less perfect utilising of the proteid. This result on dogs is, however, not applicable to man, in whose case the conditions are different, and in whom, as shown by Ranke's older experiments, a given amount of food is more completely utilised if taken in separate portions than if eaten all at once.—Dr. Engel gave an account of his observations on the blood-corpuscles of incubated hens'-eggs, leading to results essentially the same as those obtained from mammalian embryos. In birds the red and white corpuscles and platelets take their origin from nucleated red cells. These views were supported by photographs and microscopic preparations, which were, however, regarded by Dr. Benda as not excluding the possibility that the appearances they presented were purely artificial.

July 20.—Prof. du Bois Reymond, President, in the chair.—Mr. W. T. Porter, of Boston, spoke on spinal respiratory tracts, and gave an account of the following interesting experiments:—On unilateral section of the cord at the level of the nucleus of the phrenic, the movement of the diaphragm on the same side ceases or becomes very weak, whereas it continues unaltered on the other side. If now the phrenic nerve on the uninjured side be cut through, the diaphragm on this side becomes relaxed, while at the same time, on the other side with the unilateral section, the movements of the diaphragm begin again and are continued quite normally. Prof. Koenig had been able, in conjunction with Miss Koettgen, to investigate the absorption of light by visual-purple from a freshly extirpated human eye. A portion of the solution was examined in an unaltered condition, and the remainder after it had been converted into visual-yellow by the action of green light. The curves of the transmission of light for a solution of visual-purple were found to be identical with the luminosity curves of the totally colour-blind, and of bi- and tri-chromatic eyes where the intensity of light is so small that colours cannot be perceived. The curve for a solution of visual-yellow was the same as the luminosity curve of a red-green colour-blind eye. From the above, Prof. Koenig deduced the probability that visual-purple serves for the perception of undefined colourless grey, while visual-yellow serves for the perception of blue. Since both visual-purple and, hence also, visual-yellow are absent from the fovea centralis, this part of the retina should be colour-blind for blue. The speaker brought forward a series of facts in support of this view, and a discussion followed.

July 27.—Prof. du Bois Reymond, President, in the chair.—Prof. Koenig first spoke about an "experimentum crucis" as to his theory of the significance of visual-purple which had been suggested during the discussion at the end of the last meeting, and declared it to be irrelevant. Dr. Greef described the neuroglia cells of the retina and chiasma of the optic nerve as prepared by Golgi's method, and which were called spider-cells, owing to their small elongated bodies and long slender processes. A comparison of these cells in different classes of vertebrate animals had shown that they are most numerous in man, and possess the longest and slenderest processes, while they are less numerous and have shorter and thicker processes the lower one goes in the vertebrate scale. The function of the cells appears to be to isolate the individual nerve-fibres. Prof. Kossel had further investigated the products of the decomposition of nucleic acid, and obtained a much simpler chemical composition for thymin, based on its elementary analysis, than in his previous researches. He had also discovered a new base, which he called "cytosin," and whose reactions he described in detail. Prof. Kossel further described a new and simpler method for determining urea in urine, consisting in a modification of Bunsen's well-known method, and which had proved itself trustworthy as applied to solutions of urea of known composition. Dr. Krüger had isolated a new base of the xanthin group from human urine, which, while it differed materially in its reactions from the xanthin bodies, but showed much resemblance to guanin, he had named epiguanin. Dr. Lilienfeld gave an account of his further researches on diglycocollamide esters. By combining diglycocollamide with leucic acid, as also with tyrosinic and asparaginic acids, he obtained various substances which all gave proteid reactions. One of the compounds so closely resembled ordinary peptone, both in appearance and in all its reactions, that he had provisionally given it the name of synthetised peptone. He reserves for himself the further investigation of this interesting group of synthetic products.

NEW SOUTH WALES.

Linnean Society, July 25.—Prof. David, President, in the chair.—The following papers were read:—(1) Observations on the femoral gland of *Ornithorhynchus* and its secretions, together with an experimental inquiry concerning its toxic action, by C. J. Martin and F. Tidswell. The gland is a compound racemous variety with large alveoli possessing a wide lumen, and somewhat recalling the appearance of a mammary gland. The alveoli communicate with ducts which eventually join at the hilus of the gland to form the duct leading to the spur. The gland is surrounded by a capsule of fibrous tissue, exterior to which is a thin layer of smooth muscle fibre. A marked difference in the minute structure of the gland was noted in animals killed in June and those in April respectively, the former showing the appearance characteristic of an actively secreting gland, whereas the latter suggested that of a mammary gland when it had undergone retrogressive morphosis. Examination of the poison showed it to consist principally of albuminous bodies, and the introduction of these into rabbits produced very marked poisonous results. When injected under the skin, local swelling, and great general depression and rise of temperature followed, but in three days the animal was well again. When the poison was introduced directly into the vascular system, small quantities (1/8 grain) caused death in under half an hour. Larger doses so introduced produced almost immediate death, by producing nearly universal clotting of the blood whilst travelling in the blood-vessels. Such clotting naturally soon put an end to all circulation. In summing up, the authors compared the action of Platypus poison with that of the venom of Australian snakes, supposing the latter to be diluted 5000 times.—Notes on Australian "shipworms," by C. Hedley. A large species of "shipworm" or "cobra" from South Australia, perhaps the largest yet discovered, was described and figured under the title of *Teredo edax*. The type of *T. antarctica*, Hutton, from New Zealand was also figured to demonstrate that the supposed recognition of this species from the coast of Queensland was erroneous.—On five interesting shields from Northern Queensland, by R. Etheridge, jun.—Additional notes on the Palæontology of Queensland. Part i. Palæozoic, by the same.

BOOKS and SERIALS RECEIVED.

BOOKS.—The Works of Hertz and some of his Successors: Prof. O. Lodge (*Electrician* Co., Ltd.).—Glasgow and West of Scotland Technical College Calendar, 1894–95 (Glasgow, Anderson).—Catalogue of the Michigan Mining School, 1892–94: Announcements, 1895–96 (Houghton, Michigan).—Trattato di Materia Medica: Prof. P. Giacosa (Torino, Bocca).—Ponds and Rock Pools: H. Scherren (Religious Tract Society).—Heat treated Experimentally: L. Cumming (Longmans).—Theoretical Mechanics; Solids: A Thornton (Longmans).

SERIALS.—Geological Magazine, September (K. Paul).—Publications of the Astronomical Society of the Pacific, Vol 6, No. 35 (San Francisco).—American Meteorological Journal, September (Ginn).—Engineering Magazine, September (Tucker).—Tufts College Studies, No. 2 (Tufts College, Massachusetts).—Brain, Part 67 (Macmillan).—Medical Magazine, September (Southwood).—Science Progress, September (Scientific Press).—American Journal of Science, September (New Haven).—Bulletin de l'Académie Impériale des Sciences de St. Petersbourg, nouvelle serie iv., Nos. 1 and 2 (St. Petersbourg).

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THURSDAY, SEPTEMBER 20, 1894.

THE PRINCIPLES OF PURE MATHEMATICS.

Grundzüge der Geometrie von mehreren Dimensionen und mehreren Arten gradliniger Einheiten in elementarer Form entwickelt. Von Guiseppe Veronese, Professor an der königl. Universität zu Padua. xlvi. + 710 pp. Leipzig: Teubner, 1894.)

THE work before us is an authorised German translation, by Lieutenant Adolf Schepp, of Wiesbaden, of Prof. Veronese's treatise on the Foundations of Geometry, first published at Padua in 1891; and the translator tells us in his short preface that the author has communicated to him the corrections and improvements of his work that have occurred to him since its publication in Italian. To give such an account of the contents of a book, so important, so original, and, it may be added, so controversial, as would serve to render its purpose and method generally intelligible, and at the same time to subject it to adequate criticism, would require a memoir rather than a review. We shall therefore endeavour only to give such a description as will recommend it to the attention of all who are interested in the logical basis of Pure Mathematics.

The Preface of thirty-four pages gives a general view of the author's system; the Introduction of 222 pages is devoted to the logical establishment of the notions of Number and Continuous Quantity; after that the First Part deals with the Straight Line, the Plane, and Space of Three Dimensions; the Second Part is occupied with the theory of Space of four or n Dimensions. The treatise ends with an interesting historical and critical discussion of the most important previous works on the same subject, and some notes elucidatory of special principles. A full table of contents is given, and a list of authors quoted; but it would have added much to the value of the book as a work of reference if a good alphabetical index of subjects had been included. The remainder of the present notice will be confined to the Introduction, the specially geometrical parts of the book being reserved for another occasion.

The thorough revision to which, in this century, the underlying principles of mathematical reasoning have been subjected is not less remarkable than the great advances made in the ulterior developments of these principles. Crelle has said that for those who probe the depths, equally with those who build in the heights of mathematical thought, there ever remain unexplored mysteries. Among those who have probed the depths, the investigators, namely, who have occupied themselves with the notions of number and quantity, the continuum of real numbers, the infinitely great and the infinitely small, there has been much divergence of opinion as to the logical grounding of the subject. Such discussions appear to be foreign to the taste of our English writers. With us Arithmetic is an affair of sums to be done by rules; Algebra is arrived at by noting the laws of operation with the numbers of Arithmetic, and giving to them the power of holding generally. We are too used to the process humorously described by Clifford [1]—"In the science of number while five-sevenths of fourteen has a meaning, namely, ten, five-sevenths of twelve is nonsense. Let us then treat it as if it were sense, and see what comes of it." This method, which Clifford held to be "logically false and educationally mischievous," is not that adopted by continental writers, and in particular it is not the method of Prof. Veronese. For him it is necessary so to define the abstract notions—number, quantity, and so on—that the laws of operation with them may be logically well-grounded upon the definitions. Let us see how he sets about the notion of (positive integral) number.

Readers of Clifford's lecture just now quoted will remember that the *crux* of Arithmetical theory lies in the proof of the statement that the number of things in a group is independent of the order in which they are counted; and the difficulty of proving it is not diminished by the facts, firstly, that everyone is firmly convinced of its truth, and secondly, that the whole system of Arithmetic is the work of the human mind, and therefore the theorem must somehow be implicitly included in the definitions when these are given with sufficient clearness. Prof. Veronese, like Kronecker,[1] appears to regard the ordinal number as logically preceding the cardinal number; in other words, he makes the idea of a group of things arranged in an order more elementary than the idea of the number obtained by counting the things in the group. Kronecker, going out from this notion, rapidly arrived at the required result, but our author is not satisfied with his reasoning. His own process is much more leisurely. He starts from the notions of unity and multiplicity (Einheit and Mehrheit) and explains the operations of uniting (Vereinigung) the objects of a series into a group, and of separation (Zerlegung) of a group into objects by successively taking away (Wegnehmen) object after object from the group. He defines an ordered group, and explains the unique correspondence of elements in two such groups. It is only after all this that he is prepared to define a number as an ordered group of units arranged to correspond uniquely and in the same order to the objects in an ordered group of objects. This definition is found to be a sufficient ground for the definition of counting, for proving the crucial proposition above referred to, and for the establishment of the commutative law of addition and the remaining laws of operation with positive integral numbers.

To establish the notion of Quantity and the extended conception of Number, with which Algebra has made us familiar, it is necessary, as many writers (including Du Bois Reymond) have pointed out, to frame an account of the Fundamental Form, or, as we may call it, the *Locus in quo* of real Quantity. A numerical fraction implies a something divisible into equal parts, and a part of it containing a certain number of these parts. A square root implies an exact measurement of a side of a square which has a given area. These examples show that we do tacitly or expressly assume a *somewhat* capable of exact division into parts in arbitrary ways corresponding to various mathematical ideas. This *somewhat* is the Fundamental Form (Grundform), and it has been frequently figured as a geometrical straight line, as by Du

[1] "Lectures and Essays," vol. i. p. 356.

[1] "Ueber den Zahlbegriff." *Crelle*, Bd. ci. 1887.

Bois Reymond in his Algemenie Functionentheorie. According to Prof. Veronese it is more proper to give an independent abstract account of the Fundamental Form, partly because the properties of the straight line are afterwards to be determined in accordance with abstract definitions. He therefore takes as a guide the rectilinear continuum of intuition, of whose properties he gives an analysis, and then proceeds in an abstract manner. He defines a Form as anything whose marks are part, whole, order, and kind of position. Thus a line regarded as consisting of segments limited by points in a certain order having positions on the line is a Form, a song regarded as consisting of certain words pronounced in a certain order and each in a certain musical pitch is a Form. He explains how one Form may be determined by other Forms, and how the identity of two Forms may be inferred from the identity of the Forms that severally determine them. To avoid the circular reasoning that must ensue, unless some Forms are known to be identical there arises the necessity for introducing the Fundamental Form as a standard which serves for the determination of all others. He describes successively a system of one dimension as a form given by a series of elements whose order, from a certain element, is a mark of the form, a homogeneous system of one dimension, and a system of one dimension identical in the positions of its parts. Such a form is chosen as Fundamental Form. The operations of uniting segments of the Form and of separating united segments are described, and shown to obey the Laws of Algebra for addition and subtraction. The relations of segments as multiples or factors of other segments lead to the laws of multiplication and division, and to the description of the Scale founded upon any segment as unit. The Range of the Scale (Gebiet der Scala) is the part of the Fundamental Form arrived at by continual repetition of the segment chosen as unit.

The author is now prepared to introduce the conceptions of the infinitely great and the infinitely small. He assumes that there is an element of the Fundamental Form which lies outside the Range of the Scale founded on any segment as unit. This assumption is apparently free from any contradiction. Such an element being chosen, the segment limited by it, and any element within the range of the scale, is infinitely great in reference to the unit of the scale; had this segment been chosen as unit, the original unit would have been infinitely small. From the nature of the Fundamental Form, as a homogeneous system identical in the position of its parts, follows the necessity of assuming any number of orders of infinite segments and any number of orders of infinitesimal segments.

To every segment corresponds a numerical symbol, just as in particular the natural numbers correspond to the segments which are exact multiples of that one chosen as unit. The ordinary Laws of Algebra holding for the segments hold in like manner for the numbers thus introduced. To the infinitely great and infinitely small segments of different orders correspond infinitely great and infinitely small numbers of different orders. It is proved that the numbers thus arrived at are not identical with Cantor's "Transfinite numbers" (*Acta Mathematica*, Bd. II). After the introduction of these numbers, and the establishment of the laws of operation with them, come the hypotheses of continuity of the Fundamental Form, an idea here treated in a very instructive manner, the proof of the existence of Limits so elaborately discussed by Du Bois Reymond, the notions of commensurable and incommensurable segments, and the theory of Proportion, the last being especially interesting. A chapter is added for the sake of completeness, in which the properties of real, positive and negative, rational and irrational, numbers are established on the basis of principles already discussed.

It is a cardinal feature of the author's account of the theory of Quantity to dispense with the so-called Axiom V of Archimedes, according to which it is inherent in the notion of quantity that when one quantity a is greater than another b, there exists a number n such that nb is greater than a. This axiom has been found by other writers, as Stolz, extremely useful in establishing the properties and relations of finite quantities, but appears to involve difficulties in connection with the infinitely great and the infinitely small. At the expense of greater length of explanation, Prof. Veronese has freed the theory from the axiom and the involved difficulties. His own exposition is generally clear, though his doctrine of "commensurable numbers of the second kind" (pp. 182 and 213) is not without obscurity. Could not an example have been given?

Enough has been said to show that Prof. Veronese's book treats of a great deal besides the Foundations of Geometry—his Introduction might, in fact, well be entitled the Foundations of Mathematics. He tells us that although some parts of it will be useful in Geometry, much has been worked out simply for its own sake. We may well be grateful to him for the patience and trouble that he has expended in clearing up the Logic of the operations that most of us, without a thought of underlying difficulties, cheerfully perform with confidence and success. He has none of the charm of style to be found in the writings of Clifford or Kronecker. Rigorous he is, thoroughly common-sense, careful almost to tediousness, and extremely leisurely. For the elucidation of the very difficult subject he has chosen, these qualities are perhaps the greatest of merits, yet we fear that they will not render his writings acceptable to readers unprepared for a considerable sacrifice of time.

A. E. H. L.

TEXT-BOOKS ON ORGANIC CHEMISTRY.

Organic Chemistry. Part I. By W. H. Perkin, jun., Ph.D., F.R.S., and F. Stanley Kipping, Ph.D., D.Sc. (London: W. and R. Chambers, 1894.)

Lessons in Organic Chemistry. Part I. Elementary. By G. S. Turpin, M.A. (Camb.), D.Sc. (Lond.) (London: Macmillan, 1894.)

It is not surprising that "organic" chemistry should have received less attention in this country than on the continent, considering that the professors in nearly all the chief British universities have been notoriously neglectful of this department of the science, and that the highest degrees in connection with chemical science have been until recent years generally attainable without a practical acquaintance with the subject, and without evidence of capacity for research.

The influences which in Germany have led to so widespread and successful prosecution of research in organic chemistry are traceable partly to the university system, which demands the production of a piece of original work, and partly to the wonderful development in that country of the colour industry, which is now practically a German monopoly. We have, however, British chemists who have successfully devoted themselves to "organic" chemistry, and among them the names of Perkin (son as well as father) and Kipping stand out in honourable prominence. Hence a text-book issued in these conjoint names would naturally excite attention and interest.

"Our original intention," say the authors in their preface, "was to write a small text-book on organic chemistry, based on the syllabus drawn up by the Science and Art Department." Such a plan, however, was not worthy of the reputation of the writers, and they are to be congratulated upon having enlarged the scope of their work beyond this rather narrow limit.

This volume, Part I., deals with the fatty compounds, and "contains in the first place a general account of the methods most frequently employed in the separation, purification, and analysis of organic compounds, and in the determination of molecular weight. The preparation and properties of typical compounds are then described, attention being directed to those changes which come under the heading of general reactions rather than to isolated facts regarding particular substances. Questions of constitution are also discussed at some length, and in the case of the most typical compounds, the facts on which the given constitutional formula is based are specifically mentioned." From this outline it will be seen that the arrangement of the book is not essentially novel. The best feature is the discussion of the structure or constitution as expressed by the formulæ of the more important compounds, and, notwithstanding one or two statements which look rather dogmatic, this is the feature which gives it some superiority over other text-books of about the same dimensions. No reference is made in this volume to ideas of geometrical isomerism, which are prudently reserved for the second part. It is to be regretted that the authors should have allowed themselves to drop, in print, into the slovenly phraseology which is too common among all classes of chemists. For example, p. 99, cane sugar is said to be converted into "equal molecules" of dextrose and levulose. It is true that this expression is employed by writers of bigger books, but that is no justification for the continuance of a phrase which is absolutely unmeaning. On p. 204, triethylamine is said to be "a stronger base" than diethylamine; while on the opposite page, 205, tetrethylammonium hydroxide is stated to be "a stronger base" than potash or soda. If eminent chemists occupying the position of university professors are so lax, it is not to be wondered at that the poor South Kensington teacher and his pupils should be sometimes found wanting when called upon for definitions.

Chapter xiii., p. 218, opens with this statement:—

"It may be assumed as a general rule that the changes which any particular group of atoms is capable of undergoing are independent of the nature of the groups with which it is combined."

This requires for its justification something more than the example which follows, for organic chemistry is full of instances of the influence which neighbouring atoms and groups have upon the character of a given atom or group; and at the top of the very same page the authors draw attention to one of these, namely: "The influence of alkyl groups in increasing the basic character of an element." Mercury is here referred to, and the meaning is obvious to the instructed chemical reader, though the reference to the basic character of the element, coupled with the succeeding statement that mercuric oxide is a feeble base, is well calculated to confuse the mind of a learner.

Dr. Turpin's book is one of the series of science class-books adapted to the elementary stage of the South Kensington syllabus, and issued by Macmillan. Here again the arrangement runs upon well-established lines, beginning with processes of analysis, methods of estimating molecular weight, and then plunging into the successive series of hydrocarbons, alcohols, ethers, acids, and so forth. Detailed directions are given for the performance of a selection of instructive experiments, the number of which, however, being no more than twenty in the whole book, ought to be considerably increased. At the end of each chapter are some questions which will doubtless be suggestive to both pupil and teacher. These are good and useful features of the book, which it must be remembered is labelled elementary; but, oh! Dr. Turpin, where in the whole range of stereo-chemical literature did you find the "valuable hypothesis" that "the carbon atom is regarded as being similar in shape to a regular tetrahedron"? (p. 31). We certainly feel justified in protesting against the author's treatment of the "tetrahedral theory of the carbon atom," which is disposed of in about twenty lines with three shaded diagrams. It is more than doubtful whether this hypothesis should appear in an elementary book at all, but to thrust it in without reference to the sort of fact which it is intended to explain, and to state it in this crude form, cannot be too strongly condemned.

Both these little books have their good points, and both will undoubtedly be found useful by many young students; but the perusal of them and others leaves the impression that the text-book which will meet all the difficulties and provide fully for the needs of the student entering upon this ever-widening subject of organic chemistry, has yet to be written. Organic chemistry is not begun till the student has some acquaintance with inorganic and general chemistry, and if properly taught previously he ought not to require to be told how to deduce a formula from the results of analysis, or how to determine a molecular weight. The practice of reserving these matters as an introduction to organic chemistry belongs to a bygone time, and it has the disadvantage of leading many students to think that vapour density and other methods are applicable only to organic compounds. The arrangement of carbon compounds in homologous series from the outset is also confusing to the beginner, because each succeeding term of such a series is derived from distinct materials which have no apparent connection with either those which go before or those which follow after. A better plan, adopted in some of the older books, now out of date, is first to study the transformations of some one substance, such as alcohol, which lends itself to many changes, which are easily traced experimentally, and subsequently to deal with series. This leads naturally and easily to the great object of the detailed study of carbon compounds. Apart from their practical utility and the application of knowledge gained by this detailed study to the purposes of the vegetable and animal physiologist, the great aim of the organic chemist is surely to trace the relation of chemical constitution to physical properties, and so to shed light upon the wider question of the constitution of matter generally: but this is just the aspect of the study which, in most of the text-books, is kept in the background. W. A. T.

PRACTICAL PHYSICS.

Physikalisches Prakticum, mit besonderer Berücksichtigung der physikalisch-chemischen Methoden. Von Eilhard Wiedemann und Hermann Ebert. Zweite verbesserte und vermehrte Auflage. Pp. xxiv. 455. 279 Woodcuts. (Braunschweig, Viewig, 1893.)

RECENT years have seen a great development in the teaching of practical physics, and a great increase in the number of laboratories in which instruction in the elementary parts of the subject can be given to large classes of students. So much has this been the case, that now practical physics is taught in a good many of our schools, and forms one of the subjects in numerous examinations. Those who have been largely concerned in the establishment of classes for practical instruction in physics, and have had some experience in actual teaching, have often felt the need of a suitable book to put into the hands of their students, and have endeavoured, each for himself, to supply this want. This is the origin of several books on practical physics, such as Glazebrook and Shaw's manual (to take an English example), and the work before us. The authors of such books are able to employ the MS. or the proof-sheets in the instruction of their students, and thus are able to obtain a practical test of their work before sending it forth to the public, with the result that the books are generally very satisfactory for the purposes for which they are designed. The only drawback is that each book is apt to appeal only to a particular type of students, and to give descriptions of the apparatus in a particular laboratory.

The "Practical Physics" of Wiedemann and Ebert has been designed for a special class of students, viz. those who are chiefly interested in acquiring a knowledge of chemistry. Particular attention has therefore been devoted to those parts of physics which are of most use in a study of chemistry, while several parts of the subject of great interest to physicists have been either omitted or only very briefly dealt with. Thus experiments on rigid dynamics and on the magnetic properties of iron and steel are completely passed over.

The authors have not attempted to give an account of the methods of precision which may be employed in the experiments selected by them, and consequently have taken no notice of the small corrections which become of so great importance in an accurate research. In those cases where it seemed desirable that some sou[rce] of error should be brought prominently before t[he] student's notice, the experiment is so arranged that t[he] correction shall not be too small.

To each section there is an introduction wherein t[he] general laws to be employed are stated, and the quantit[ies] to be measured are sometimes defined; but, as a rule, [no] account whatever is given of the reasoning by which t[he] formulæ are arrived at. This is bound to be unsat[is]factory, and must lead the student to be continually a[sk]ing for explanations of the formulæ, unless indeed he [is] a person of little mental vigour, when he will acc[ept] formulæ without a murmur. In many instances [no] explanation or definition whatever of the quantity to [be] measured is vouchsafed to the student. For example, [he] is informed that the coefficient of viscosity of a liq[uid] can be determined by the formula

$$\eta = \frac{\pi p r^4 t}{8 V l}$$

where V is the volume of liquid which is driven thro[ugh] a fine tube of radius r and length l in time t by a pr[es]sure p, but there is absolutely no definition of [the] coefficient of viscosity, although it might have been gi[ven] in a few lines. The same complaint may be made ab[out] several other sections. The authors are surely mistak[en] in their idea that by their method the use of books [on] "the higher mathematics" may be dispensed with, a[nd] the "Prakticum" become a self-contained treatise on pr[ac]tical physics, wherein the student may find all he requi[res] without the trouble of searching through special te[xt]books. Besides, it is in every way better that the stud[ent] should endeavour to acquaint himself with the metho[ds] by which the formulæ have been deduced. He gains [in] this way a grasp of the principles of the subject which [is] hardly attainable in any other manner; and if he d[oes] learn a little mathematics, he may hope that it will [not] seriously injure his ability for chemistry.

Before dealing with the contents of the book, it may [be] well to mention some points in which the book is far l[ess] satisfactory than the authors were capable of making [it]. The first complaint is that the results of the sample [ex]periments are frequently set down without any stateme[nt] of the units in which they are expressed. For instan[ce], the modulus of rigidity of brass is found by an expe[ri]ment to be 4770 *somethings*, but what the *somethings* [are] is not stated. The student who happened to express t[he] linear magnitudes in centimetres instead of millimetr[es] would doubtless be much perplexed when he fou[nd] by his experiment the value 477,000 instead of t[he] result in the book. If, on the other hand, the value [of] the modulus had been expressed as 4770 kilogramm[es] per square millimetre, all the difficulty would have be[en] avoided. The student should be so trained to state pr[e]cisely the units in which his results are expressed, th[at] the bare statement that the modulus of rigidity is 47[70] should produce an unsatisfied feeling, in his mind, mu[ch] the same as is called up by the conundrum, Why is [a] house? In some instances where units are given, th[ey] are given wrongly, as when the velocity of sound is fou[nd] to be 331·5 *metres*, and the average velocity of hydrog[en] molecules is stated to be 1698 *metres*.

A minor defect is that one system of units is r adhered to throughout. Sometimes centimetres are employed, and sometimes millimetres. This is of no consequence, except so far as it tends to keep alive and propagate the state of confusion from which the C.G.S. system might have been expected to deliver the scientific world.

The first part of the book deals with the mechanics of solids, liquids, and gases. The usual methods of measuring lengths, &c., are described, and an account is given of experiments on the balance, on the laws of the pendulum, on elasticity, and on acoustics. The greater portion of the space is devoted to experiments with liquids and gases. The full account which is given of the methods of making measurements of a mechanical nature upon matter in these two states, should be very useful to the students for which the book is designed.

The second division, which is devoted to heat, is excellent. A large number of experiments are described, most of them of great importance to the modern chemist. In this connection may be mentioned specially the sections dealing with melting points, the effect of dissolved substances on the freezing and boiling points of liquids, and the amount of heat evolved in solution and chemical combination. A section is devoted to the determination of the mechanical equivalent of heat by the aid of what is practically a model of Joule's apparatus.

Optical measurements and observations occupy the next portion. Some simple experiments with reflecting surfaces, lenses, and prisms are given, so as to form an introduction to the subject. A few simple experiments with combinations of lenses with lenses or mirrors would have been of much use here, for students generally find difficulty with such experiments, and require some little experience before they can deal practically with the real or virtual images which are seen in mid-space, and not down the tube of a telescope. A large part of the section is devoted to spectrum analysis, and there are some excellent plates of emission and absorption spectra. A short account of the phenomena of polarisation leads up to a chapter on the rotation of the plane of polarisation by various substances, and the use of this property for saccharimetry and other purposes.

The last division of the book, which is devoted to electricity and magnetism, is somewhat abbreviated, only those parts of the subject being included which are supposed to be of interest to the chemist. Voltaic electricity practically takes up the whole of the space. The same omission of definitions, which has been already noticed, shows itself strongly here, no definition being given of either the ampere, the volt, or the ohm, while the enunciation of Ohm's Law is just what a schoolboy might be expected to put down. Although a tangent galvanometer is described, no hint is given that it is possible to calculate its "reduction factor" if the value of "H" is known, and, in fact, the electromagnetic definitions of the units seem quite kept out of sight. From a physical point of view, this division compares quite unfavourably with the three other divisions.

The volume is brought to a conclusion by a useful collection of numerical tables, physical and mathematical.

In spite of the defects which have seemed to call for notice, the book is undoubtedly a useful one, the defects being such as the teacher can very easily remove. If a third edition is called for, it is to be hoped that the authors may see their way themselves to remove them.

The book will often be of service to those teachers who are engaged in the task of conducting classes in practical physics, for it will often suggest fresh experiments to be added to those forming the regular course of the laboratory. But it must be remembered that although a demonstrator in the course of a few years may acquire a knowledge of a large number of experimental methods, yet the students who come under his care for a year or so have only time to acquire a very limited acquaintance with the subject, so that if a new experiment is added to the course, it practically displaces some old one. The course of experiments which is most suitable for students of a particular type working for a particular end, very soon settles itself by a process of selection, and then must remain practically unchanged, although there may be a gradual evolution in the employment of improved methods.

G. F. C. SEARLE.

OUR BOOK SHELF.

Object Lessons in Elementary Science. By Vincent T. Murché. Three volumes. (London: Macmillan and Co., 1894.)

WHEN a child is shown any object, he usually asks "What is it?" and then "What does it do?" If these questions are sensibly answered the child learns much about the properties of common things while he is very young, and, what is more, his faculty of observation is developed. Evidently, then, an excellent grounding for a scientific education can be obtained from object lessons. Simple objects are brought under the children's notice, and their peculiarities observed. For instance, liquids such as water, oil, wine, milk, and quicksilver are taken and used to show that they flow, break up into drops, have no shape of their own, and keep a level surface. Physical properties of solids can then be treated; but whatever the subject of the object lesson, the aim of the teacher must be to let the class come to their own conclusions upon the points illustrated. This principle of sound instruction is well exemplified by the lesson on hard and soft bodies in the first of the three volumes before us. The aim of the lesson is to enable a child to express clearly (1) what he understands by "hard" and "soft"; (2) that hardness and softness are merely relative terms; (3) how to test the hardness of a body. Such objects as an apple, a turnip, a potato, cork, chalk, wood, lead, iron, flint, steel and glass are taken, and children are asked to scratch them with the finger-nail. It is then found that some of the objects can be scratched easily, others not so easily; a third class can only be scratched with difficulty, and a fourth cannot be marked at all with the finger-nail. The experiments are afterwards repeated with a knife, and then the objects are rubbed against one another, and the results noticed. By these means the pupils learn that there are many degrees of hardness, some bodies which are commonly called hard being really soft when compared with others; *e.g.* lead is hard when compared with wood, but soft when compared with iron, and so on. To our minds, this method of teaching elementary science is admirable. It must not be supposed however, that Mr. Murché only deals with physical conditions. His excellent little volumes are also concerned with the chemistry of common things, with the mechanics of every-day life, with zoology, botany, and physiology, and with various arts and manufactures. The volumes follow a scheme of object teaching in elementary science issued by the London School Board some years ago. The author adopted this scheme for use in his school as soon as it was issued, and the experience gained since then has enabled him to produce a thoroughly practical work. We know no better work for teaching elementary science to young children. Though designed for Standards I. to VI. of Board and National schools, most of our private, and many of our public, schools would gain by introducing these object lessons into their curricula.

Précis de Météorologie Endogène. By F. Canu. (Paris: Gauthier-Villars et Fils, 1894.)

LA MÉTÉOROLOGIE ENDOGÈNE is, according to the author's definition, concerned with (1) all acoustic and dynamic phenomena produced more or less directly by variations of atmospheric pressure within the earth's crust; (2) internal manifestations of electricity and magnetism. Ritter gave this branch of knowledge its name, but it was De Rossi who reduced it to a system. M. Canu's volume is an elementary description of phenomena belonging to the physics of the earth. Among the subjects dealt with are the aurora and its connection with the sun; earth currents; subterranean noises, and circumstances affecting them; terrestrial magnetism; earthquakes and earth tremors; and causes producing the escape of fire-damp. All these phenomena are first treated descriptively, and then in relation to other phenomena. Thus, after descriptions of the height, spectroscopic features, acoustic properties, electric character, and geographical distribution of auroræ, we find brief statements of all the causes believed to influence the phenomena. This plan is followed in each chapter, and though the correlation between the phenomena described is sometimes very doubtful, in general the observations quoted deserve consideration. "Pour propager une science," says the author, "il faut avant tout la vulgariser." To accomplish this object the book has been made easily understandable to a French-reading public.

Sach- und Orts-Verzeichnis zu den mineralogischen und geologischen Arbeiten von Gerhard vom Rath. Im Auftrage der Frau vom Rath bearbeitet von W. Bruhns und K. Busz. Pp. 197. Leipzig: Engelmann, 1893.)

THIS book is a tribute by the widow of Prof. vom Rath, of Bonn, to the memory of her late husband. It had been her wish to republish his numerous memoirs in a collected edition, but the expense of reproduction of the elaborate crystal drawings with which his researches have been illustrated was found to be prohibitory; hence the tribute has taken the form of a detailed Index to his works. The plan adopted for the Index is identical with that of the useful Repertorium of the "Zeitschrift für Krystallographie und Mineralogie von P. Groth." There are two alphabetically arranged lists, the one a subject-index, the other a locality-index. The crystallographical and mineralogical part is the work of Dr. Busz, while for the petrographical and geological part Dr. Bruhns is responsible. The Index gives striking evidence of the vast range of Prof. vom Rath's studies and observations, while the high standard of excellence which characterised his work is known to all who have occasion to refer to his memoirs. By reason of the diversity of the species and subjects discussed by him, this Index will be of great advantage to students of mineralogy.

Elementi di Fisica. Vols. I. and II. By Antonio Ròiti. (Florence: Successori Le Monnier, 1891 and 1894.)

THE first volume of the third edition of this work was published in 1891, but the second volume, revised and enlarged, has only recently appeared. The two constitute an admirably-arranged work on general physics, similar in structure to Ganot's "Natural Philosophy," After an introduction on the properties of matter, Prof. Ròiti passes to the mechanics of solids, and then to the mechanics of fluids. The next section is devoted t acoustics, after which come chapters on heat and energy. These conclude the first volume; the second being concerned with radiant energy, and electricity and magnetism. There are nearly nine hundred illustrations in the complete work, but the majority of them are old friends. However, scientific judgment has been used in making the compilation, and the only matter for complaint is the absence of an index—a common defect of continental publications. In a work of science having the scope of that under review, such an omission is unpardonable.

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.*]

Latitude by Ex-Meridian.

THE problem under consideration is that of finding latitude by an altitude of a heavenly body taken near the meridian, commonly called the "Ex-Meridian." The method most frequently employed by navigators is that in which a reduction is applied to the observed altitude in order to reduce it to the meridian, this reduction being either found by calculation or taken by inspection from special tables such as the "Ex-Meridian Altitude Tables," by Messrs. Brent, Walter, and Williams. In the following it is proposed to show how this reduction may be effected by the use of the Azimuth and Traverse Tables.

If l be the latitude, d the declination, and h the hour angle, the formula of reduction is

$$x = Ch^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where

$$C = \frac{\cos l \cos d}{2 \sin (l-d)} \left(\frac{\sin^2 1''}{\sin 1''} \right) \text{(Godfray's "Astronomy")}.$$

Now since C may be considered constant

$$dx \text{ or } dl = 2\,Ch\,dh \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Again from the fundamental relation

$$\cos d \cos l \cos h = \cos z - \sin d \sin l$$

it is easily found that

$$dl = dh \cos l \tan A \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where A is the azimuth, and eliminating C between (1) (2) and (3) the formula is obtained in the simple form

$$x = \tfrac{1}{2}\,h \cos l \tan A$$

which expresses the reduction in minutes of arc, h being the number of minutes of arc in the hour angle.

As an example of the use of this formula, take the observation given at the beginning of the Brent Tables.

Date, November 18, D.R. latitude 51° north, hour angle 0h. 24m. 54s., declination 19° 20′ 43″ south, and altitude 19° 29′ 18″. Required the true latitude.

From Burdwood's Azimuth Tables the bearing is found to be about 6° 15′, and we have

$$x = 186'{\cdot}75 \cos 51° \tan 6° 15' = 12' 48''$$

giving a latitude 50° 57′ 11″ north.

The result found in the book is 50° 57′ 10″ north.

To find the reduction by the Traverse Table we may proceed as follows:—With 187 as distance and 51° as course, we have d lat. 117′·7; with this as d lat. and 6° 15′ as course, we have in the departure column 12′·8, which agrees with the result found above.

A difficulty attending the above method is that the Burdwood Tables do not give the azimuths of bodies having an altitude greater than 60°, and are only calculated for bodies whose declinations do not exceed the maximum declination of the sun. However, this should hardly be sufficient to condemn the method, especially as the sun is the body most frequently observed.

It may be also of interest to notice an additional use of the Brent Tables. These are constructed on formula (1), Table III. giving the value of C for every degree of latitude from 0° to 70°, and of declination from 0° to 60°. Now (2) may be written in the form

$$2h = \frac{1}{C}\frac{dl}{dh}.$$

So that if we wish to find during what time observations may be taken so that an error dh in the estimated longitude will not produce more than an error dl in the latitude, we have, if t be expressed in time,

$$t = \frac{15}{C}\frac{dl}{dh}.$$

Thus in the above example, suppose it were required to find during what time observations should be taken, so that an error of a second of time in the estimated longitude would not produce more than an error of a second of arc in the latitude, we have

$$t = \frac{15}{1 \cdot 23} = 12\text{m. } 11\text{s.}$$

In cases where the latitude and declination are of the same name and do not differ by very much, this time is very small, but when of different names in high latitudes t is considerable.

J. WHITE.

H.M.S. *Hawke*, Mediterranean Squadron.

Magnetism of Rock Pinnacles.

OWING to my absence from home, I have only just seen the letters of the Rev. E. Hill, M.M.S., and James Heelis, in NATURE of August 2 and 9, on the above subject. The writers have apparently overlooked the very interesting report by Profs. Rucker and Thorpe, published in the Brit. Assoc. Report for 1889, p. 586, in which it is shown that "all the principal masses of basalt in the kingdom form centres of magnetic attraction," and that "the Malvern Hills, though composed of diorite in which magnetic polarity can barely be detected, produce deviations of twenty minutes of arc at a distance of one mile from their axis."

The mineral magnetite is an original constituent of basic igneous rocks; and, owing to the action of gravity on this heavy mineral whilst the magma which contained it was still in a fluid or plastic condition, or to some other cause, it has sometimes segregated into masses, or has become more or less concentrated, in certain parts of igneous rocks. Two very interesting papers on gabbros, in which remarkable concentrations of magnetite have been observed, have quite recently been read before the Geological Society—one by Sir Archibald Geikie and Mr. Teall, and the other by Mr. Alfred Harker—in which the concentration observed in these rocks is accounted for in different ways. Rocks in which a local concentration of magnetite has taken place must have a very powerful effect on the magnet even at a distance.

In addition to original magnetite, basic rocks, especially those of igneous origin, contain secondary magnetite, and magnetic pyrites, formed by aqueous and other agents, out of the unstable minerals of which the original rocks were built up. Serpentine, for instance, usually contains secondary magnetite formed out of the mineral olivine, one of the principal constituents of the peridotite from which serpentine was derived.

Owing to the presence of the above original and secondary minerals, small hand-specimens of ordinary igneous rocks—even those in which special segregation of magnetite has not taken place—will generally be found, when examined, to attract a magnet more or less powerfully.

A suitable instrument for testing hand-specimens may be formed by attaching a small horse-shoe magnet to one arm of a chemical balance. After the equilibrium of the balance has been restored, place the hand-specimen under the magnet and raise it carefully. The balance will dip unmistakably towards the specimen if it contains an appreciable amount of magnetite.

20 Nevern Square, S.W. C. A. MCMAHON.

Aurora.

IN Barrhead, Renfrewshire, on Friday (14th), at 9.15 p.m., I witnessed the finest aurora I have observed for years. The luminous arch extended from south-west to north-east, and shortly reached the zenith. The rapid fluctuations in the streamers were remarkable. There were no coloured bands. The moon, nearly full, was shining, rendering the appearance less vivid. In about fifteen minutes the auroral light began to wane.

Tynron, Dumfriesshire, September 18. J. SHAW.

BRIGHT PROJECTIONS ON MARS' TERMINATOR.

THE appearance of bright spots on the surface of Mars has been long familiar to observers of this planet. An idea of the ease with which they may be observed can be gathered from the following words of Schiaparelli, our highest authority on Martian questions.

"It would not be difficult to find a series of hypotheses which would explain satisfactorily the appearance of the polar and other white spots by attributing them in some way to the evaporation of the supposed seas, and to the atmosphere of the planet whose existence is indisputable. But I consider it more useful to point out that these different white spots are, of all the species of appearances on *Mars*, the easiest to observe. They require only an instrument of moderate power and a very persevering attention. The . . . . peculiarities concerning these spots show that they offer a field for the most interesting investigations, whose importance in the study of the physical constitution of Mars is obvious; and in this field useful work could be done by those observers who are not able to decipher the much more difficult details of the canals and their doubling."

Now the appearances of some of these spots in different positions on the planet's disc have been observed at times to undergo rapid changes in brightness, and it was, if we do not err, the distinguished observer just quoted who first pointed out the tendency of some of these bright regions to increase relatively in brightness as the terminator of the planet was approached.

Observations of more recent date than those just referred to, have, however, made us acquainted with other surface phenomena connected, perhaps, in some way with, but of more importance than, the bright spots, and these are the bright prominences or projections at the terminator.

It must be remembered, nevertheless, that bright projections may be of two kinds, optical and real.

The former is an effect of contrast. It may be brought about by the approach of a very bright spot to the terminator where the adjacent darkness tends to give it the appearance of a projection, or, in other words, it is the result of pure irradiation. As a somewhat parallel example may be mentioned the "drop" seen at the transits of Venus. That numbers of such spots have been seen at various times, can easily be shown by a brief examination of the records. Terby, for instance, in 1888, on several nights watched three such points, which, as they approached the western edge of the disc, became very bright, and before passing behind the planet, projected beyond the edge of the disc, as was the case with the polar cap. At Mount Hamilton, also, numerous similar observations at various times have been made.

The second kind of bright projection is that due to the physical peculiarities at the surface of the Martian globe itself, and may correspond to elevated highly illuminated regions. These were first observed at the Lick Observatory in 1890, at the Observatory at Nice, and at the Arequipa Observatory in 1892. The first prominences observed this year were seen on June 28 at Mount Hamilton, and since then have been more or less constantly observed.

To give the reader an idea of what actually is seen at the telescope when such a projection is under observation, an instance or two may not be out of place.

On July 5, 1890, at 10h. Pacific standard time, a sketch by Prof. J. E. Keeler, with the 36-inch, showed a narrow, elliptical, white spot from 1″·5 to 2″·0 long, projecting northward at a slight angle with the line of the terminator. Half an hour later the spot was within the disc, but still visible as an oval white patch on a darker background. The following day (8h. 3m.) Prof. Holden saw a projecting spot curved upwards and nearly meeting, and the smaller projecting spot some 2″ farther towards the south. The lower spot changed very considerably its shape during the time of observation, about an hour, and was observed to be always situated at the end of a long bright stripe of the surface of the planet which lies north of Deuteronilus.

A second case may be taken from the observations of Prof. Hussey and Campbell, made at the opposition of 1892, on July 11, with the Lick instrument. They record that a most striking one (prominence) was visible when the observations began at 12h. 15m., and remained constantly in view for about two hours. Its shape changed a great deal during that time. At 13h. 25m. it was unusually prominent, and its outer extremity was perceptibly bent upward toward the south polar cap. On July 13 these observations were duplicated; the southern one of the two projections presented the hooked or bent appearance most strongly at 14h. 35m., just as it was seen two nights earlier at 13h. 25m. Allowing for the longer rotation period of *Mars*, the same point on the planet was under observation on the two nights.

A somewhat indirect reference to these bright projections made by the Arequipa observers is included in the statement made by Prof. W. H. Pickering, that "clouds have on several occasions been observed to project beyond the terminator and also beyond the limit, thus confirming the observations made at the Lick Observatory."

Besides the above-mentioned observations, inserted to serve as samples of what has been seen, many more, by different observers, might be given, but they are all of the same type, and undoubtedly describe the same phenomena. One principal fact about them seems to be that although their shapes undergo distortions of all kinds, due to the different directions of the illuminating source, their mean positions seem to be at all times more or less constant.

As they appear beyond the terminator, not too far from it and within the limb, and are brilliantly illuminated, the natural conclusion to draw from this is that they must either be the tops of high mountains lighted up by the sun, or clouds at a high altitude in the Martian atmosphere, rendered bright by the same source. The latter suggestion, which, in the face of the most recent facts, does not seem to have much weight, was put forward by Prof. W. H. Pickering, and their height above the surface of Mars was measured to be at least twenty miles: more recent measures indicate that these estimates are far too high. That they may be, and most probably are, mountain tops, is the most general explanation; and Prof. Campbell,[1] whose opinion coincides with our own, says they are "due to mountain chains lying *across* the terminator of the planet, possibly covered with snow in some cases, and in others not necessarily so."

The reasoning he adopts may be summed up as follows: On July 11, 1892, the Earth was approximately 39,000,000 miles distant. With powers of 350 to 520 the equivalent distances were reduced to 110,000 and 75,000 miles respectively, distances equal to one-half and one-third of that of our Moon from us. Now if, with the *naked eye*, one can see at the terminator of our satellite bright projections at a distance of 240,000, surely projections, if any, at much lesser distances should be visible on the Martian disc.

If they be due to mountains, a small calculation has shown that they need be only of a moderate height, entirely comparable with those on the Earth and Moon. The figures computed to represent the height of the hills, satisfying the July observations, represented an altitude a little more than 1·89 miles.

A well-observed fact, which strengthens the mountain theory to a certain extent, is the presence of extremely brilliant star-like points which have appeared both on and off the snow-cap. If these are really mountain-tops, they should be visible always with suitable illumination, for when seen on a background of snow their height should enable them to catch all available light for reflection; and, secondly, when observed on darker surroundings (as when the snow serving as a background has melted), their height would still serve the same purpose, besides preserving for them their snow-capped peaks. The constancy in position of these spots shows that they are rigidly connected with the surface, and not due to the atmosphere, unless they be looked upon as stationary clouds or mists, which does not seem likely in the Martian atmosphere. Mr. Lowell this year has observed and measured some, the positions of which correspond with the measurements made by Green in 1877.

In Prof. Holden's mind the mountain theory seems to be thoroughly conclusive, for at Mount Hamilton, night after night, and even month after month, the prominences on the planet appear in the same longitudes and latitudes, insomuch that a map of some of the chains is in preparation.

The positions of these brilliant spots on the globe of Mars, just referred to, lie much nearer the South Pole than those which have appeared as projections. This shows that we must not look upon the Martian surface as very flat, but as one studded with hills and dales, if we have such indications of unevenness as we are led to believe.

It may be remarked here that at Mount Hamilton and at Nice no bright prominences have been seen outside the limb, the only observations of such a nature of which we are aware being those of Martian clouds at Arequipa, where, Prof. Pickering states, "clouds have on several occasions been observed to project beyond the terminator and also beyond the limb."

In considering the visibility of mountains at the terminator and at the limb, certain important points must, as Prof. Campbell says, be taken into account.

In the first place, to obtain the greatest "seeing effect" at the terminator, it is not so much the height of the mountain in question, but the length of its chain that is the chief function. On the other hand, a mountain at the limb is seen simply by virtue of its *height* above the general surface, the *length* of the chain in this case being entirely eliminated. It must not be forgotten, however, that we view Mars from the earth, and not from the sun. This fact, combined with the different positions of the planet's axis at the times of opposition periods, accounts for the innumerable ways under which mountain chains can be illuminated, rendering them sometimes visible and sometimes invisible, according to the conditions in vogue. For instance, in 1890 the mountainous part observed was in the region a little to the north of Tempe (lat. 40° N., long. 45°). In 1892 the projections were chiefly observed about the region of Noachis (lat. 30° and 50° S.), two small ones being remarked at 25° N. lat. At Nice projections were noticed in approximately the same position, and in addition at 30° S. lat. and 220° long. to the south of Hesperia.

Such, then, are some of the facts and deductions to which a discussion of the observations of these prominences, made up till now, has led us. There is, no

[1] "An Explanation of the Bright Projections observed on the Terminator of Mars," by W. W. Campbell. *P. Astronomical Society of the Pacific*, vol. vi. No. [illegible] p. [illegible]

doubt, much to be learnt before we can say with certainty that we are dealing with mountain ranges pure and simple; but, as Prof. Campbell says, this hypothesis is a good one to work upon. The explanation, which assumes the presence of clouds, does not, as previously hinted at, seem to be any longer tenable, for would not permanent clouds (as these must necessarily be) at a considerable height mean land at a high altitude, and therefore mountains?

Those making measures of the positions of projections on the Martian terminator may find the following method of procedure, recommended by Prof. Campbell, serviceable:—"Marth's valuable ephemeris of Mars gives the 'position angle of the greatest defect of illumination.' With the micrometer wires set to that position angle, place the fixed wire tangent to the upper limb and bisect the projection with the movable wire. Again, place the fixed wire tangent to the lower limb, and bisect the projection with the movable wire. The diameter of the planet should also be measured, without changing the position angle of the wires. Irradiation caused by the bright polar cap is liable to increase some of the distances measured, especially with small telescopes."

Before concluding this brief summary, a few words may be added with respect to a recent note which appeared in these columns (p. 319), entitled "A Strange Light on Mars." The note in question was based on a telegram issued by the International Bureau, and referred to an observation made at the Nice Observatory. The "strange light" alluded to was regarded by the writer as referring to something quite exceptional, and *not* to the well-known prominences which during 1892 were so often seen, and which during this present period of opposition have been observed and measured several weeks before the telegram was dispatched.

W. J. S. Lockyer.

NOTES.

The funeral of Prof. von Helmholtz took place on September 13, at Charlottenburg. Among the numerous tributes of admiration were magnificent wreaths from the German Emperor and the Empress Frederick, both of whom were represented at the ceremony. Most of the learned societies of the capital and many of the Universities and scientific bodies in other parts of the Empire also sent representatives. Among those present at the funeral were Baron von Marschall, the Secretary of State for Foreign Affairs, Count Eulenburg, Dr. Miquel, Dr. von Botticher, Herr von Schelling, and Herr Thielen.

We are glad to learn that the Technical Education Board have made a grant of £500 to Bedford College (for Women), to aid in the full equipment of the laboratories of that institution.

The *Lancet* states that the trustees of the late Mr. Richard Berridge have, with the consent of the Attorney-General, now handed to the British Institute of Preventive Medicine the residue of the legacy, amounting to over £20,000, for the purpose of building and endowing a laboratory for the chemical and bacteriological examination of water-supply and the investigation of processes of sewage purification. The permanent laboratory is now in course of erection on the site secured by the Institute at Chelsea, but, pending its completion, a temporary laboratory has been fitted up in order that the work may be at once proceeded with. Mr. Joseph Lunt, formerly assistant to Sir Henry Roscoe, has been appointed by the Institute to carry on this work under the director's supervision. The Institute is now, the *Lancet* understands, prepared to undertake the bacteriological and chemical examination of any samples of water which may be submitted. In addition to this, the Institute will give expert assistance in the bacteriological or pathological diagnosis of any pathological material. The demand for this kind of work has greatly increased, so much so that, although Dr. Ruffer will still retain charge of this department, a specially trained bacteriologist has been appointed to work under his direction. Particulars may be obtained by writing to the director at the temporary offices of the Institute, 101 Great Russell Street, London, W.C.

According to the *British Medical Journal*, a Clinical Research Association has been formed, under the patronage of Sir James Paget, Dr. Wilks, Mr. Jonathan Hutchinson, Sir W. H. Broadbent, Sir George Humphrey, Dr. Clifford Allbutt, and others, with the object of assisting medical practitioners in the investigation and treatment of disease by furnishing trustworthy reports upon excretions, tumours, and other morbid products. A laboratory has been fitted up, and will be under the direction of Dr. J. Galloway and Messrs. J. H. Targett and F. G. Hopkins. Further particulars of the Association can be obtained from the secretary, Mr. C. H. Wells, 5 Denman Street, S.E.

A Medical School for Women is to be established by the Russian Government at St. Petersburg. This step, which is said to be due to the influence of Prince Wolkowski, acquires additional importance from the fact that only a few years ago the Ministry of Instruction was strongly opposed to every movement favourable to the higher education of women. The fate of the new institution will, we hope, be happier than that of the one established by Prof. Gerie, which was closed in 1884.

An international Congress of Chemistry and Microscopy will be held in Vienna during the last week of the present month. Dr. E. Ludwig is the president of the committee of arrangements, and the secretary is Dr. Hans Heger, I. Kolowrating, Pestalozzigasse 6, Vienna.

We notice that in the Universal Exhibition to be held in Paris in 1900, there are to be sections devoted to hygiene, military and naval hygiene, and medicine and surgery.

Information has been received respecting an Exhibition of Industry which is to be held at Kioto from April 1 to July 31, 1895. The exhibition is the fourth of the kind organised by the Japanese Government, and will be divided into classes under the following heads:—Manufactures, Fine Arts, Agriculture, Waste Products, Education, Mines and Mining, and Machinery.

We have on several occasions referred to the great landslip at Gohna, and on July 5 printed an illustrated abstract of the report upon it by Mr. T. H. Holland. The dam, as readers of our notes for August 30 are aware, burst on August 26, and, as a consequence, very considerable destruction of property ensued. Further information respecting the occurrence has now reached England, and the *Times* of Saturday last published the following interesting details received from a correspondent:—"On August 24, at 8 o'clock in the morning, an automatic bell, placed within a foot of the top of the dam, sounded the first note of alarm. The warning was communicated throughout the whole of the threatened territory almost instantaneously by means of telegraphic messages, bonfires, rockets, the beating of drums, and other signals, and the people immediately fled, with all their cattle and personal belongings, into the hills. In this way ample warning was given and the apprehended loss of life averted. Three hours after the first signal the water reached the lowest point of the ridge, and the officials thought it expedient to block the passage through which the torrent would first escape, so that the lake should not overflow before 7 o'clock on the morning of the 25th. Warning telegrams were despatched along the valley. The weather was very unfavourable for observation, a heavy mist obscuring the landscape. Signs of collapse were visible at 8 o'clock in the evening, and shortly before midnight the dam burst. A flood 30 feet high, sweeping onward with irresistible force, reached Chamoli, half-way between Gohna and Srinagar, at half-past 12 on the 26th. At 1 in the morning there was another tremendous rush of water, which descended with an awful roar; but nothing was visible owing to the constantly thickening mist. The flood travelled at an average rate of twenty-four miles an hour all down the valley, rising in places to a height of 200 feet. At Chamoli it rose to a height of 160 feet, destroying the bazaars and the hospital. At Srinagar the devastation was even more widespread. The flood reached Hardwar at 9 o'clock on Sunday, and by noon the river had risen 12 feet. It presented a magnificent spectacle, and the view from the surrounding heights was at once grand and terrible. At Hardwar all Government buildings, with the exception of the telegraph office, were destroyed. The whole lake was discharged in about two hours."

AT the August meeting of the Calcutta Microscopical Society, the retirement of Dr. William King from the Geological Survey of India was referred to, and a brief notice of his work in India, and especially in connection with the Society, was read. We take the following information from a report in the *Englishman*:—Dr. King joined the Geological Survey in Calcutta under its first Director, Dr. T. Oldham, in March 1857. In May of that year, a memorable month in Indian history for its connection with the mutiny of the Native Army, he went to Madras with the first survey party for that Presidency, under Mr. H. F. Blanford. Dr. King continued in Southern India for over twenty-five years, with only occasional visits to headquarters in Calcutta; and during that period he took part in the surveys of, or himself surveyed, the districts of the Coromandel and part of the Northern Sircars, working chiefly at the Crystalline, Transition, Vindhian, Gondwana, and Cretaceous formations of Peninsular India. In 1870 he became Superintendent of the Madras Survey Party, and the latter years of his work in Madras were spent in connecting the coastal Gondwanas of Nellore and the Godaveri District with the coal-bearing division of the series in the Central Provinces, by the Godaveri Valley and Western Hyderabad. After this Dr. King's labours lay in the Central Provinces, where in his progress over the Mandla and Bhundara districts, and eventually over the whole of Chatti-garh, he connected most of the rock formations of Southern India with those of the Central Provinces and Central India, up to the western frontiers of Chota Nagpur. In 1887 he became Director of the Geological Survey of India. During the period of his directorship the geology of the north-west frontier (particularly in Beluchistan and in the Salt Range) and of Burma, was considerably advanced in respect to the extent of area mapped, and its correlation with European and Europo-Asian geology. The mineral development of those regions in the way of coal, oil, and tin was also greatly advanced during the same period. Dr. King is the author of four memoirs on the geology of districts in the Madras Presidency, and of more than twenty reviews on the geology, or mineral condition, of other tracts. Dr. Simpson has been appointed President of the Microscopical Society of Calcutta, in the place of Dr. King.

THE Pilot Chart of the North Atlantic Ocean for September shows the remarkable drift of the derelict *Fannie E. Wolston*. On October 16, 1891, the vessel became a derelict not far distant from Cape Hatteras, and on June 13, 1892, was reported in 39° west longitude, from which position, after a number of irregular gyrations, she drifted back to about longitude 75° west by th[e] end of January last, and on August 6 was again sighted i[n] latitude 34° N. and 67° W. This vessel has thus been a derelic[t] for over 1000 days, during which time she has drifted abo[ut] 8600 miles. The American Hydrographer points out that th[e] dangerous character of these derelicts is illustrated by the fa[ct] that during a period of seven years there have been forty-fiv[e] collisions with them, which caused the total loss of nine vessels[.] The United States Government has employed the steamshi[p] *San Francisco* in destroying these obstructions, and durin[g] the above period sixty-nine have been burnt, and one blown u[p] by torpedoes. The efficacy of destroying derelicts by fire i[s] thus illustrated.

THE Italian Meteorological Office has published part 1 of [it]s *Annali* for the year 1893, showing the work done in variou[s] departments of the service. Special studies of the behaviour o[f] thunderstorms are carried on in the interest of agriculture, wit[h] the view of establishing for each province, and for each week o[f] the year, the mean number of storms, distinguishing thos[e] which were accompanied with rain or hail, attention also bein[g] paid to the size of the hailstones. A list of all hailstorm[s] which have occurred during a period of fifteen years is bein[g] prepared. The volume contains several discussions of earth[-] quake shocks, especially those which occurred in Zante, in 1893[.] A new seismograph has been erected at the Collegio Romano, provided with a long and heavy pendulum, which registers shocks that occur at great distances. This instrument, which was devised by Dr. Agamennone, has worked so well tha[t] others are to be established in various parts of the kingdom[.] The department of terrestrial magnetism has been occupied with the preparation of a series of magnetic charts, and a[n] account is given of some modifications and improvements made in a small portable magnetometer, for the study of loca[l] magnetic disturbances.

AN interesting paper on the temperature variation in the electrical resistance of some organic bodies (esters of the fatty acids), by Prof. A. Bartoli, is published in the *Proceedings* o[f] the Reale Instituto Lombardo di Scienze e Lettere. The liquids examined were in most cases obtained from Kuhlbaum, and the author gives their boiling point. The conclusions to which the author has come are as follows:—(1) In a series o[f] esters derived from a given alcoholic radicle with different acids of the fatty series the conductivity, both at ordinary temperatures and at the boiling point, decreases with increase in the complexity of the constitution of the body. In addition, the alcoholic radicle affects the conductivity, which diminishes with increased complexity; thus, while methyl valerate conducts to a fair extent, amyl valerate is an insulator. (2) In general the conductivity of these esters increases with increase of temperature, the rate of change with temperature being smaller for those having a more complex composition than for those with a simpler formula. Thus, while the rate of change is considerable for amyl valerate, amyl butyrate, and isobutyl valerate, it is small in the case of methyl formate, methyl acetate, and ethyl formate. (3) Of the sixty different bodies experimented upon, one sample of ethyl acetate had a conductivity which decreased with increase of temperature; another sample of the same body, however, which the author considers to be purer, gave an increasing conductivity. A sample of isobutyl acetate also gave a negative rate of variation with temperature. These anomalous results the author considers to be due to the presence in the samples of a small quantity of one of the alcohols. (4) The addition of from 1 to 20 per cent. of any alcohol to any of the esters experimented upon, gives a solution of which the variation of the conductivity with temperature is negative, while the addition of a phenol, a ketone, an analine, or a paraldehyde of any acid, gives a solution whose resistance increases with rise of temperature.

IN a paper contributed to the *Archives Néerlandaises*, M. P. Zeeman gives an account of the observations he has made on the Kerr phenomenon on the reflection from surfaces of iron, cobalt, and nickel in a magnetic field. The author has continued the experiments commenced by M. Sissingh, using a slightly modified form of apparatus. He finds that the difference between the observed and calculated phases (obtained from Lorentz's formulæ) is practically constant for radiation of all wave-lengths, and is equal to 80° in the case of iron. Similar results were obtained with nickel and cobalt. In the case of these two metals the author, after attempting to obtain suitable mirrors by the deposit of the metal on polished iron, or by electrolysis, was obliged to have plane faces cut on blocks of the pure metal, which when polished formed good mirrors.

THE specific heat of gases at constant pressure has been investigated by Dr. Silvio Lussana, by means of a new and ingenious apparatus. The contrivance, as described in the *Nuovo Cimento*, is intended to overcome the difficulty of providing a sufficient quantity of gas to experiment upon. With the resources of an ordinary physical laboratory it is difficult to obtain a pure gas in sufficient quantity to make an impression upon the calorimeter, so Dr. Lussana decided to use the same quantity over and over again. Two substantial iron tubes were placed vertically, and communicated at the bottom by means of an india-rubber tube strengthened with five layers of canvas. They were partly filled with mercury, and by elevating or lowering one of them the mercury could be made to completely fill the one or the other. When one tube was full of mercury, the other was filled with the gas to be investigated, and the amount of gas which filled the tube could be driven out and through the calorimeter by lowering the tube. The gas was then made to pass through an india-rubber tube leading to a brass worm immersed in a heating bath, and another immersed in water, which constituted the calorimeter. It then passed through a small subsidiary worm, to test whether it had lost all the heat acquired, and finally entered the other iron tube which was being emptied of mercury. By means of a short circuit provided with a valve, the gas and the mercury in the two iron tubes could be exchanged, and the same process repeated. The water equivalent of the calorimeter was determined experimentally by sending a measured quantity of hot water through it. To ensure constancy of pressure, the level of the mercury was always adjusted to the same fiducial mark on a short length of glass tubing introduced in the india-rubber tube. The gas was introduced by a Natterer compression pump. Seeing that pressures were employed up to forty atmospheres, special care had to be bestowed upon stop-cocks and junctions, some of which were constructed in a novel manner. The results of the measurements, which promise to be of great interest, will shortly be published.

THE May number of the *Transactions of the North of England Institute of Technical Brewing*, a copy of which has been sent to us, contains an interesting and very useful paper by Mr. Fellowes, on "Some of the micro-organisms causing the diseases of beer." Mention is made of the important services rendered by Pasteur, Hansen, Van Laer, Lindner and others to this subject, and we are introduced to quite a number of microbic foes with all of which the brewer has to wage war. The cause of viscosity in beers has recently been elaborately studied by Van Laer, who has isolated certain micro-organisms which he has classed together under the name of *Bacillus viscosus*. When these organisms are introduced into sterilised wort along with pure yeast, the liquid is rendered more or less ropy, the degree of viscosity depending upon the proportion in which the disease organism is introduced. Curiously, however, although the *Bacillus viscosus* behaves in this characteristic manner in the case of Belgian beers, so far, similar results have not been obtained with it when subjected to the English system of fermentation. Mr. Fellowes has himself isolated various organisms present in samples of viscid beer, but has not been able to obtain with such pure cultures or individual varieties a viscosity equal to that of the sample from which they were originally derived. He suggests that the cause of this failure may be sought in the probable modifications induced in the physiological character of the micro-organisms during the process of isolation by means of gelatine cultures. In support of this supposition he refers to Prof. Percy Frankland's investigations on the fermentation of calcium citrate by means of a particular bacillus, which although in the habit of fermenting this substance, for years past absolutely refused to do so when introduced into calcium citrate solutions direct from gelatine cultures. Mr. Fellowes is of opinion that the viscosity in English beers may be due to the associated action of various micro-organisms present, their activity depending not only on the particular varieties, but also on the relative numerical strength in which they are present. It is obvious that to obtain such particular conditions artificially is by no means an easy task, but there can be no doubt that a wide field for research on the question of symbiotic fermentation, or the associated life of micro-organisms, remains yet to be explored.

The *Berichte der Deutschen Botanischen Gesellschaft*, vol. xii. part 5, contains a paper, by J. E. Humphrey, on nucleoli and centrosomes. The author favours the theory that the nucleolus is not a definite organ of the nucleus, but regards it, with Strasburger and Guignard, as a reserve material of the nucleus. In this connection he examined the nuclei of the sporangia of *Psilotum triquetrum*, in which Karsten considers that the centrosomes of the dividing nuclei arise from the nucleoli, and after division are re-included in the daughter nuclei. His observations, however, lead him to the conclusion that the nucleoli and centrosomes are completely distinct from one another, and that the latter are altogether extra-nuclear. Another interesting result, which he obtained in the course of his observations, is that the body, which is often found in connection with the nuclei of the pollen-sac, and which has been called the "paranucleolus," is probably not a natural structure, but is formed during the process of fixing the material in which it is found, as it was seen regularly on that side of the nuclei which was the last to be reached by the fixing fluid.

NATURALISTS may sometimes have wondered that a region so classical in the annals of marine biology as the neighbourhood of St. Vaast-la-Hougue was not earlier made the site of one of those marine laboratories which our neighbours across the Channel conduct with such efficiency and economy. For some years past, however, the Museum of Natural History of Paris has been engaged in altering and refitting the extensive buildings of an ancient *lazaret* on the island of Tatihou to this end, and at the first September meeting of the Academy of Sciences M. Edmond Perrier was able to report the practical completion of the laboratory. A circulation of sea-water has been fitted up throughout the laboratories and tank-rooms, and marine animals of all kinds live perfectly within the aquaria. M. Malard-Duméril, the naturalist in charge, and his staff reside permanently upon the spot, and there is full accommodation for eighteen additional naturalists. The work of the new laboratory is not, however, to be limited to the promotion of pure scientific research, but, if the hopes of its founders are realised, will also include operations on a practical scale in marine pisciculture.

On the title-page to the second edition of the "Manual of the Geology of India," recently noticed in Nature, the name of the author of that edition alone appears. The Government of India, on this circumstance being brought to their notice, have ordered the title-page in question to be cancelled, and a revised title-page, with the names of the original authors of the work inserted, to be substituted.

We are informed that Mr. J. Nisbet, some of whose books on Forestry were recently reviewed in these columns, has undertaken to contribute a series of short articles on "Birds in Relation to Forestry" to the Natural History Department of the *Yorkshire Weekly Post*.

The syllabus of the Manchester Municipal Technical School and Municipal School of Art, for the session 1894–5, has just been issued, and may be obtained from the director and secretary, or the Guardian Printing Works, Manchester. Attention is drawn to several new subjects and courses of instruction, among which we may mention—honours classes in theoretical mechanics, applied mechanics and steam, a course of lectures in hygiene, and special courses in magnetism and electricity for telegraph employés.

The fifth annual report of the Missouri Botanical Garden, covering the year 1893, has just come to hand, and forms a handsome volume. The year under review seems to have been a very satisfactory one for the garden, both from a financial and scientific standpoint. In addition to the reports of the officers of the Board and of the director, the volume contains several scientific papers, some of which are illustrated; there are also several well-executed process illustrations of objects of interest in the garden.

We learn from the abstract of the *Proceedings* of the Linnean Society of New York for the year ending March 27, 1894, that at the annual meeting, held on the date mentioned, there were 136 resident and 35 corresponding members. At the beginning of the year the society had on its roll 37 resident and 37 corresponding members. During the year 29 papers were read, and 214 publications were added to the library.

Messrs. J. and A. Churchill have sent us the new edition —the third—of the translation, by T. H. Waller and H. R. Procter, of Kohlrausch's "An Introduction to Physical Measurements." The present edition is translated from the seventh German edition, and contains nearly four times the number of pages than the first German edition, which appeared in 1869. The tables have been corrected to the present state of knowledge, and a good deal of new matter has been embodied in them.

A magazine entitled the *American Historical Register* has been started this month in Philadelphia, the special mission of which is to form the medium of inquiry and communication between the members of various American patriotic associations, to chronicle their proceedings, and to preserve in its pages matters of historical value and of personal interest to their members; it bears, therefore, the sub-title of "Monthly Gazette of the Patriotic-Hereditary Societies of the United States of America." The magazine is tastefully printed on good paper, and several successful process illustrations grace its pages.

The *Journal* of the Royal Horticultural Society dated August has just reached us, and contains, in addition to the usual extracts from the *Proceedings* of the Society, the following papers:—"The Cedar of Goa," by Dr. M. T. Masters, F.R.S.; "The Deciduous Trees and Shrubs of Japan," by James H. Veitch; "Rare Trees and Shrubs in the Arnold Arboretum," by Maurice de Vilmorin; "Hybrid Narcissi," by the Rev. G. H. Engleheart; "Botanical Exploration in Borneo," by F. W. Burbidge; "Flowering Trees and Shrubs," by George Nicholson.

Messrs. Dulau and Co. have issued part xxxiv. of their catalogue of zoological and palæontological works, containing descriptions of the books on mammalia offered for sale by them.

We have received from Dr. F. Krantz, Rhenish Mineral Office, Bonn-on-the-Rhine, a catalogue of minerals, and plates of minerals for exhibiting optical phenomena, which he has for sale.

The additions to the Zoological Society's Gardens during the past week include a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Mr. J. C. Alleyne; a Boschbok (*Tragelaphus sylvaticus*, ♀) from South Africa, presented by Mr. J. E. Matcham; a Silver Pheasant (*Euplocamus nycthemerus*, ♀) from China, presented by Mr. Thomas Harris; a Larger Hill-Mynah (*Gracula intermedia*) from India, presented by Mr. Charles E. Brooke; a Cape Bucephalus (*Bucephalus capensis*) from South Africa, presented by Mr. A. W. Arrowsmith; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. G. T. Elphick; a Slowworm (*Anguis fragilis*), British, presented by Mr. G. H. Morton Middleton; a Malbrouck Monkey (*Cercopithecus cynosurus*, ♀) from West Africa, a Blue-fronted Amazon (*Chrysotis æstiva*), from South America, twenty Painted Terrapins (*Clemmys picta*) five Stink-pot Terrapins (*Aromochelys odorata*), an American Box Tortoise (*Terrapene carinata*) from North America, deposited; a —— Hedgehog (*Erinaceus*, sp. inc.) from India, a Mitred Guinea Fowl (*Numida mitrata*) from Madagascar, a Bull Frog (*Rana catesbiana*) from North America, purchased.

OUR ASTRONOMICAL COLUMN.

The Semi-Annual Variation of Meteors.—"It is a saying of Arago," wrote Prof. A. S. Herschel thirty years ago, "founded upon observation and confirmed by constant experience in later years, that the Earth encounters more shooting stars in going from aphelion to perihelion than in going from perihelion to aphelion." The fact of this semi-annual variation in the number of meteors has since been confirmed by many observers, and has also furnished a subject for much discussion. Mr. G. C. Bompas summarises the state of knowledge on the matter in the current number of the *Monthly Notices* of the R.A.S., and criticises the explanation believed to account for the facts of observation. The theory accepted by most observers is that the semi-annual variation referred to is due to the planetary motion of the Earth, just as the horary variation is due to the Earth's rotation. It will at once be seen that observations in the southern hemisphere supply a test of the validity of this explanation; for the greater number of meteors should appear in the southern hemisphere from January to June in each year—that is, when that hemisphere is in front of the Earth's orbital motion. From June to December, when the northern hemisphere is in front, we encounter a larger number of meteors than during the first half of the year. There can be no doubt that the change in the position of the Earth's axis relatively to her motion does really tend to increase the number of shooting stars seen in the second half of the year in the northern hemisphere, but Mr. Bompas thinks that this cause is insufficient to account for the very large increase observed, viz. from two to three times the number observed in the first half of the year. He has examined the meteor observations made by Dr. Neumayer at the Melbourne Observatory from 1858 to 1863, and he finds that the variation is not reversed, but follows the same law as in the northern hemisphere, the hourly number of meteors seen in the second half of the year exceeding the number seen in the first half. It seems, therefore, that some cause further than that hitherto assigned must help in producing the semi-annual variation of meteors. The whole discussion leads Mr. Bompas to submit: (1) That the explanation hitherto adopted of the semi-annual variation of meteors is inadequate; (2) that the variation is connected with and mainly due to the cosmical motion of the solar system; (3) that it renders highly probable the cosmical origin and motion of meteors.

GEOLOGIES AND DELUGES.[1]

IN the days when geology was young, now some two hundred years ago, it found a careful foster-mother in theology, who watched over its early growth with anxious solicitude, and stored its receptive mind with the most beautiful stories, which the young science never tired of transforming into curious fancies of its own, which it usually styled "theories of the earth"

Of these, one of the most famous in its day and generation was that of Thomas Burnett, published in 1684, in a work of great learning and eloquence. Samuel Pepys, of diary-fame, is said to have found great delight in it, and it is still possible to turn to it with interest when jaded with the more romantic fiction of our own day.

It was the fashion to commence these theories with chaos, and chaos, according to Burnett, was a disorderly mixture of particles of earth, air, and water, floating in space; it was without form, yet not without a centre, a centre indeed of gravity, towards which the scattered particles began to fall, but the grosser, on account of "their more lumpish nature," fell more quickly than the rest, and reaching the centre first accumulated about it in a growing heap, a heap, as we might now express it, of fallen meteorites; the lighter particles, which form fluids, followed the heavier in their descent, and collected around the solid kernel to form a deep ocean. This was at first a kind of emulsion, like milk, formed of oily and watery particles commingled, and just as in the case of milk, there separated on standing, a thick creamy upper layer, which floated on the "skim-milk" below. That this really happened, the good Burnett bravely remarks, "we cannot doubt." The finest dust of chaos was the last to fall, and it did not descend till the cream had risen; with which it mingled to form, under the heat of the sun, the earth's first crust, an excellent but fragile pastry, consisting of fine earth mixed with a benign juice, which formed a fertile nidus for the origin of living things. Outside nothing now was left, but the lightest and most active particles of all, and these "flying ever on the wing, play in the open spaces" about the earth, and constitute the atmosphere of air.

Such was the earth when first it formed the abode of unfallen man—perfect in form and beauty, for it was a true sphere, smooth as an egg; undisfigured by mountains, and unwasted by the sea. It was unfortunately but too like an egg, since its fragile shell rested on the treacherous waters of the interior abyss, "the waters under the earth," and the sun over-roasting, finally cracked and burst it; the broken fragments of the ruined world fell downwards into the abyss, and the subterranean waters rushed out in a mighty flood to remain as our present seas and oceans, from which the broken crust protrudes as continents and islands. As might naturally be anticipated, the bursting out of the abyss corresponds to the Noachian deluge, which we thus perceive to have been profounder in its origin and wider reaching in its effects than we might previously have supposed. This, for distinction, we may call Burnett's deluge; of his geology we may say that it is cosmological, since it endeavours to trace the history of the earth backwards to its origin in chaos; that it is catastrophic, because it attempts to account for all the great features of the earth by a single event which occurred suddenly and with violence; and that it is theologic, since it owes its inspiration to Holy Writ.

As geology grew older it went to school: what was the name of the school is not quite certain; some have called it "Science falsely so called," others, more briefly, "Inductive Science." However this may be, the immediate effect on the manners of young geology was very distressing. It grew contradictory, and was frank in the expression of obnoxious opinions. One of its most irritating remarks was that the world was not made in a week, and it would appear that at this time the relations of child and foster-parent became not a little strained. Still geology proved an apt scholar, and its progress was rapid. One of the most important lessons it learnt was that if we want to know how the world was made, the first essential is to study the earth itself, to investigate with patient drudgery every detail that it presents, and particularly the structures that can be seen in river-banks, sea-cliffs, quarries, pits, and mines. Thus it discovered that the solid land beneath our feet is to a large extent composed of layers of sediment which were once deposited more or less quietly at the bottom of ancient seas, and certain curious bodies known as fossils, it concluded to be the remains of plants and animals, sea-shells and the like, which were once the living denizens of these seas.

It discovered that these deposits lie so regularly one upon another, that it compared them to a pile of books, or to a slanting row of books lying cover to cover; and that in some cases, at least, the simile was not strained, will appear if we trace the structure of England from Oxford westwards towards Bristol. We then find that the thick bed of clay upon which Oxford stands, lies evenly on a series of gently sloping beds known as the lower Oolites; these in like manner repose on those thin seams of limestone and clay called the Lias, and these in their turn upon the red beds of the Trias. It might perhaps have been expected that this uniform arrangement would continue through the whole thickness of the stratified rocks, but it was discovered, and the importance of the discovery was recognised so early as 1670 by Bishop Steno, a man of great genius, that the regularity of the succession is liable to interruption at intervals. Thus as we approach Bristol, we encounter those beds of limestone which are associated with our coal-bearing strata, and which are consequently called "carboniferous"; but these are by no means related to the beds we have just passed over in the same manner as they are to one another—we do not find the highest bed of the carboniferous series offering its upper surface as a gently sloping platform on which the trias may rest; on the contrary, the carboniferous beds are seen to lie in great rolling folds, with the tops of the rising folds absent, as it were sliced off, and it is on the edges not on the surface of these beds that the red trias layers are seen to be spread out. This sudden change in disposition may well be called a break in the succession of the rocks, and, as if to emphasise it and compel attention to it, we find it accompanied by a complete change in the character of the fossils, those occurring in the carboniferous rocks being of entirely different kinds to those which are found in the overlying beds.

Evidently the carboniferous beds could not have been laid down in the sea in the steeply folded form they now present, at first they must have been spread out in nearly horizontal layers, and the folded form must have been subsequently impressed upon them, no doubt by the action of some stupendously powerful force. Subsequent also must have been the removal of the upper parts of the folds and the general planing down which they appear to have undergone.

To the young geology all this might seem perfectly clear, but in its impulsive explanations it assumed that nature must have frequently acted in a great and terrible hurry: thus the folding of the rocks was supposed to have been produced suddenly and violently by a single mighty convulsion, which simultaneously changed sea-floors into mountain chains, split open the land in wide gaping chasms—our present river valleys—and with the same blow destroyed every living inhabitant in the world.

But the discordance between two sets of rocks is met with not once only, but several times, in the stratified rocks of the earth's crust, and for every discordance there must have occurred a corresponding catastrophe.

These catastrophes were as wonderful as Burnett's, and there were more of them, so that at this stage of its existence geology was appropriately designated "catastrophic." It had completely severed the apron-strings, and ceased to be theologic, but it still to its credit remained cosmologic. It traced the earth from chaos up to a stage when islands and continents rose out of a primeval ocean, the waters of which were boiling; saw it peopled with strange and various forms of life, and watched it run its course, rejoicing in the sun, "chearfull, fresh, and full of joyaunce glad," then pictured it overtaken with disasters, shaken with earthquakes, overwhelmed by floods, and agonising in the labours of a new birth. Calm followed after storm, and life rejoiced afresh in a remade world to be again destroyed. Thus, through alternations of peace and strife, the earth moved on its changeful way, to the crowning creation of man, who was himself a living witness of the last great catastrophe of all, the Noachian deluge. Its waters covered the whole earth, to the tops of the highest mountains under heaven, and on their retreat they left behind, as a standing witness to their extension, great sheets of sediment, supposed to be spread out over the entire surface of the globe, and appropriately named the "diluvium." The diluvium may be seen in most parts of the British Isles, except in the south of England; it consists of clays and sands, containing vast numbers of curiously scratched stones.

[1] British Association Address to working men, by Prof. Sollas, F.R.S.

As the powers of geology matured it became increasingly able to dispense with catastrophes. The very diluvium itself was shown to be local in its distribution, and glacial in its origin; masses of moving ice, like that which buries the greater part of Greenland out of sight, covered a large part of the temperate regions, and this it was that produced the curious scratched stones and the deposits containing them, which are consequently no longer called "diluvial" but "glacial." More important yet, land could be shown to be still actually rising from the sea, and mountains growing into the air, but so slowly that the fact was not established without much dispute, which is hardly yet over. Valleys could be shown to result, not from any bodily fracturing of the land, but from the slow wearing action of the rivers which flow through them, and the waves of the sea were shown to be capable of cutting down cliffs and of reducing the land to a plain.

From these facts the discordance in the succession of stratified rocks found an easy solution. Recurring to the instance of the carboniferous rocks and their relations to the trias, we no longer need suppose that the stupendous force which folded the carboniferous rocks and raised them into the air, acted suddenly or even very rapidly; judging from the rate at which mountains rise now, their upheaval may have proceeded slowly; a few feet in a century would suffice. If we allow but one foot in a century, it would only require two millions of years to produce a mountain range 20,000 feet in height. The movement might naturally be expected to be accompanied by earthquakes, but there is nothing to lead us to suppose that these would be on a much grander scale than those of the present. During its slow elevation, the mountain range would be exposed to wind and weather, rain and rivers would carve it out into ridges and valleys and frost would splinter its peaks into spires and pinnacles. Subsequently it would sink beneath the sea, and the waves of the sea, as they battered down its cliffs, would remove the last remnants which had escaped the rain and rivers, and roll over an unbroken plain. On this plain, as it continued slowly to subside beneath the sea, the immense deposits of the trias, lias, lower oolites, and Oxford clay would be piled up.

If the rise of the sea-floor into the Bristol Alps took place slowly, and involved a great lapse of time, so equally did the sinking of the land to form the sea-floor afresh, and in this long interval time was afforded for great changes in the organic world; and thus we reach an explanation of the great and striking differences which distinguish the fossils of the carboniferous rocks from those of later date.

There is no insuperable difficulty in this explanation; its great merit lies in its accordance with the course of nature as we observe it at the present day; and henceforward it became the motto of geology that the processes of the present furnish the key to the interpretation of the past. The changes in which the life of the earth is manifest are not only slow and gradual now, but they have ever been the same. The earthquakes, which in ancient times shook the land, were no more violent than those of which we have lately read in the daily newspapers; the ancient volcanoes were not more terrible in their outbursts than Krakatoa; floods were not more appalling than those which still from time to time sweep away tens or even hundreds of thousands of human beings from the Ganges Plain, and the earth, instead of falling into convulsions every now and then, proceeds on the even tenour of her way, without haste and without rest, preserving a uniformity in her progress which impresses us with its solemn grandeur, but which sometimes seems a trifle monotonous. From its belief that an unbroken uniformity in the operations of nature extends from the present into the most remote past, geology now came to be called "uniformitarian." It was no longer theologic, no longer catastrophic, and, I am sorry to add, no longer cosmologic. It persistently refused to inquire into the early history of our planet, and restricting its study to the accessible parts of the earth's crust, it abdicated its regal position as the science of the earth, and became as it were a mere petty chieftain, dealing only with rocks and the fossils they contain; the fossils, by the way, not rightly belonging to its province at all. And it was because it passed from being a science of the earth to become a mere study of rocks and fossils, that Hutton was able to make his famous declaration that as a result of his inquiries into the system of nature he could discover "no vestige of a beginning, no prospect of an end." Apart from this, however, and in its self-limited career, geology pursued a luminous advance, and as it did so the Noachian deluge began to sink into an oblivion which it might be thought to have scarcely merited. For if the biblical account is to be taken literally, it furnishes us with a catastrophe of the first order, and since it is said to have occurred comparatively recently, or at least in historic time, the uniformitarian, by his own principles, would have been compelled to infer, as the catastrophist had done, that such deluges form a part of the orderly scheme of the world. The universality of the deluge had, however, for various reasons, been denied, not only by geologists, but by writers of other schools of thought, and towards the middle of the century, belief in it amongst the learned was gradually expiring; such a number and variety of convincing arguments as converged against it could indeed but lead to that result; and that the deluge, so far from being universal, was a local, and very local phenomenon, became an article of belief, so settled amongst all good geologists—and I think I may add theologists—that it may be said to have finally fallen into the deep slumber of a decided opinion, from which I for one have no desire to arouse it.

Thus the deluge, so far from shaking the uniformitarian position, was rather itself submerged by uniformitarian views, and growing geology was in danger of taking the uniformitarian formula for an infallible dogma. It was saved from this by physics, a clever brother of its own, which had now discovered the famous principle of the "conservation of energy," and another equally famous, "the dissipation of energy." From these it was deducible that the duration of the earth as a living planet must be strictly limited in time. It must have had a beginning, and at the beginning was furnished with a store of energy, which it has ever since been spending. In this spending of energy its life consists, and when the store is at length exhausted its life will cease, and it will become numbered amongst the dead planets.

A good deal of this uniformitarian geology might perhaps itself have guessed, had it extended its views beyond rocks and fossils to the stars and other shining bodies which people the vast realms of space. The present then, strange to say, will still afford a key to the past. We have but to turn to the sun, our nearest luminary, though still more than ninety millions of miles away from us, and in that great orb we find much to suggest the state of our planet some ninety millions of years ago or more. It is scarcely necessary to remind you of the fact that the sun is a body so hot that the most refractory substances known to us on the earth exist in it in a state of gas or vapour: tongues of glowing gas shoot from it like flames; the clouds which emit its brilliant light are probably clouds of carbon or silicon, which have momentarily condensed from a gaseous state; and rain, if rain ever occurs, must be a rain of molten metals, such as iron, which will be dissipated in gas before it has fallen very far.

If we proceed to the more remote nebulæ, largely composed of glowing masses of gas, we find a suggestion of a stage more embryonic still, when the earth had as yet no separate existence, but formed, with its sister planets and the sun, a single shining cloud. On the other hand, if we turn our gaze on our nearest relative—offspring possibly—that dead planet, the moon, we may read in its pallid disc the sad reminder, "Such as I am, you, too, some day will be."

But this was not all that was contained in the admonition of physics; it showed not only that the earth is mortal, but that its span of life, as measured in years, or millions of years, is brief compared to the almost unlimited periods which geology had been in the habit of postulating. If catastrophic geology had at times pushed nature to almost indecent extremes of haste, uniformitarian geology, on the other hand, had erred in the opposite direction, and pictured nature when she was "young and wantoned in her prime," as moving with the tame sedateness of advanced middle age. It became necessary, therefore, as Dr. Haughton expresses it, "to hurry up the phenomena."

With its uniformitarianism thus moderated, geology has again become cosmologic, and neglecting no study that can throw light on any question connected with our planet, has regained its position as the science of the earth: it is henceforth known as evolutional geology.

The change has not taken place without occasional relapses into catastrophism. Some indications of this can, I fancy, be perceived in the writings of that eminently great geologist Suess, who, amongst other suggestions savouring of heresy, has lately recalled attention to the "Deluge," and endeavoured to show that though certainly local, and indeed confined to the

Mesopotamian valley, it was on a grander scale than we had been accustomed to suppose, or, in plain language, a genuine historic catastrophe.

A local flood must have had a locality, and the clue to this is furnished by Genesis itself, which informs us that Abraham, the founder of the Hebrew race, left his ancestral city, "Ur of the Chaldees," at a time long subsequent to the flood; it is, therefore, rather in the land of the Chaldees than in Palestine, that we should be led to seek the scene of this momentous tragedy.

This land is no other than the famous and once beautiful valley of Mesopotamia, through which the great Euphrates and arrow-swift Tigris flow to empty themselves into the Persian Gulf. Almost lost sight of for awhile, interest in it was re-awakened some seventy years ago by the investigations commenced by Mr. Rich, and followed up with such wonderful results by Botta, Place, Layard, George Smith, and others. Their discoveries have revealed to us in unexpected fulness the details of a complex and advanced civilisation almost, if not quite, as ancient as the Egyptian, and far more profoundly interesting, for the ancient nations of Mesopotamia are the intellectual forefathers of the modern world. The learning of the Chaldees was the heritage of the Jews and Greeks, from these the torch was handed on to the Romans, and Jew and Greek and Roman inspired, and still inspire, for good and evil, the civilisation of the nineteenth century. There is much more of the Chaldean in every one of us than we are given to imagine.

The people whom we find in possession at the dawn of history were Semites, the parent stock from which the Jews subsequently branched off; and one has but to glance at their faces and forms, as portrayed in their statues and pictures, to recognise the strong family likeness, while the emphasis with which muscular development is expressed in parts of the human figure suggests that the remarkable assertion, "The pride of a young man is in his legs," was a Semitic opinion long before the time of Solomon.

Just as Egypt is the gift of the Nile, so is Mesopotamia equally the gift of the Tigris and Euphrates, for it is built up of the mud brought down from the mountains by these two streams into the Persian Gulf, which is thus in process of obliteration. So long as the two great rivers were not regulated, they produced terrible floods in the wet season; and one of the earliest works of the Chaldeans was to control their flow by great dams, and by diverting a part of their water into canals. These canals covered the country like a network, and served not merely to ease the rivers, but also to irrigate the land, which thus richly supplied by water, became, under the hot sun, so fat and fruitful, that corn is said to have borne 300-fold. Groves of palms, orchards, with grapes and many other luscious fruits, were cultivated, while the pastures supported abundant flocks and herds. It was a true garden of Eden, and differed chiefly from the biblical paradise, which Delitsch thinks was actually situated within this garden, in the fact that even here man had still to earn his bread in the sweat of his brow. This the Turks, who now possess the country, have no inclination to do, and consequently it is rapidly returning to its primitive desolation. Were England as enterprising as she was in the time of Elizabeth, we should rent this land from the Porte, run a railway through it, and thus shorten our route to India by a thousand miles, farm it, and thus provide ourselves with one of the richest granaries in the world.

In a land so favoured, it is nothing wonderful that the inhabitants teemed in millions, villages were everywhere dotted about, and in their midst great and flourishing cities arose: Ur, the City of the Moon-good; Erech, the City of Books; Nippur, and, most famous of all, proud Babylon, "the Gate of God," which stood on the left bank of the Euphrates, some 280 miles above its present mouth. In early times, probably about 2300 B.C., the Jews left this beautiful land for some unknown reason, and after various vicissitudes settled in Palestine. Another branch of the Chaldean stock migrated in later times to the northern part of the Tigris valley, where they built many mighty cities, and founded the warlike kingdom of Assyria. Of their cities it is sufficient to mention Assur, which gave its name to the kingdom, and Nineveh, which afterwards became the capital.

The Mesopotamian plain, owing to the way in which it has been produced, is an almost dead flat, and offers no natural elevations for building; the Chaldees, therefore, to raise the foundations of their palaces, temples, and houses above the reach of floods and fever, and for better defence against their enemies, constructed, with incredible labour, great mounds, by piling together quantities of sun-dried bricks and rubbish, and building round this a thick wall of burnt bricks, well cemented together. Some of these mounds, as that of Kojundjik at Nineveh, are as much as 60 feet in height, and it has been computed that this mound alone would have required the labour of 20,000 men for six years in its construction. But there was never any difficulty in obtaining all the labour that was wanted. Prisoners of war were compelled to work under the stick, and the building of mounds was one of the wholesome occupations to which the Jews were set during their captivity in Assyria.

On the mound of Kojundjik stood two great palaces, one of them that of King Assurbanipal. It was evidently not merely a royal residence, for one of its chambers at least was devoted to public purposes; this was the king's library, to which the citizens, who were taught in their early years to read and write, had free access. Whether any of the books were written on papyrus is uncertain; all that have survived the conflagration, in which the palace was destroyed, are on tablets of kiln-made brick. Of such tablets many thousands have been recovered, not only from Nineveh, but from other towns, and many of them are now preserved in the British Museum. Thus within the last fifty years modern Europe has obtained a glimpse, and more than a glimpse, into the literature of a civilisation that perished just as the Roman was coming into existence; for, as Sir Walter Raleigh puts it, "In Alexander's time learning and greatness had not travelled so far west as Rome, Alexander esteeming of Italy but as a barbarous country, and of Rome as but a village. But it was Babylon that stood in his eyes, and the fame of the east pierced his ears."

The recovered literature covers a vast field of human interest, in science, as in astronomy and mathematics, particularly in astronomy, for the Chaldeans were famous star-watchers, and had already named the stars and constellations, associating them with the deeds and mighty works of their heroes and demigods, so that the star-lit sky became a pictured dome, and the zodiac a frieze to the Assyrian, reminding him of history or fable, like the sculptures and paintings which adorned the king's palaces; in religion and poetry, and in commerce, many of the tablets recording business contracts, and revealing a system of mortgage and banking, money being frequently lent at from 13 to 20 per cent., which was moderate; for the advantages of cent. per cent. were already known and appreciated by these simple Semitic folk.

It was amongst the tablets from King Assurbanipal's library at Nineveh, that George Smith, now over twenty years ago, made a famous discovery. He found a fragment of a tablet, bearing words, which he deciphered as follows:—"On the Mount Nizir the ship stood still. Then I took a dove, and let her fly. The dove flew hither and thither, but finding no resting-place, returned to the ship." Every Englishman who knows his Bible would have guessed, as George Smith immediately did, that he had before him a piece out of a Chaldean account of the deluge. He searched for more fragments, and found them. He went out to Assyria, visited the King's palace, and found still more tablets and pieces of tablets, some of them just those he required to fill up missing gaps in the story. Since its first translation by its discoverer it has been again translated and retranslated by some of the acutest scholars in Europe, so that we now possess a fairly complete knowledge of it; a few missing words or even lines, and occasional obscurities occur, but these are of no great importance. In a town which has the privilege to number the distinguished Assyriologist, Prof. Sayce, among its residents, there will be no necessity to present the story more than briefly. It runs as follows:—Sitnapistim, the Chaldean Noah, is warned by Ea, the god of wisdom and the sea, that the gods of Surippak, a city on the Euphrates, even then extremely old, had decided in council to destroy mankind by a flood. Sitnapistim is told to build a ship in which to save himself, his family, household, and belongings. Anticipating the curiosity of his neighbours, since he had never before built a boat, he asks what answer he is to make when questioned as to his unusual proceedings. Ea, who as the god of wisdom is naturally a master of evasion, provides him with a subterfuge, and Sitnapistim sets about building his boat. He forms it of timber and reeds, and makes it water-tight by filling up the crevices with pitch, which he poured over it both within and without. It is of great interest, as showing the local colouring of the legend and the survival of an ancient custom. To observe that this practice of paying the native boats of the Euphrates with pitch has persisted in Mesopotamia down to the present day, natural pitch being used, which occurs at various localities in the valley, but particularly near the town of Hit. Sitnapistim's method of procedure, both in building and paying his boat, may still be witnessed at Hit as a matter of almost every-day occurrence.

Sitnapistim having provisioned the vessel, and brought into it all his goods and chattels, received an intimation of the immediate approach of the catastrophe; he went on board with his family and friends, closed the roof, and prudently entrusted the helm to the sailor—Buzar-sadi-rabi. Heavy rain fell during an anxious night, and as soon as daybreak appeared—

"There arose from the foundation of heaven, a dark cloud,
The storm-god Ramân thundered in its midst and
Nebo and Merodach went in front.
As leaders they passed over mountain and plain
Ninib went therein, and the storm behind him followed.
The Anunnaki raised high their torches,
With their radiant brightness the land glittered,
The turmoil of Ramân reached to heaven
All that was light was turned to darkness.

* * * * * *

In the earth men perished. . . .
Brother beheld not his brother, men knew not one another In the heaven
The gods were terrified by the deluge, and
Hastened to ascend to the heaven of Anu.
The gods were like a dog—sat down cowering on the ring wall of heaven.
Ishtar cried like one filled with anger.
Cried the mistress of the gods—the sweet-voiced—
'The former generation is turned to clay. . . .
What I have borne, where is it?
Like fish spawn it fills the sea.'"

For six days the flood lasted and ceased on the seventh, and then Sitnapistim is made to say—

"I looked on the sea and called aloud,
But the whole of mankind was turned to clay.
I opened the air-hole, and the light fell on my face:
I bowed low, sat down, and wept,
Over my face flowed my tears."

Sitnapistim then beheld the land, Mount Nizir, on which the ship grounded. It remained swinging there for seven days; on the seventh day Sitnapistim sent out a dove, which returned, then a swallow, which flew to and fro, but also returned, and finally a raven:—"The raven went, saw the going down of the waters, came croaking nearer, but did not come back." Sitnapistim then left the ship with his people, built an altar on the summit of the mountain, and offered sacrifice. The poem then runs—

"The gods smelt the savour, the gods smelt the sweet savour,
The gods gathered like flies over the sacrificer
The mistress of the gods, Ishtar, lifted up the (bow?) which Anu had made according to her wish."

A discussion then takes place among the gods, who all through are very human, and in its course Ea suggests to Bel, who seems to have been the prime mover in all the mischief, that he should for the future destroy mankind in a less undiscriminating manner—by wild beasts, pestilence, and famine. The scene ends happily with the apotheosis of Sitnapistim and his wife.

The surprising resemblance of the story to the biblical narrative, extending into identity of words, as in the case of the "gods smelt the sweet savour," points to direct derivation or borrowing, and there can be very little doubt in deciding on which side the borrowing lay. The biblical narrative is indeed a Jahvistic or Monotheistic edition of the Chaldean. To this conclusion the most distinguished Assyrian scholars have been led. I need only mention here Prof. Sayce, whose opinion is expressed on page 119 of his work on "The Higher Criticism and the Monuments," published by the Society for Promoting Christian Knowledge, during the current year.

The Chaldean story certainly reduces the flood to much smaller dimensions, and so far brings it nearer the range of probability; the rain lasted only seven days, and the waters have subsided sufficiently at the end of a fortnight for Sitnapistim to land. They do not cover all the high mountains, and the stranding of the ship on Mount Nizir when the flood was at its climax, gives us a maximum height, which it cannot have exceeded; for if this mountain had been deeply submerged, it could not have arrested the passage of the ship. The height of the Nizir mountains is about 1000 feet above the sea-level, which still leaves room for a very respectable flood.

The scepticism which prevailed in the middle of this century with regard to legends seems to have given place to an almost equally great credulity. The older argument seemed to be that the presence of some obviously unveracious statements in a legend condemned the rest, want of faith in some was want of faith in all; while the more modern view would appear to be that since so many discredited legends have been found to enshrine some important truth, all are to be assumed trustworthy till they are proved otherwise.

It may be in this spirit that Suess has elaborately discussed the Chaldean legend as though it presented us with a trustworthy account of the Mesopotamian deluge.

Reasoning from the facts as it records them, Suess lays great stress on the course taken by the ship from Surippak, supposed to have been situated near the mouth of the Euphrates, to the land of Nizir, a distance of about 240 miles up stream. Had the flood been produced solely by heavy rainfall and a consequent overflowing of the swollen rivers, the ship instead of being carried inland would have been drifted out to sea, *i.e.* southwards into the Persian Gulf. Suess therefore suggests that a great wave was produced in the Persian Gulf, partly by a cyclone and partly by an earthquake. This wave of twofold origin then rolled in upon the low-lying land of Mesopotamia, and drove its floods of water up the valley till they washed the foot of the Nizir Hills.

Of all catastrophes none are more terrible, none more disastrous than those thus produced. When the shock of an earthquake occurs beneath the sea, and affects the adjacent land, a trembling of the ground is first felt, then the sea retires and leaves the beach bare, only to return in a long mighty wave which breaks with violence on the shore. Thus on October 28, 1746, Callao in Peru, after being shaken by an earthquake, was overwhelmed by a sea-wave and utterly destroyed; of its 5000 inhabitants only 200 survived the flood. Still more destructive was the famous earthquake of Lisbon, November 1, 1755, when the inhabitants, without a warning, were destroyed in the falling city, and in six minutes 60,000 persons perished. The sea in this case, as in others, retired first, and then rose 50 feet or more above its usual level, swamping the boats in the harbour; at Cadiz the wave is said to have reached a height of 60 feet, and it was felt over the greater part of the North Atlantic Ocean, arriving even on our own shores, as at Kinsale in Ireland, where it rushed into the harbour and poured into the market-place.

That a great sea-wave so produced might have thus arisen in the Persian Gulf is quite within the bounds of possibility, particularly as a zone of the earth's crust, very liable to earthquakes, stretches across the mouth of the Gulf near the Ormus Mountains.

But if we are to follow the legend, we must follow it faithfully, and as a result of the most recent investigations it turns out that all the passages which were supposed to refer to an earthquake have been mistranslated. The earthquake is thus put out of court, and we are left with what help we can get from the hurricane, a kind of disturbance which often vies with the earthquake in the destructive nature of the sea-waves to which it gives rise.

The Andaman Islands of the East Indies are a centre which give birth to some of the most terrific hurricanes in the world. Travelling more or less westwards and northwards, these whirlwinds sweep over the waters of the Bay of Bengal and raise the sea into waves mountains high, which every now and again rush over the low-lying lands of the Ganges delta, overwhelming the unfortunate inhabitants by myriads. Thus on the night of October 14, 1737, one of these waves, estimated at 40 feet in height, suddenly overtook the dwellers by the Ganges and destroyed them to the number of 100,000, or, as some say, 300,000 souls. These storms do not, as a rule, travel towards the Persian Gulf, and the North Arabian Sea is singularly free from them; but Suess, tracing the course of the storm of October 24, 1842, suggests that for once, in the case of the deluge, an East Indian storm may have lost its way and blundered, as it were, into the Persian Gulf. The track of this storm of 1842 was as follows:—At 5 o'clock on October 24 it reached Pondicherry; it then slightly altered its direction and veered more to the south-west, and on the 25th at midday it crossed the western Ghats, and then divided into two parts; the south centre need not concern us. The northern centre travelled north-eastwards towards the Persian Gulf, and was felt from the Gulf of Aden to Cap Guardafui, wrecking in this tract a number of vessels.

The greatest estimated height of storm-waves is from 40 to 45 feet, and, as Suess points out, it must have needed a much greater wave than this to drown out all Mesopotamia up to the Nizir Hills. How much greater, is a question we are fortunately able to answer positively, thanks to the accurate measurements made by the engineer Czernik during a survey for a projected railway. The Tigris rises very slowly from its mouth inland, but at Bagdad it is already 154 feet above the sea-level, and at Mansurijah, the lowest point where its tributary Diala Tschai emerges from the Hamrin Mountains, the height is given as 285 feet; but the land of Nizir lies even still more to the north than this, and the Lower Zab, which cuts through it, cannot have a less elevation than 600 or 700 feet. No storm wave of which we have any record, no recorded earthquake wave, nor any combination of the two, approaches even remotely the height that would be required to carry the sea even to Bagdad; while as for the Nizir Mountains, the Valiant Phersor, who "nearly spoilt the flood," might have drank up all the sea-water which came there without any assistance from Glenlivat. If we admit that the Tigris valley was ever submerged up to this point and restored to its original condition in the course of fourteen days, we are confronted with a catastrophe not only stupendous in degree, but of a nature beyond our present powers of explanation.

But are we compelled to admit anything of the sort, and would it not be well before doing so to inquire a little more closely into the credentials and character of the Chaldean story? We have seen that the tablets on which it occurs were found in King Assurbanipal's library, and it is fairly certain that they were copied from others much older preserved in the ancient city of Erech, the city of books. It is indeed probable that the tablets in Erech may date from the time of King Khammarubi, or from about 2350 B.C. The tablets present themselves therefore with good recommendations, and we proceed to the character of the story itself. It does not occur alone, but as one chapter out of twelve in a long poem of about 3000 lines, concerning the adventures of a mythical hero named Izdubar or Gizdubar, perhaps the same as Nimrod, that "mighty hunter before the Lord" of biblical story, and plainly the prototype of the Greek Heracles.

The first tablet, containing the first chapter, is incomplete. So far as can be made out, it sets forth the misfortunes of the city of Erech, probably under the oppression of its Elamite enemies, who were so terrible in battle that poor Ishtar, its protecting goddess, "could not lift up her head against the foe."

The second and third introduce Gizdubar, already famous as a hunter, as the hero, who was looked for to deliver the city. His rivals induce Ururu, the mother of the gods, to fashion a strange being, Eabani, half man and half bull, to fight with Gizdubar. This monster comes to Erech, bringing with him a powerful lion, desert-bred, to fight Gizdubar; but the hero succeeds in slaying the lion, and so wins the friendship and esteem of Eabani. In the fourth and fifth tablets the friends encounter and overcome the terrible tyrant Humbaba, whose voice was as "the roaring of the storm, his mouth wickedness, and his breath poison." The sixth tablet, which is well preserved, tells how the hero was beloved of Ishtar. "Be my husband," she says, "and I will be thy wife. I will make thee to ride in a chariot of gold and precious stones, with golden wheels and diamond horns. When thou enterest our house under the pleasant fragrance of the cedar, men shall kiss thy feet. Kings, princes, and lords shall bow down before thee, and bring tribute." Gizdubar, however, is not to be seduced; he repels the advances of the goddess, who then presents herself as a naturally angry woman before her father Anu, and persuades him to frame a divine bull which is to destroy Gizdubar. He and Eabani together slay this bull, however, and the goddess, now terribly incensed, pronounces a terrible curse upon Gizdubar. The seventh tablet is unfortunately missing. The eighth, ninth, and tenth narrate how Gizdubar, suffering under the divine anger, loses his friend Eabani, and is smitten with a grievous illness. He journeys to the river's mouth to consult his divine ancestor Sitnapistim. On his way he crosses a desert where "scorpion men" guard the dark path to the "waters of the dead," which separate him from his quest. On the shore of this sea he finds a park of the gods, with wonderful trees bearing precious stones for fruit. After waiting here a long time a ferryman takes him over to the fields of the blessed, where he meets Sitnapistim. He tells his sorrowful tale, and the heart of Sitnapistim is filled with pity; but, alas! neither gods nor men can give him help. In the eleventh tablet Gizdubar inquires of Sitnapistim how he became immortal, and receives in answer the story of the deluge. After its recital Sitnapistim heals Gizdubar of his disease, and gives him the plant of life, its name being "Altho'-a-grey-beard-the-man-becomes-young-again." Unfortunately an evil demon robs him of this on the way home. In the twelfth and last tablet Gizdubar returns to Erech, and utters a lament over his lost friend Eabani, whose ghost subsequently appears and recounts the doings of the dead in Hades.

Thus the deluge story is a myth within a myth, containing statements plainly unveracious; and how we are to distinguish in this mass of fiction the true from the false passes the wit of man to conceive. If we say of the deluge-part of it that it is a gross exaggeration, the judgment will sound mild, but this is all that is requisite to reduce the catastrophe to commonplace proportions.

Whether Gizdubar ever existed in the flesh or not has been doubted; it is certainly remarkable that each of the chapters of the poem corresponds to one of the signs of the zodiac, and they are arranged in the same order as the signs of the zodiac. A fanciful correspondence is thus drawn between the succession of events in the life of Gizdubar and the yearly course of the sun through the heavens, and it has consequently been maintained that Gizdubar is no other than the sun himself personified. The stages in the life of man find, however, so ready an analogy in the course of the sun, that this conclusion is by no means forced upon us, and we may turn to another identification of more significance in our inquiry. It is that of the Greek story of Heracles with the legend of Gizdubar. Heracles himself is no other than a Greek Gizdubar, the Chaldean Eabani corresponds to the centaur Cheiron, the tyrant Humbaba to the tyrant Geryon, the divine bull to the bull of Crete, the park of the gods to the garden of the Hesperides, the lion slain by Gizdubar to the lion of Nemea which Hercules slew, and finally, just as Gizdubar is ferried across the waters of the dead, so Hercules is taken by Helios in the golden boat of the sun across the ocean.

As the Greeks have borrowed so much of the legend it would be surprising if they had not taken the rest, including the story of the deluge, and accordingly we find the Greeks provided with a legend of the flood, or with more than one, as they appear to have had more than one Heracles: but that which most closely accords with the Chaldean, is the flood of Deukalion.

On the other hand the Egyptians, who had sun-stories of their own, did not borrow the legend of Gizdubar, and are silent as to a deluge; a fact of extreme importance when we consider that the Egyptian civilisation was contemporaneous with the Chaldean, if not indeed older. The Nile is gentler in its overflowing than the Tigris, so that Egypt did not suffer under the scourge of unexpected floods.

If, finally, we turn to China, also possessed of very ancient historic records, and liable to the destructive deluges of the Yellow River, which have earned for it the designation "The Curse of China," we discover a deluge story of great importance, to which Suess has already called attention. In the third Schu of the Canon of Yao, a monarch who reigned, it is supposed, somewhere about 2357 B.C., and therefore contemporaneous with Khammurabi, we read:—The Tî said, "Prince of the Four Mountains, destructive in their overflowings are the waters of the flood. In their wide extension they inclose the mountains and cover the great heights, threatening the heaven with their floods, so that the lower people is unruly and murmur. Where is a capable man whom I can employ this evil to overcome?" Khwan was engaged, but for nine years he laboured in vain: a fresh engineer, named Yü, was therefore called in; within eight years he completed great works: he thinned the woods, regulated the streams, dammed them, and opened their mouths, provided the people with food, and acted as a great benefactor to the State.

It is refreshing thus to pass from the ornate deceptions of legend to the sober truth of history; and if the facts on which the Gizdubar legend of the deluge is founded could be expressed in the same simple language, we should probably find it narrating similar events, or events as little calculated to surprise us as those of the straightforward Chinese Schû.

History then fails to furnish evidence of any phenomenon which can be called catastrophic in the geologic sense of the word, and geology has no need to return to the catastrophism of its youth; in becoming evolutional it does not cease to remain essentially uniformitarian.

And the careful foster-mother? She too, as it appears to me, has widened her studies, and must, I should think, recognise with pride the stalwart growth of her early friend. May they be drawn nearer together, and feel the warm glow which is produced by the sympathy of a common love for truth.

THE INTERNATIONAL GEOLOGICAL CONGRESS AT ZURICH.

THE sixth meeting of the International Geological Congress was held at Zurich from Wednesday, August 29, to Monday, September 3, and was highly representative. Over 220 members were present, including leading geologists from all parts of Europe. Swiss and German members were in the majority. We may mention the names of MM. Renevier, Heim, Golliez, Forel, Schardt among the Swiss representatives, and Baron Richthofen, MM. Beyrich, Hauchecorne, Zittel, Credner, Groth, Gumbel among the German. From Austria there were present, among others, MM. Suess, Mojsisovics, Tietze, Penck; from France, Prince Roland Bonaparte, MM. Gaudry, de Lapparent, Michel Levy, Bertrand, de Margerie; from Britain, Sir A. Geikie, Sir J. Lubbock, Prof. Hughes, Prof. Sollas, Mr. W. Topley; from Scandinavia, Prof. Brögger; from Belgium, Prof. Dewalque; from Italy, Prof. Capellini, MM. Pellati, de Gregorio; from Russia, MM. Karpinsky, Nikitin, Pavlov, von Toll; from Roumania, M. Stefanescu; from the United States, Profs. R. Pompelly, Lester Ward, van Hise. Prof. Haeckel, of Jena, was also present at several meetings.

Prof. Capellini opened the Congress, and called Prof. Renevier to the presidential chair for the meeting at Zurich. The new President intimated in his address that, according to a decision of council, the official language of the Congress should remain as before, French; at the same time communications made in German would be accepted, and would be reported in the same language. Communications written in other languages had to be translated into French.

Without doubt the most important feature of the Congress was the new international geological map, which has been under course of preparation in Berlin since the Congress meeting of 1881, and is now exhibited for the first time. A report on its progress was read by Dr. Hauchecorne, of Berlin. The topographical groundwork has been prepared by Kilpert, to scale 1 : 1,500,000; the system of geological colouring followed has been most successful, and the Congress has certainly every reason to be satisfied with the result of the co-operation of the various surveys and societies to produce an international map. The whole map will contain 49 sheets; only six are now ready for issue, including the north west part of Europe, Northern Germany, with parts of France, Belgium, Poland, &c. The next part, to be issued within a year, will contain ten sheets, and will include the British Isles, France, Spain and Portugal, Italy, and Switzerland. Some difficulty has arisen in regard to the older Palæozoic rocks of various districts, and also as to the method of showing the Quaternary beds. It is now settled that solid rocks, where their distribution is known, will be shown by thin bands of colour over the general colour for Quaternary beds. (We reserve a fuller notice of this important work until the sheets are published.)

The subscription for the entire map is £4, but this can be paid in instalments as the various parts are published. The proportion for the first part will be 10s. Subscriptions must be sent to Dietrich Reimer, Berlin, before the end of December 1894; after that the subscription price will be raised.

On three days of the Congress meeting, communications were delivered to a general assembly of members; on one day, sections were formed, and a large number of papers in this way read. Unabated interest made itself felt throughout. At the general assembly on August 29, Prof. Suess gave an address "On the Southern and the Northern Alps," in which he distinguished two main directions of movement in the Alps. The Northern zone and the Central chain of the Alps formed a region of "zufluss" (flow towards the North Pole); the Southern zone, continued into the Dinarian Alps, was a region of "abfluss" (flow away from the North Pole). In the former case the relations were in harmony with those of general European movements; in the latter, the relations were associated with those of Asiatic chains.

Prof. Heim described the "Geology of the neighbourhood of Zurich," and made it most clear by reference to a splendid set of original maps and models. During the course of the Congress Prof. Heim also organised several excursions on the lake and on its banks, demonstrating that post-glacial movements of old fluvial terraces are in direct connection with the origin of the Lake of Zürich. As might have been expected, animated discussions were held among the members on the points at issue—the origin of the lake-basin, proofs of interglacial periods, mountain-movement which had affected glacial deposits, original and ultimate direction of the valleys, &c.

On August 31, the general assembly was addressed by M. Michel Levy and Prof. von Zittel. Michel Levy's subject was "The principles to be followed in a universal classification of the rocks." He regretted the confusion which threatened petrography with regard to its classification and nomenclature. Every day the number of names derived from particular localities increased, and useless synonyms were added. He proposed that some general system of classification should be agreed upon by petrographers, and suggested it might be founded (1) on the *texture*—affording the great divisions; (2) on the essential *constituent minerals*, to give the names of the smaller groups. In compliance with M. Michel Levy's desire, a Congress commission was appointed to consider and revise the nomenclature.

Prof. von Zittel spoke on "Phylogeny, Ontogeny, and systematic arrangement." He gave a word of warning against the assumption that Darwin's Theory of Descent had been actually demonstrated by palæontology. In his experience its application to palæontology had been in but few cases successful. Great breaks occurred between the various classes of fossil animals for which there was still no sufficient explanation. Again, Ernst Haeckel's law, that the development of one individual repeats the development of the whole family, had been confirmed in few classes of palæontological forms. The tendency of recent research had been becoming more and more subjective; even young investigators freely constructed new species, new genera, a new system of classification or line of descent. Others as freely questioned the validity of the new names and families, until a kind of anarchy prevailed in some of the groups of the plant and animal kingdom. Solid facts and experiences must be carefully studied, while theory, even the most brilliant, must be held at its mere theoretical value.

At the general sitting on Saturday, September 1, Sir Archibald Geikie and M. Marcel Bertrand spoke. Sir A. Geikie's paper, delivered in French, was on the "Banded Structure of oldest Gneisses and Tertiary Gabbros." Intrusive basic rocks of Tertiary age in which no mechanical deformation had taken place, had assumed a banded structure during their crystallisation from the original magma, the bands being occasionally plicated. The structure exactly resembled what is observed in many old banded gneisses, and arguing from analogy, these gneisses might have acquired their banding during their original consolidation, and not as the result of subsequent dynamometamorphism. A series of photographs admirably illustrated this suggestion.

M. Bertrand treated the "Structure of the French Alps and the recurrence of certain facies." After describing the metamorphism of various sedimentary formations into the condition of gneiss as the result of great dynamic changes, he pointed out that in different countries and in quite different formations certain facies followed each other in the same order of succession. These were a deep-sea facies, a "Flysch" facies formed during uprise, followed by an archipelago and river facies. In the French Alps, for example, the deep-sea facies was represented by the Devonian gneiss, the period of movement by the carboniferous deposits, the shallow water by the later red sandstones. Taking the Swiss Alps, the same facies recurred in younger formations; one might distinguish gneiss of Permian age, Flysch—(1) fine and schistose of Triassic and Jurassic age; (2) the coarser deposits of Cretaceous and Eocene age—and ultimately the archipelago facies of molasse and nagelflue in young Tertiary and Glacial time.

M. de Margerie read the report of the Commission of Bibliography. In accordance with the council, the Commission offers to furnish gratuitously a copy of the Catalogue of Geological Bibliographies, at present in the press, not only to all the members of the preceding Congress, as had been agreed upon at Washington, but also to those of the Congress of Zurich. The sectional meetings on Thursday, August 30, were of a special character. At the General Geology Section, with Prof. de Lapparent as president, most of the papers related to glacial questions. The Congress, acting upon proposals of

Prof. F. A. Forel and Captain Marshall Hall, has appointed a committee to investigate the variations of glaciers. Representatives of various countries are appointed. Prof. Forel and Dr. L. du Pasquier will have charge of this committee, the expenses of which will be defrayed by Prince Roland Bonaparte, the representative of France on the committee.

Dr. A. Rothpletz spoke on "Overthrusts and their methodical investigation"; M. Steinmann gave a note on the "Extent of the Indo-Pacific Cretaceous region." The Section of Stratigraphy and Palæontology, presided over by M. Gaudry, heard papers by Prof. Hull, by MM. Sacco, Fallot, Mayer-Eymar, Depéret; on "Tertiary strata and their classification," by Profs. Steinmann and Boehm, and by M. Pavlov on "Cretaceous strata"; by M. Kilian, on "the limit of the Jurassic and Cretaceous systems"; and by M. Stephanescu, on the "Fossil camel in Roumania." The other sections were Mineralogy and Petrography, M. Michel Levy presiding; and Applied Geology, Dr. Hauchecorne presiding. At the Mineralogy and Petrography Section several papers were read; among others, one on the petrography of Attica, by Prof. Lepsius, on grorudites and tingnaites, by Prof. Brogger. Prof. Groth showed a simple apparatus for demonstrating the direction of the vibrations in biaxial crystals.

An interesting interlude was formed at the meeting on August 31, by the presentation to Geheimrath Beyrich of a magnificent wreath of Alpine flowers made in the name of the assembled geologists. The day was the eightieth anniversary of Beyrich's birth, and Prof. Heim expressed the feelings of all present in the warm words of congratulation and appreciation which he addressed to the veteran geologist. Not less touching was the reply of the Geheimrath to the graceful token of love and respect from his colleagues of all European nations.

Space will not permit a description of the excellent exhibition of maps, photographs, models, and specimens in connection with the Congress. Exhibits had been sent from all countries. Also the great collection of the Zürich museums was an attraction in itself, and Prof. Heim was untiring in his efforts that all the guests should see all and even more than all which they had hoped to observe. The new geological map of Switzerland, scale 1 : 500,000, prepared by Heim and Schmidt, won the admiration of all, and together with the geological guide-book of the excursions published by the organisation committee, will remain as a valuable, lasting witness of the enterprise and energy displayed by Switzerland and her professors on the occasion of the sixth Congress.

It is rather unfortunate that the weather, which had been the best of summer weather during the excursions in the Jura Mountains previous to the meeting, and throughout the meeting itself, should have broken just as the excursions into the Alps began. Rain and mist undoubtedly bid fair to mar the enjoyment and lessen the benefits. From September 17 to 23 an excursion will be conducted by Profs. Penck, Bruckner, and du Pasquier, for the study of glacial appearances in the Alps. A special paper has been published by these three geologists, more especially with a view to this excursion, but also of general interest, entitled "The Glacial System of the Alps."

The seventh meeting of the International Geological Congress will be held in 1897 at St. Petersburg. The geological tours proposed were shown in a map of Russia exhibited during the Congress. An excursion across Russia and the Ural Mountains will precede the St. Petersburg meeting, and one is arranged to be undertaken to the Caucasus and the Caspian Sea at the close of the meeting. The Czar, it is said, has invited the Congress to St. Petersburg, and has already subscribed 30,000 roubles to defray in part the expenses of the Congress.

THE INTERNATIONAL CONGRESS OF HYGIENE.

THE International Congress of Hygiene and Demography, recently held at Budapest, does not appear to have been very successful from a scientific point of view. The medical journals say that serious work was impossible at the Congress, owing to the numerous social amusements and entertainments provided for the members. This opinion is borne out in a report in the *Times*, to which we are indebted for the following notice.

Our contemporary remarks that unless some sweeping reforms are introduced into the procedure of the Congress the same loss of prestige which has reduced other similar institutions to impotence or extinction seems certain to overtake it. The Congress appears to have ended in a chaotic confusion for which the word fiasco is none too strong, and the principal reasons for this unfortunate state of things are said to be (1) an overwhelming development of what may be called the picnic element; (2) an abuse of the system of passing sectional resolutions; (3) the superabundance of papers.

But, in spite of the confusion and turmoil resulting from the foregoing defects of procedure, an abundance of valuable material was brought forward at the Congress, some of which might, under more favourable circumstances, have been focussed into a shape which would exercise a real influence on practical questions of public health and social economy. Much sound and useful work, for instance, was done upon such questions as the housing of the working classes, the influence of dwellings and occupations upon health, the movements of population, and especially the townward migration, upon the condition of the insane, upon school hygiene, practical sanitation, and many others. The real scientific life of the Congress, however, lay in the department dealing with infectious disease and bacteriology. Here three crowded meetings took place on three successive days to discuss the following questions:—(1) Immunity from infectious disease; (2) diphtheria; (3) cholera.

The first of these is of great practical importance, because the future of medicine, from the present bacteriological point of view, lies in solving the problem of immunity. According to one school immunity is effected by certain cells (leucocytes) which eat up the germs, and are therefore called phagocytes. This fascinating theory was introduced a few years ago by M. Metchnikoff, the eminent chief of the Pasteur Institute in Paris; but the balance of opinion seems to be turning against it in favour of the theory that the germs are mainly destroyed by certain chemical substances contained in the watery part of the blood. Prof. Buchner, of Munich, is a prominent supporter of this theory, and his paper, read at the Congress, summarises the latest views on the subject. "The natural capacity for resistance to infection (the so-called natural immunity) rests on essentially different conditions and causes from the artificial or acquired immunity. The former rests on the one side upon the bactericidal activity of a substance called Alexine, which is secreted by the organism, on the other by a natural insusceptibility of the cells and tissues of the body to particular bacterial poisons. The leucocytes play an important part in the natural protection of the organism, not, however, as phagocytes, but through the action of substances secreted by them. Acquired immunity, upon the other hand, rests on the presence of modified bacterial products, the so-called Antitoxine, either in the blood or in the tissues of the body." M. Metchnikoff defended his theory of phagocytosis with great vivacity, but the other leading bacteriologists present, including Prof. Roux, of Paris, were on the other side. The debate marks a step in the advance of knowledge, though not a very decided one.

The morning devoted to diphtheria was the central point of the Congress. An overflowing and animated audience attended the meeting. This fearful disease is the most burning question in the medical world at the present time, partly because of its alarming increase, and more recently because of the hopes entertained of the new method of treatment, derived from bacteriological research. Prof. Löffler, the eminent discoverer of the diphtheria bacillus, opened the proceedings by reading the German report, which recommended "immediate bacteriological examination of all suspected cases; notification to the police of all bacteriologically determined cases and of all doubtful ones; isolation of every case; protective inoculation with serum of persons about the invalid, particularly children; extension of this principle as far as possible in families and schools; disinfection, keeping of convalescents apart until the bacillus has disappeared."

Similar drastic measures were recommended in the French report. The English report did not suggest any practical measures for dealing with the evil, but pleaded for more careful study, and more accurate knowledge of its causes and conditions. The Danish, Hungarian, Swedish, and Swiss reports also pleaded for further investigation. It is much to be regretted that the Congress could not find time to formulate some, and carefully-weighed, conclusions on this important matter.

In a debate on cholera, which followed in the same section, Prof. Max Gruber said, at the commencement of his address, that the bacteriology of the disease is by no means so simple as was once supposed; "the deeper investigation goes the greater the difficulties that rise up before us." Continuing, the *Times* reports him as remarking that the result of his own investigations had brought him to doubt the specific character of the cholera bacillus. "The question," he said, "is in this strange position—that, while we know with certainty that the vibrios which appear in cholera are the cause of the symptoms of the disease, we do not know for certain that these vibrios are of a distinct species. We cannot say for certain whether in all cases of true cholera they belong to a single species or to several, whether they are distinct from our own native vibrios or not." He was inclined to think they were not distinct, and propounded a quite new theory to the effect that these native and harmless vibrios take on an injurious character and give rise to cholera when some other at present undiscovered germ is introduced; for it is certain that cholera is introduced, and yet apparently the germs are here all the time. M. Metchnikoff, on the other hand, defended the specific character of the cholera vibrio, but admitted that it was not everything. It is frequently present, and yet does no harm. To explain this he has invented yet another theory, very curious and rich in appalling possibilities. The cholera germ, he thinks, is only powerful for evil when the native bacilli of the human interior, the *flora* of the stomach and intestines, as he quaintly calls them, are favourable to its growth. It is pointed out by our contemporary that these utterances are interesting as marking a distinct change of front and a distinct advance in knowledge. Bacteriologists, as the result of their own investigations, are beginning to come into line with the position long maintained by other observers, who reached their conclusions by the old method of studying the facts of epidemic disease. The germ is, no doubt, the cause of the disease, but it alone will not suffice. Its effects depend upon the conditions in which it is placed, upon its environment; it must have a favourable soil in which to grow, or it changes into a harmless variety. And this bacteriological doctrine has an important bearing on the encouragement of hygiene, for it helps us to understand more precisely how hygienic measures work in rendering the soil unfavourable to the growth of the injurious micro-organisms.

SCIENCE IN THE MEDICAL SCHOOLS.

THE students' number of the *Lancet* furnishes some interesting information upon the curricula of the medical schools of Great Britain. With the idea of seeing how far science instruction in subjects not purely medical is provided in these schools, we have prepared the subjoined table, from lists given in our contemporary, of classes to be held during the session

—	Physiology.	Biology or Zoology.	Botany.	Chemistry.	Practical Chemistry.	Natural Philosophy or Physics.	Practical Physics.	Bacteriology.	Hygiene or Public Health.	Natural History.
METROPOLITAN MEDICAL SCHOOLS.										
St. Bartholomew's Hospital	×	×	...	×	×	×	×	...		...
Charing Cross Hospital and College	...	×	...	×	×	×	×	×		
St. George's Hospital		...		×	×	...	...	...		
Guy's Hospital		×	...	×	×	×	...	×		...
King's College Hospital		...	...	×	×	×		...		
London Hospital		...	...	×	×	×	×	×		
St. Mary's Hospital		...	...	...	×	...	...	...		
Middlesex Hospital	×	×	...	...	×	...	...			
St. Thomas's Hospital and School		...	...		×	×	...	×		...
University College and Hospital			×		×	×	...	×		...
Westminster Hospital			...	...	×	×	...	...	×	...
PROVINCIAL MEDICAL SCHOOLS.										
University of Durham College of Medicine	...	×	×	×	×	×	×	×	×	...
University College, Liverpool	...	×	...	...	...	×	×		×	...
Owens College School of Medicine		...			×	×	×	...		...
Sheffield School of Medicine		...			×		×	...		...
Mason College	...	...	...		×	×	...	...		...
University College, Bristol		×			×	...		×		...
Cambridge University	...				×	×		...		
Oxford University					×	...		...		
Yorkshire College, Leeds										
University College, Cardiff							...	...		...
MEDICAL SCHOOLS OF SCOTLAND.										
Aberdeen University			×		×	×				
St. Andrews University			×		×	×				
Edinburgh University					×					
Glasgow University			×		×		...			×
St. Mungo's College and School of Medicine					×					
Anderson's College, Glasgow										
School of Medicine, Edinburgh										×
University College, Dundee					×	×				
MEDICAL SCHOOLS OF IRELAND.										
Dublin University		×			×	×				
Dublin Royal College of Surgeons										
Catholic University, Dublin	×					×				
Queen's College, Belfast										
Queen's College, Cork										
Queen's College, Galway										

1894–95, which begins next month. The table does not pretend to be complete; nevertheless, it will serve to show the kind of science subjects on which lectures are given to medical students outside medical technology. The courses advertised are indicated by crosses.

It has not been considered necessary to tabulate courses only given in two or three medical schools. Organic chemistry, for instance, is only down as a specific subject in the lists of lectures at the London Hospital and the University College Hospital. Probably the reason for this is that, at many colleges, the lectures on chemistry embrace the organic and the inorganic branches. Chemical physics is down in the medical curricula of the University College, Mason College, Cambridge University, and Yorkshire College, and physiological chemistry is among the courses at St. George's Hospital and Oxford University. Though psychological medicine is taught in a number of colleges, psychology only appears as the subject of lectures at St. Bartholomew's Hospital, Charing Cross Hospital, Edinburgh School of Medicine, and Queen's College, Cork. In the first two of these institutions, and also at Oxford University, pharmacology is treated distinct from practical pharmacy. It will be seen from the table that, in Scottish medical schools, the students are instructed in natural history, whereas this subject does not appear in the lists of lectures in the medical schools of England and Ireland.

Courses of lectures on bacteriology are advertised to take place at nine medical schools, but it must not be supposed that they are the only schools having facilities for carrying on this study. The *Lancet* has something to say on bacteriology and the medical curriculum. Our contemporary points out that "it is now almost imperative that those who are engaged in the teaching and study of medicine should consider the position of bacteriology in medical education with regard (*a*) to students proper, and (*b*) to those students of more mature years known as post-graduates. We think that the time has nearly come when it will be insisted upon that every medical student should receive not only some systematic instruction in the principles of bacteriology, but, more important still, should be put through a thorough, if short, course of practical laboratory instruction, in which the theories propounded in the class-room may be clearly illustrated. . . . Many of the medical schools have already recognised this fact, and in London alone there are now several well-equipped bacteriological laboratories where a thorough course of instruction can be obtained by the medical student. Guy's Hospital, University College Hospital, St. Bartholomew's Hospital, for example, have all acquired special facilities for carrying on the work; but there is still much room for the more general teaching of the subject. In the large university medical schools, especially in Oxford, Cambridge, Victoria, Durham, Edinburgh, Aberdeen, and Glasgow, the subject is more or less thoroughly taught, but not in all cases as practically as is desirable."

FORTHCOMING SCIENTIFIC BOOKS.

THE following scientific books are reported as being in preparation for the forthcoming publishing season. The list, though not so lengthy as the one we printed a year ago, is still a representative one, and lovers of each and every branch of science appear to be well catered for:—

Messrs. Macmillan and Co. announce:—"A Treatise on Bessel Functions," by Profs. G. B. Matthews and A. Gray; "Elementary Treatise on the Theory of Functions," by James Harkness and Frank Morley; "Elliptic Functions," by A. C. Dixon; "Practical Plane Geometry," by J. Humphrey Spanton; "An Introductory Account of Certain Modern Ideas and Methods in Plane Analytical Geometry," by Dr. Charlotte Angas Scott; "Integral Calculus and Differential Equations for Beginners," by Joseph Edwards; "Geometrical Conic Sections," by Charles Smith; "Elementary Mensuration, with Exercises on the Mensuration of Plane and Solid Figures," by F. H. Stevens; "The Theory of Light," by Thomas Preston, second edition, thoroughly revised; "Magnetism and Electricity," by Prof. Andrew Gray, illustrated; "Steam and the Marine Steam Engine," by John Yeo, with illustrations; "Pumping Machinery," by Dr. Julius Weisbach; "A Laboratory Manual of Physics and Applied Electricity," arranged and edited by Edward L. Nichols, vol. ii. Senior Course and Outline of Advanced Work, by George S. Moler, Frederick Bedell, Homer J. Hotchkiss, Charles P. Matthews, and the Editor, illustrated; "Theoretical Chemistry," by Prof. Nernst, translated by Prof. Charles Skeele Palmer; "Manual of Physico-Chemical Measurements," by Prof. Wilhelm Ostwald, translated, with the author's sanction, by Dr. James Walker, illustrated; "Lassar Cohn's Organic Chemistry," translated by Alexander Smith; "The Rise and Development of Organic Chemistry," by the late C. Schorlemmer, F.R.S., translated and edited by Prof. Smithells; "Chemical Analysis of Oils, Fats, Waxes, and their Commercial Products," by Prof. R. Benedikt, translated, edited, and enlarged by Dr. J. Lewkowitsch; "The Planet Earth, an Astronomical Introduction to Geography," by R. A. Gregory, illustrated; "Papers on Geology," by Joseph Prestwich, F.R.S.; "The Cambridge Natural History," edited by J. W. Clark, S. F. Harmer, and A. E. Shipley; vol. iii. "Molluscs," by Rev. A. H. Cooke; "Aquatic Insects," by Prof. L. C. Miall, F.R.S., illustrated; "Text-book of the Diseases of Trees," by Prof. R. Hartig, translated by Dr. W. Somerville, with a Preface by Prof. H. Marshall Ward, F.R.S., with numerous illustrations; "Timber and Timber Trees, Native and Foreign," by Thomas Laslett, new edition, revised by Prof. H. Marshall Ward, F.R.S.; "A Text-book of Comparative Anatomy," by Dr. Arnold Lang, translated into English by Henry M. Bernard and Matilda Bernard, vol. ii.; "Human Anatomy," by Prof. Wiedersheim, translated from the last German edition by H. M. Bernard, revised and annotated by Prof. G. B. Howes, illustrated; "A Text-book of Pathology, Systematic and Practical," by Prof. D. J. Hamilton, vol. ii.; "Lessons in Practical Bacteriology," by Dr. A. A. Kanthack and J. H. Drysdale; "Mental Development in the Child and the Race," by Prof. J. Baldwin; "A Course of Experimental Psychology," by Dr. J. McKeen Cattell; Leibnitz's "Nouveaux Essais," translated by A. G. Langley; "The Right to the Whole Produce of Labour: the Origin and Development of the Theory of Labour's Claim to the Whole Product of Industry," by Prof. Menger, translated by Mary E. Tanner; "Elementary Course of Practical Science," part ii., by Hugh Gordon; "Short Studies in Earth Knowledge," by William Gee, with illustrations; "Physiography for Beginners," by J. E. Marr, F.R.S., and Alfred Harker; "Physiology for Beginners," by Dr. Michael Foster, F.R.S., and Dr. L. E. Shore; "Agriculture, Practical and Scientific," by Prof. James Muir; "Horse-Breeding for Farmers," by A. E. Pease; "Garden Plants and Flowers: a Primer for Amateurs," by J. Wright; "Greenhouse and Window Plants, a Primer for Amateurs," edited by J. Wright; "Vegetables and their Cultivation, a Primer for Amateurs, Cottage Gardeners, and Allotment Holders," by A. Dean, edited by J. Wright; "The Mechanism of Weaving," by Thomas William Fox; "Boot and Shoe Manufacture," by C. W. B. Burdett, with numerous illustrations; "Facts about Processes, Pigments, and Vehicles: a Manual for Art Students," by A. P. Laurie, illustrated.

Messrs. Sampson Low and Co. will issue:—"Instruction in Photography," "Photography with Emulsions," "Negative Making," "Colour Vision" (being the Tyndall Lectures delivered before the Royal Institution during the present year), all by Captain Abney, C.B., F.R.S.; "Art and Practice of Silver Printing," written by Captain Abney in conjunction with H. P. Robinson; "Pictorial Effect in Photography," "The Studio, and what to do in it," "Letters on Landscape Photography," by H. P. Robinson; "Specifications, for the use of Surveyors, Architects, Engineers, and Builders," by J. Leaning; "Sweet-scented Flowers and Fragrant Leaves: interesting Associations gathered from many Sources, with Notes on their History and Utility," by Donald McDonald, with sixteen coloured plates; "A Text-book of Mechanics and Hydrostatics, by Herbert Hancock, with over 400 diagrams; "Thermodynamics: treated with Elementary Mathematics, and containing applications to Animal and Vegetable Life, Tidal Friction and Electricity," by J. Parker, with numerous diagrams; "The Theory and Practice of Handwriting: a Practical Manual for the Guidance of Inspectors, School Boards, Teachers, and Students," with diagrams and illustrations, by John Jackson, second edition, greatly enlarged with two additional chapters, two extra appendices, and several pages of facsimile illustrations.

Messrs. Swan Sonnenschein and Co. will publish:—"A

Student's Text-book of Botany," by Dr. Sidney H. Vines, F.R.S., second half, completing the work; also the complete work in one volume; "Text-book of Embryology: Invertebrates," by Drs. Korschelt and Heider, translated and edited by Dr. E. L. Mark and Dr. W. L. Woodworth; part i., fully illustrated; "The Cell: its Anatomy and Physiology," by Dr. Oscar Hertwig, translated and edited by Dr. H. J. Campbell, fully illustrated; "Text book of Palæontology for Zoological Students," by Theodore T. Groom, fully illustrated, forming a supplement to Claus and Sedgwick's "Text-Book of Zoology"; "Lectures on Human and Animal Psychology," by Prof. Wilhelm Wundt, translated and edited by James Edward Creighton and Edward Bradford Titchener; "Handbook on Systematic Botany," by Dr. E. Warming, translated and edited by Prof. M. C. Potter, fully illustrated; "Introduction to Physiological Psychology," by Dr. Theodor Ziehen, with 21 illustrations, a new and revised edition; "Zoology: Introduction to the Study of," by B. Lindsay, illustrated; "Fishes," by the Rev. H. A. Macpherson. "Flowering Plants," by James Britten; "Grasses," by W. Hutchinson; "Mammalia," by the Rev. H. A. Macpherson; "Pond Life," by E. A. Butler; "English Coins," by Llewellynn Jewitt, new edition; "Rainmaking and Sunshine," by John Collinson.

Mr. Murray's list contains:—"The Life and Correspondence of William Buckland, D.D., F.R.S.," sometime Dean of Westminster, twice President of the Geological Society, and first President of the British Association, by his daughter, Mrs. Gordon, with portraits and illustrations; "The Life of Prof. Owen, based on his Correspondence, his Diaries, and those of his Wife," by his grandson, the Rev. Richard Owen, with a chapter by the Right Hon. T. H. Huxley, with portraits and illustrations, 2 vols.; "The Scientific Papers and Addresses of Werner von Siemens," volume ii., including the following subjects: induction writing telegraph, magneto-electric quick type-writer, electric water-level indicator, mine exploder, alcohol meter, the universal galvanometer, automatically-steered torpedoes, automatic electric lamp, electric plough, electric elevator, electricity meter, energy meter, &c., with illustrations; "Handbook of Ancient Roman Marbles, consisting of a History and Description of all Ancient Columns and Surface Marbles still existing in Rome, with a List of the Buildings in which they are found," by the Rev. H. W. Pullen; "An Introduction to Physical Science," by Prof. John Cox; "The History of Astronomy," by Arthur Berry.

Messrs. Longmans and Co. have in the press, or in preparation:—A new edition, in four volumes, of Prof. Max Muller's "Chips from a German Workshop." The first volume will contain "Recent Essays," the second "Biographical Essays," the third "Essays on Language and Literature," and the fourth "Essays on the Sciences of Language, of Thought, and of Mythology"; "Butterflies and Moths (British)," by W. Furneaux, with twelve coloured plates and a large number of illustrations in the text; "Studies of Nature on the Coast of Arran," by George Milner, with illustrations; "From Edinburgh to the Antarctic," by W. G. Burn Murdoch; profusely illustrated by the author; supplemented by the Science Notes of the naturalists of the expedition, W. S. Bruce, J. J. W. Campbell, and C. W. Donald; "A Primer of Evolution: being a popular abridged edition of 'The Story of Creation,'" by Edward Clodd, with illustrations; "The Teaching of Physical Exercises," by F. J. Harvey; "Jacquard Weaving and Designing," by F. T. Bell; "The Magnetic Circuit in Theory and Practice," by Dr. H. Du Bois, translated from the German.

Mr. Edward Stanford's forthcoming works include:—"Cloudland," a study of the nature and forms of clouds, by the Rev. W. Clement Ley, with a number of coloured illustrations and reproductions from photographs; a third edition of Prof. James Geikie's "The Great Ice Age," almost entirely rewritten and with a new chapter on "The Glacial Phenomena of North America," by Prof. T. C. Chamberlin, also some new maps and diagrams; an addition, by Dr. Guillemard, on "Malaysia and the Pacific Archipelagoes," to Stanford's "Compendium of Geography and Travel," with numerous new illustrations and maps; and in the same series, volumes on "Africa" and "Asia," by A. H. Keane; a second edition of J. Scott Keltie's "The Partition of Africa," brought up to the most recent changes, and with some new maps.

In Messrs. Blackie and Son's list we notice:—"A Text-book of Organic Chemistry," by Dr. A. Bernthsen; translated by Dr. George M'Gowan, new edition, thoroughly revised and much enlarged by author and translator; "Elements of Metallurgy," by W. Jerome Harrison and William J. Harrison, jun., fully illustrated; "The Natural History of Plants: their Forms, Growth, Reproduction, and Distribution," from the German of Prof. Anton Kerner von Marilaun, translated by Prof. F. W. Oliver, with assistance of Marian Busk and Mary Ewart, with about 1000 original woodcut illustrations and sixteen plates in colours, issued in sixteen parts, also in four half-volumes, at intervals of four months.

Messrs. Whittaker and Co. will shortly issue a new edition, mostly rewritten, of Gisbert Kapp's "Electric Transmission of Energy;" "Model Engine Construction," by J. Alexander, with working drawings; "Steel Works Analysis," by Prof. J. O. Arnold; "Steam Power and Mill Work," by G. W. Sutcliffe; "The Manufacture of Modern Explosives," by Oscar Guttmann; the third and fourth (concluding) parts of C. Gordon Brodie's "Dissections Illustrated"—they will include the head, neck, and thorax, and the abdomen, respectively.

Messrs. Crosby Lockwood and Son have nearly ready for publication:—D. K. Clark's new volume on "Tramways, their Construction and Working," in which will be given a comprehensive history of the earlier forms, as well as the latest developments of tramways in this country and abroad, including the various modes of traction; a popular handbook on "Fertilisers and Feeding Stuffs, their Properties and Uses," by Dr. Bernard Dyer, with Notes on the Fertilisers and Feeding Stuffs Acts of 1893, by Mr. A. J. David.

Mr. T. Fisher Unwin is preparing:—"Travels and Studies in the Far East," by Henry Norman, illustrated; the volume supplementary to "Climbing and Exploration in the Karakoram Himalayas," by Prof. W. M. Conway, containing the scientific memoranda of the expedition by the author and various specialists; "In the Guiana Forest," by James Rodway, illustrated; "The Mountains of California," by John Muir, illustrated; and "The Story of Australian Exploration," by R. Thynne, illustrated.

The Clarendon Press will publish shortly:—"A Glossary of Greek Birds," by D'Arcy W. Thompson; "Index Kewensis," compiled at the expense of the late C. R. Darwin, under the direction of Sir Joseph D. Hooker, by B. Daydon Jackson, part iii.; "A Monograph on the Oligochæta," by Frank E. Beddard, F.R.S.; "A Manual of Crystallography," by M. H. N. Story-Maskelyne, F.R.S. (This work, which has been so long announced, is on the point of publication.)

Messrs. W. and R. Chambers have in the press, or in preparation:—"Chambers's Concise Gazetteer of the World," topographical, statistical, and historical, with pronunciation of the more difficult names of places and information regarding the derivation of names; "Elementary Science," by S. R. Todd; "Organic Chemistry," part ii., by Prof. Perkin and S. Kipping.

Messrs. Chapman and Hall announce:—"The Progress of Science: its Origin, Course, Promoters, and Results," by V. Marmery; "Naval Architecture and Shipbuilding," by G. V. C. Holmes, illustrated; "Machine Construction: a Key to the Examinations of the Science and Art Department," by Hy. Adams; "A Text-book of Mechanical Engineering," by Wilfrid J. Lineham; "Practical Plane and Solid Geometry," by Henry Angel; "The Nests and Eggs of Non-Indigenous British Birds," by Charles Dixon.

Messrs. A. and C. Black's arrangements include:—"Monism; or, the Confession of Faith of a Man of Science," by Prof. Ernst Haeckel, translated from the German by J. D. F. Gilchrist; "The Senile Heart: its Symptoms, Sequelæ, and Treatment," by Dr. George William Balfour; the last part of the "Dictionary of Birds," by Prof. Newton.

Messrs. Cassell and Co. have in hand:—"The Electric Current, how Produced and how Used," by R. Mullineux Walmsley; a new edition of "Electricity in the Service of Man," revised by Dr. Walmsley; "The Year-Book of Treatment for 1895."

Messrs. G. Bell and Sons promise:—"Arithmetic for the Standards," by Charles Pendlebury and W. S. Beard; "Cotton Weaving," by R. Marsden, illustrated; an authorised abridgment of "Webster's International Dictionary," entitled "Webster's Brief International Dictionary."

Messrs. Methuen and Co. will publish in their University

Extension Series:—"Insect Life," by F. W. Theobald, illustrated.

In Mr. Edward Arnold's list we find:—"Psychology for Teachers," by Prof. C. Lloyd Morgan; "Systematic Science Teaching," by Edward G. Howe.

The S.P.C.K. announce:—"Edible and Poisonous Mushrooms: what to eat and what to avoid," by Dr. M. C. Cooke, with eighteen coloured plates illustrating forty-eight species.

Messrs. G. P. Putnam's Sons will issue:—"Diagnosis, Differential Diagnosis, and Treatment of Diseases of the Eye," by Dr. A. E. Adams.

Messrs. W. B. Whittingham and Co give notice of a book entitled "What is Heat?—a Peep into Nature's most Hidden Secrets," by Frederick Hovenden.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Major Craigie, the Director of the Statistical Department of the Board of Agriculture, has presented a report on the distribution of grants for agricultural education in Great Britain in the financial year 1893–94. From a summary in the *Times*, it appears that out of the total vote of £8000 entrusted to the Board of Agriculture for educational purposes the necessary provision had been made for the cost of inspection, and the sum of £7450, which remained available, had been applied in the form of specific grants, a small sum being devoted to the reproduction of the records of the Rothamsted experiments for the past fifty years. The Board had been confirmed by further experience in their estimate of the value of establishing fully-equipped agricultural departments in collegiate institutions capable of aiding the work of distinct groups of local authorities charged with the provision of technical education. The collegiate centres established by the several University colleges at Bangor, Leeds, Newcastle, and Aberystwyth had continued to develop and to extend their usefulness as centres of educational energy for the surrounding counties. Further centres had been fully equipped and new agricultural teaching organisations definitely set on foot, on lines more or less similar, at Cambridge, Nottingham, and Reading. In Scotland, where the institution of definite centres was being more slowly developed than in England, several of the south-western counties had continued to make use of the facilities for agricultural instruction offered by the central classes provided, and by the itinerant lecturers supplied for local work by the Glasgow and West of Scotland Technical College. Besides assisting institutions such as the Durham College of Science and the Glasgow Technical College, where lectures on certain forestry subjects were included in the general curriculum, the Board had again been able to repeat the grant towards the cost of the special forestry class established in the University of Edinburgh. An endeavour had been made to continue, although necessarily on a reduced scale, the assistance given to experimental work, and provision had also been made for experiment stations or demonstration plots at each of the Welsh colleges. A beginning in the same direction had been made at Reading. The grants awarded by the Board during the year range from £800, given to the University College of North Wales, at Bangor, the Yorkshire College, Leeds, and the Durham College of Science, Newcastle-on-Tyne, to £25 given to the Dounby Science School, Orkney. In all there were twenty grants, eight being for work in collegiate centres, five for agricultural experiments, three for dairy instruction, one for special cheese research and agricultural experiments, one for forestry work, and two for special classes.

SCIENTIFIC SERIALS.

American Journal of Science, September.—The effect of glaciation and of the glacial period on the present fauna of North America, by Samuel H. Scudder. Statistics of the number of genera and species found in the areas formerly covered by the ice-sheet and the driftless areas respectively, and of the number common to both, would indicate whether the northern fauna had recovered from the effects of glaciation. Tables are given showing this for the Coleoptera, as the best known among insects, which are very sensitive to climatic changes. The conclusion arrived at is that, on the whole, the fauna has nearly or quite recovered from its enforced removal from the Northern States and Canada.—Tertiary and later history of the island of Cuba, by Robert T. Hill. No positive evidences of subsidence after the beginning of Tertiary time could be discovered. Nowhere do the rivers show any revival or other evidence of subsidence below the sea-level, but all have continuous downward cutting sections. On the other hand, some of these streams are now forming delta deposits in places outside their mouths, which is more indicative of present elevation than of subsidence. Since the old folding or orogenic movements occupied at least a small portion of post-Tertiary time, we may reasonably conclude that the periods of uniform uplifting must have taken place at least since the beginning of the Pleistocene. In other words, they are comparatively modern in geologic time—some of them absolutely recent.—Thermoelectric heights of antimony and bismuth alloys, by C. C. Hutchins. The best combination for a thermo-function from these alloys is, for one element, bismuth with from 2 to 5 per cent antimony; and for the other, bismuth with from 5 to 10 per cent. tin. They may be cast into thin leaves as follows: Two pieces of plate glass are smoked slightly, or are very finely ground, and rubbed with plumbago. The metal being melted upon charcoal or under fused sodium chloride, a little pool is found upon one plate, and the other is applied to it as quickly as possible. Leaves thus obtained can be worked with a fine file as thin as 0·03 mm. and are sufficiently tough to stand ordinary treatment.—On the nitrogen content of California bitumen, by S. F. Peckham. Oils from the tunnels in Wheeler's cañon on the south side of the Sulphur Mountain yielded 1·1095 per cent. of nitrogen. These and other oils of this region issue from strata protected from infiltration of rain-water and accompanying oxygen by overlying formations.

Quarterly Journal of Microscopical Science, vol. xxxvi. part 3.—Prof. A. G. Bourne gives an exhaustive account of the structure of *Moniligaster grandis*; and adds a revision of the genus, including diagnoses of some new species. Some good coloured figures of the different species accompany Prof. Bourne's memoir.—Mr. E. W. Macbride has a review of Spengel's monograph on Balanoglossus, and criticises that author's views on the affinities of the Enteropneusta.—Under the name *Monocystis herculea*, Mr. W. C. Bosanquet gives a number of observations on the structure and life history of a large Gregarine found in the earth-worm *Lumbricus herculeus*.

Wiedemann's Annalen der Physik und Chemie, No. 9.—On refractive power and density of dilute solutions, by W. Hallwachs. The increase in the difference of molecular refraction previously observed with increasing dilution is completely explained by the peculiar behaviour of the density. The constitutive influences analogous to dissociation, which find their most characteristic expression in the changes of electric conductivity, have no effect upon the refractive power.—On the motion of dielectric bodies in the homogeneous electrostatic field, by L. Graetz and L. Fomm. Mascart and Joubert, in their development of Poisson's original theory, assume that small bodies placed in a dielectric do not exert any forces upon each other. This is contradicted by experiments upon small bars and plates of dielectric materials introduced into homogeneous fields, which tend to turn their axes and planes respectively into a direction parallel to the lines of force. When the condenser plates are statically charged, the rotations depend upon the sign of the charge, but in the case of oscillations they are always in the same direction and proportional to the square of the difference of potential. A small disc, made of sulphur or paraffin, suspended between the plates may be used as a "dielectric voltmeter."—On electric oscillations of long duration and their effects, by H. Ebert. The author investigates the conditions of obtaining the best luminous effects of the type of those produced by Tesla. He points out that the secondary circuit must be turned to the primary, and that the condensers must have the least possible capacity. He describes a "luminescence lamp" made of a glass globe containing a piece of luminous paint. Oscillations are conducted to tinfoil armatures on the globe, and produce vivid luminescence. The light effects were about one-thirtieth or one-fortieth of the amyl-acetate standard. The energy consumed counted by millionths of a watt, so that the economy of the new lamp is very striking, consuming as it does only about a two-thousandth of the energy consumed by the acetate lamp. The difficulty involved in the fact that the high frequency currents employed could not be conducted any distance without encountering enormous inductive resistances, could be got over by effecting the transformation in the immediate neighbourhood of the lamp. Since only condensers of small capacity and inductance are required, a transformer might be attached to the lamp itself.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 21.—"On the Evolution of the Vertebral Column of Fishes." By Dr. H. Gadow, F.R.S., and Miss E. C. Abbott.

The following are a few of the more important points in the paper:—Each skleromere lies within the influence or range of action of two successive myomeres. Taken as a whole, the skleromere is "interprotovertebral," more correctly bi-protovertebral, because it is composed of two successive sklerotomes, namely, the ventral half of one and the dorsal half of a second.

Consequently, the "resegmentation" or "neugliederung" is brought about in a manner fundamentally different to that hitherto supposed to have taken place. If A and B mean two successive sklerotomes, a and b their dorsal, α and β their respective ventral halves, then the new skleromere is composed of $b + \alpha$ and not of $\frac{A + B}{2}$.

The formation of a skleromere by the combination of alternating dorsal and ventral halves of sklerotomes explains also the presence of eight (four pairs) cartilaginous pieces, namely, basalia (so-called dorsal and ventral arches) and interbasalia (so-called intercalary pieces) for each complete segment.

Concerning the formation of centra or bodies of the vertebræ, we distinguish:—

I. *Chorda-centra, i.e.* centra cut out of the full of the chordal sheath, which itself has been strengthened by invasion of cartilaginous cells from the skeletogenous layer. Chorda-centra are possessed by all Elasmobranchs, potentially by Dipnoi and Holocephali.

II. *Arch-centra, i.e.* centra formed by the skeletogenous mass which remains entirely on the outside of the chordal sheath, which latter takes no share in their formation: osseous Ganoids and Teleostei.

Chorda-centra and arch-centra represent two different modes of development, each starting from an acentrous condition. This can be expressed as follows:—

Chordal sheath remaining entirely cordagenous.	Chordal sheath strengthened by invasion of skeletogenous cells, therefore with possibility of chorda-centra.
Cyclostomata.	
Cartilaginous Ganoids.	Dipnoi and Holocephali.
Formation of Centra.	
Osseous Ganoids, Teleostei.	Elasmobranchs.
ARCH-CENTRA.	CHORDA-CENTRA.

The formation of chorda-centra being independent of the arcualia explains how and why the number of "centra" does not necessarily agree either with that of the arcualia or with that of the trunk-segments, *e.g.* Hexanchus and tail of most other Elasmobranchs.

In *Amia calva*, the *postcentrum, i.e.* the posterior, archless disk of a complete tail-vertebra, is formed by the interdorsalia and interventralia of the same sklerotome, while the *precentrum, i.e.* the arch bearing disk or anterior half is formed by the basidorsals of the same sklerotome and the basiventrals of the next previous sklerotome. The intermuscular septum runs obliquely across the precentrum, or, in other words, the precentra are bi-protovertebral or bi-myomeric, but not the postcentra.

In *Lepidosteus* the combination of parts into one vertebral complex is superior to that of Amia, because each vertebra belongs, with its entire anterior half, to one, and with its posterior half to the next following myomere. The vertebræ are now truly bi-protovertebral or bi-myomeric.

PARIS.

Academy of Sciences, September 10.—M. Lœwy in the chair.—Truffles (*Terfas*) from Tunis and Tripoli, by M. Ad. Chatin. Truffles have been received by the author from Tunis belonging to the species *Terfezia Claveryi*. They seem always to occur in company with a herb called by the natives *Arong-Terfess*, which is *Helianthemum sessiliflorum*, Pers. (*Cistus sessiliflorus*, Desf.). Truffles similarly received from Tripoli are classed as *Terfezia Boudieri*.—On the equations of mechanics, by M. Wladimir de Tannenberg.—On Pfaff's problem, by M. A. J. Stodolkievitz.—On another determination of the circle derived from seven right lines and on some of its applications, by M. Paul Serret.—On Diptera harmful to cereals; observations from the Paris Entomological Station in 1894, by M. Paul Marchal. *Cecidomya destructor* (Say) has been very prevalent among wheat in the West. Oats have hitherto been considered proof against Hessian fly, but a form of Cecidomya has ravaged large districts in 1894. It remains to be seen whether this fly is a new species or only a variety of *Cecidomya destructor* modified by the difference of food. Other pests noted which have caused serious damage are the following: *Cecidomya* (*Diplosis*), *tritici* (Kirb.), *Oscinis pusilla* (Meig.), *Camarota flavitarsis* (Meig.), which has not heretofore been considered as injurious to cereals, and *Elachiptera cornuta* (Meig.).—On the recent fall of aeroliths in Greece, by M. C. Maltézos.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—An Introduction to Physical Measurements: Dr. F. Kohlrausch, translated by Waller and Procter, 3rd edition (Churchill).—A Naturalist on the Prowl: "Eha" (Thacker).—Primer of Hygiene: Dr. E. S. Reynolds (Macmillan).—Elements of Marine Surveying: Rev. J. L. Robinson, 2nd edition (Macmillan).—Theophrastus of Eresus on Winds and on Weather Signs, translated, &c., by J. G. Wood (Stanford).—Missouri Botanical Garden, Fifth Annual Report (St. Louis).—Municipal Technical School and Municipal School of Art, Manchester, Session 1894-5, Syllabus (Manchester).—The Earth: E. W. Small (Methuen).

PAMPHLETS.—Creameries and Infectious Diseases: Dr. J. J. Welpley (Baillière).—The Cretaceous Rim of the Black Hills: L. F. Ward (Chicago).—Principes et Méthodes d'Étude de Corrélation Geologique au Moyen des Plantes Fossiles: L. F. Ward (Chicago).

SERIALS.—Proceedings of the Society for Psychical Research, Part xxvi. Vol. x. (K. Paul). Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie, Achtzehnter Band, 5 Heft and Neunzehnter Band 2 and 3 Heft (Leipzig, Engelmann).—Journal of State Medicine, August (Renshaw).—Journal of the Franklin Institute, September (Philadelphia).—Museum d'Histoire Naturelle des Pays Bas, tome xiv. Catalogue-systematique, &c.: F. A Jentink (Leide, Brill).—Quarterly Journal of Microscopical Science, August (Churchill).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1894, Part 1 (Philadelphia).—Insect Life, Vol. vi. No. 4 (Washington).—Journal of the Royal Horticultural Society Vol. xvii. Parts 1 and 2 (117 Victoria Street).—Psychological Review September (Macmillan).—Abstract of the Proceedings of the Linnean Society of New York for the Year ending March 27, 1894, No. 6 (New York).—American Historical Register, No. 1 (Philadelphia).—Economic Journal, September (Macmillan).

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THURSDAY, SEPTEMBER 27, 1894.

THE WORKS OF HENRY J. S. SMITH.

The Collected Mathematical Papers of Henry John Stephen Smith. 2 vols. Edited by Dr. J. W. L. Glaisher. (Oxford: Clarendon Press, 1894.)

THE long looked for collected papers of Prof. H. J. S. Smith, late Savilian Professor of Geometry in the Jniversity of Oxford, have now appeared in two handome quarto volumes issued by the Clarendon Press at)xford. This fact is, as far as England is concerned, he mathematical event of the year, and is of the utmost mportance to mathematicians in general, and to the ising race of investigators in pure mathematics in paricular. The work has a portrait on the frontispiece, nd is introduced by a biographical sketch by Dr. Charles I. Pearson, and recollections by Prof. Jowett, Lord Bowen, Mr. J. L. Strachan-Davidson, and Mr. Alfred Robinson, also by an introduction by Dr. J. W L. Glaisher. A perusal of the sketch is calculated to greatly npress the reader with the all-round scholarship and ntellectual eminence of its subject. To have gained, mongst other honours, the Ireland University Scholarhip, and subsequently to have become one of the most rofound and rigorously exact mathematicians the world as ever known, implies the possession of powers of mind hat must fill any chronicler or student of past events ith amazement. There are men who will succeed in ny line of life or branch of study by sheer mental trength; they have the faculty of becoming fascinated y any pursuit in which inclination, force of circumtances, or accident leads them to engage; with them tudy is intense concentration leading, through a flood of ew ideas, to such an admiration for and interest in the ubject, of whatever kind, as can only be experienced by nother in some special branch for which his mind is articularly and peculiarly adapted.

That Prof. Smith was such a man, was the general elief of his contemporaries. Prof. Conington said to he biographer, "I do not know what Henry Smith may be t the subjects of which he professes to know something; ut I never go to him about a matter of scholarship, in a ne where he professes to know nothing, without learning nore from him than I can get from anyone else."

At one time it appeared to be probable that he would evote himself to chemical science, but, looking back, here seems to be little doubt that pure mathematics was he branch of knowledge towards which he felt himself nost attracted, and which was in reality best adapted o call forth his grand powers for close and accurate hinking, and to give scope to his brilliant imagination.

The recollections are of great interest. They show learly the extent to which he was admired and loved by hose who were privileged to know him best. Dr. Glaisher's introduction is chiefly, though not wholly, of nathematical interest, and will be further alluded to. The works set forth were published between the years 851 and 1883. They may be considered as arranging hemselves under four heads: (1) Theory of numbers; 2) elliptic functions; (3) geometry; and (4) addresses. Space merely permits me to note some of the original contributions to science which stand forth pre-eminently, and helped to build up a great reputation.

During the years 1859 1865 was produced the "Report on the Theory of Numbers," compiled for the British Association for the Advancement of Science. Prof. Smith said of Clifford that he was "above all and before all a geometer"; so of him it may be said that he was above all and before all an arithmetician, and that the Report could not have come under a stronger hand. It contains an account, confessedly not exhaustive, of the state of knowledge at the date of writing. There is interpolated in the history of the science, as it was originated by Gauss and Legendre, and developed by Cauchy, Jacobi, Lejeune-Dirichlet, Eisenstein, Poinsot, Kummer, Kronecker, and Hermite, a considerable amount of masterly criticism as well as original work. He considers the higher arithmetic to be comprised of two principal branches, the theory of congruencies and the theory of homogeneous forms. It will be observed that he does not include the combinational or partitional analysis. He doubtless did not regard this important subject as a branch of arithmetic proper, but rather as occupying the ground intermediate to arithmetic and algebra. It is, in point of fact, far less abstruse and less dependent upon methods which are regarded as purely arithmetical. In the future, however, it is probable that it will be recognised that the combinational analysis is able to throw quite unexpected light on the theory of congruencies, and is worthy of being considered as an important instrument of research in arithmetic proper. As an example it may be stated that the enumeration of certain permutations on a circle yields the number

$$\frac{1}{n} \Sigma \phi(d)\, x^{\frac{n}{d}},$$

where x and n are any positive integers, d a division of n, and $\phi(d)$ the totient of n; and hence

$$\Sigma \phi(d)\, x^{\frac{n}{d}} \equiv o \bmod n$$

a congruence which includes several of the elementary results of the theory of numbers. The author's intention was to present the theory of homogeneous forms in the following order:—(1) Binary quadratic forms; (2) binary cubic forms; (3) other binary forms; (4) ternary forms; (5) other quadratic forms; (6) forms of order n decomposable into n linear factors. It is much to be regretted that only the first of these was given in the report. A consideration of the remaining divisions seems to have convinced him that much remained to be done, and he appears to have deferred these matters for future investigation by himself. The solution of the so-called "Pellian Equation" is of primary importance in the theory of quadratic forms of positive and not square determinant, and we find in the foot-note of p. 193, vol. i. "There does not seem to be any ground for attributing either the problem or its solution to Pell." This is particularly interesting to those who were privileged to listen to Prof. Mittag Leffler's paper on automorphic functions, which was read before Section A of the British Association at Oxford. The Professor inveighed against the too common practice of associating mathematicians' names with theories and theorems on the ground that mistakes are of frequent occurrence and necessarily so;

he instanced the use made by Poincaré of the names of Fuchs and Klein in regard to theories, priority in respect of which those eminent men would be the first to repudiate. In the present instance we find that the problem of the "Pellian Equation" was proposed by Fermat and solved by Lord Brouncker, and these facts need not detract in the least from the reputation earned by Pell by his skill in the Diophantine analysis.

In the solution of the problem of the "Composition of Quadratic Forms," Prof. Smith introduces the important notion of fundamental sets of solutions of indeterminate systems of equations, and thus replaces Gauss' purely synthetical solution by analysis. In the arrangement of the genera of quadratic forms into classes he extends to irregular determinants the principles employed by Gauss for the case of regular determinants.

Gauss' geometrical representation of forms of a negative determinant is given at length. Klein has recently, in the lectures on mathematics delivered before the Evanston Colloquium in the autumn of 1893, given a remarkably simple statement of the method, and has introduced the expressions "line lattice" and "point lattice" to describe the diagrams. He also has extended the method to forms of positive determinant in the *Göttingen Nachrichten* for January 1893. To this the reader's attention may be directed as elucidating and amplifying Prof. Smith's statement of the work of Gauss. Klein's lecture VIII. (Evanston) should also be referred to in connection with the theory of complex primes and the ideal numbers of Kummer.

On the completion of the report, his attention was directed to the subject of ternary quadratic forms. At the time an important memoir by Eisenstein had appeared, in which were defined the ordinal and generic characters of ternary quadratic forms of uneven determinant; but several of the results were left undemonstrated. Prof. Smith supplied the omissions, and extended the results to the more difficult and complicated case of the even determinant. By giving a table for forming the complete generic character of any form, he accomplished for the ternary theory that which had been already carried out by Lejeune-Dirichlet for the binary theory. He gave, moreover, a demonstration of the criterion for distinguishing between possible and impossible generic characters. This he was enabled to do by the important new notion of a certain particular generic character, termed by him "the simultaneous character of a form and its contravariant," which had not been regarded by Eisenstein. He gave a more complete definition of a "genus" of forms as dependent upon transformation by substitutions, and showed that two forms are or are not transformable into one another according as their complete generic characters do or do not coincide. He proved the formulæ which assign the weight of a given genus or order both for even and uneven discriminants. This he accomplished by a comparison of two expressions, obtained by different methods, for the limiting ratio of the sum of the weights of the representations, by a system of forms representing the classes of any proposed genus, of all the numbers contained in certain arithmetical progressions and not surpassing a given number, to the sesquiplicate power of the given number when that number is indefinitely large. This paper is one of great power, constituting one of his most important contributions to science.

The above was followed by another great work "On the Orders and Genera of Quadratic Forms" containing more than three indeterminates. This paper will always be a celebrated one in the history of mathematics. It contains under date 1867, implicitly, the solution of the problem proposed fifteen years later for the Grand Prix des Sciences Mathématiques by the French Academy. The problem referred to was given as "Théorie de la décomposition des nombres entiers en une somme de cinq carrés." In the paper of 1867 it was indicated that the four, six, and eight-square theorems of Jacobi, Eisenstein and Liouville were deducible from the principles set forth. He then completed Eisenstein's "enunciation" of the five-square theorem by bringing under view the numbers which contain a square divisor, and added the corresponding seven-square theorem. The demonstrations were not given, but a general theory, which includes these theorems as corollaries, was given in detail. On these facts being pointed out to Hermite, a correspondence ensued, which the reader will find given, with comments, in the introduction by Dr. Glaisher. The result was that Prof. Smith sent in his demonstrations, and that ultimately the prize was divided between him and M. Hermann Minkowski, of Königsberg. The latter memoir followed closely the lines of the paper of 1867, a fact which gave rise at the time to much discussion concerning the action that was taken by the French Academy. The prize memoir is the concluding paper of vol. ii.

Passing over, for want of space, other arithmetical work of much value, a few words may be said concerning the papers on elliptic functions, which constitute the bulk of the second volume.

The paper, "Mémoire sur les équations modulaires," contains a theory of singular beauty. Mathematicians were aware, thanks to profound researches of Kronecker and Hermite, of the intimate relations that exist between the theory of binary quadratic forms of negative determinant and the transformation of elliptic functions, but beyond Kronecker's elliptic function solution of the "Pellian Equation," no association had been discovered between the binary quadratic forms of positive determinant and the elliptic functions.

In this paper it is shown that if

$$F(k^2, l^2) = 0$$

be the modular equation for the transformation of order N, the Cartesian equation

$$F(\tfrac{1}{2} + X + iY, \tfrac{1}{2} + X - iY) = 0$$

is a curve which gives an exact image of the complete system of forms of positive determinant N. By the simple process of enumerating the spirals and the convolutions of each spiral, he determines the number of non-equivalent classes and the complete system of "reduced" forms in each class.

In "Notes on the Theory of Elliptic Transformation" will be found a complete discussion of the case in which the modular equation has equal roots; it is shown that the squares of the corresponding multipliers are always different, and that this is consistent with Kœnigsberger's theorem, which states that the multiplier is a rational function of the squares of the moduli. The latter is shown, in fact, to break down when the modular equation has equal roots.

The long memoir on the Theta and Omega Functions was originally written as an introduction to the long-expected "Tables of the Θ Functions." It may be regarded as an advanced work on elliptic functions, in which the arithmetical treatment is given the prominent place. The theory of the transformation, and in particular of the modular equations and the associated curves, is exhibited with remarkable elegance.

Everywhere the treatment is characterised by extreme rigour. In fact, the subject matter, dealt with in these volumes, leads to work of so recondite a nature that only an investigator to whom any slurring over of difficulty, or exceptional case is absolutely repulsive, can expect to make a real advance. Those who look chiefly to results, and do not care to know the precise circumstances under which they exist, may be warned off the monument to Prof. Smith's genius which is given to the world in these pages.

On two principal occasions Prof. Smith found opportunity to place his views on mathematics in general before the scientific world. We have the valedictory address to the London Mathematical Society, delivered in the year 1876, on his retiring from the office of president. He took as his text some "comparatively neglected regions of pure mathematics"; and now, after an interval of eighteen years, it is a matter of great interest to re-survey the ground and estimate the advances that have been made. In the theory of numbers, then as always the subject of his predilection, he called attention to the state of knowledge with respect to (1) the theory of homogeneous forms; (2) the theory of congruences; (3) the determination of the mean or asymptotic values of arithmetical functions. With respect to quadratic forms of four or more indeterminates, he referred to the fundamental theorem of M. Hermite concerning the finiteness of the number of non-equivalent classes of forms having integral coefficients and a given discriminant; and to the researches of Zolokoreff and Korkine on the minima of positive quadratic forms. In a foot-note also he referred to his own great work "On the Orders and Genera of Quadratic Forms containing more than Three Indeterminates." These three papers mark the extent to which the inquiry had been pushed at that time. The latter is much the most important, and, so far as I know, but little further progress in the same direction has since been made. In the theory of congruences an important advance has been made by G. T. Bennett, in a paper published in the *Phil. Trans. R S.* vol. 184A. The investigation is "On the Residues of Powers of Numbers for any Composite Modulus, Real or Complex." Remarking that primitive roots exist only when the modulus is a power of an uneven prime or the double of a power of an uneven prime, and that a primitive root may be said to "generate" by its powers the complete set of residues, Bennett exhibits the mode of formation, and the relations connecting, the most general set of numbers capable of generating the $\phi(m)$ numbers which are prime to any composite modulus m, and extends his results to complex numbers.

Prof. Smith gave an historical account of our knowledge of the series of prime numbers. Prof. Sylvester has made a considerable contraction of Tchébychef's limits, and has established important general principles in connection therewith.

Passing on to the discussion of the transcendency of e and π, it may be noted that since the address was delivered (in fact, six years subsequently) the question has been triumphantly set at rest for ever by the labours of Hermite and Lindemann. The former established the transcendency of e, and the latter, standing on the shoulders of the former, demonstrated the transcendency of π. Lindemann's proof shows that π cannot be the root of any algebraic equation, and marks a distinct epoch in the history of mathematical science. The death-blow was thus given to the circle squarers in 1882 (*Math. Ann.* vol. xx.). Quite recently extraordinarily simple proofs of the transcendency of both numbers have been given by Hilbert. Prof. Smith noted and lamented the want of advanced treatises in English on various branches of pure mathematics. Our position to-day in this respect exhibits a marked improvement. On differential equations, theory of functions, integral calculus, theory of numbers, important works by English and American authors have been published, and certain eminent mathematicians are known to be engaged in the preparation of advanced works, which will shortly appear and further fill in the gaps.

Prior to the above, in 1873, was delivered the address to the Mathematical and Physical Section of the British Association. Remarking on the recent appearance of Maxwell's "Electricity," he observes: "It must be considered fortunate for the mathematicians that such a vast field of research in the application of mathematics to physical inquiries should be thrown open to them at the very time when the scientific interest in the old mathematical astronomy has for the moment flagged, and when the very name of physical astronomy, so long appropriated to the mathematical development of the theory of gravitation, appears likely to be handed over to that wonderful series of discoveries which have already taught us so much concerning the physical constitution of the heavenly bodies themselves." Mathematical astronomy to-day, it may be said, no longer flags. Thanks to the work of Hill, Poincaré, and Gylden, the subject has received a new impulse, and the world of science watches with intense interest the process of its evolution under the powerful hands of these mathematicians.

Prof. Smith had much at heart the organisation of scientific education as influencing the supply of scientific men. He asserts the importance of assigning to physics a very prominent place in education. He gives as his opinion that from the sciences of observation the student "gets that education of the senses which is after all so important, and which a purely grammatical and literary education so wholly fails to give." These are weighty words when we consider the all-round attainments of their author, and that he was, in particular, a classical scholar of the first rank. The effect of these volumes on the progress of research is sure to be considerable. A student will have before him work whose style has never been surpassed, and demonstrations which are absolutely rigorous. In the latter respect Gauss' work seems to have left a lasting impression upon his mind.

I conclude by quoting the noble words from the British Association address:—

"But in science sophistry is impossible: science knows no love of paradox; science has no skill to make the worse appear the better reason; science visits with a not long-deferred exposure all our fondness for preconceived opinions, all our partiality for views that we have ourselves maintained, and thus teaches the two best lessons that can well be taught—on the one hand the love of truth, and on the other sobriety and watchfulness in the use of the understanding."

P. A. MACMAHON.

ABSTRACT GEOMETRY.

Grundzüge der Geometrie von mehreren Dimensionen und mehreren Arten gradliniger Einheiten in elementarer Form entwickelt. Von Guiseppe Veronese. (Leipzig: Teubner, 1894.)

MODERN speculations on the Foundations of Geometry have raised the question of the character of Geometry as a science, and the question has been answered in different ways. Some writers have held that our space-intuition is an absolute guarantee of the truth of geometrical axioms; others have treated Geometry as a science of observation and experience, whose results accordingly are liable to the same kind and degree of inexactness as any other Physical Science. If either of these answers were correct, the method of Geometry would seem to require revision. The method is to deduce the properties of figures by logical processes from definitions and a few propositions (Axioms) assumed in advance. But if space-intuition were a sufficient guarantee for the truth of the Axioms, it would seem to serve equally well for a guarantee of the truth of many of the Propositions, and there would appear to be no good reason for assuming as few as possible and deducing the rest. If, again, Geometry is to be purely a Natural Science, there would be simplicity in proving its propositions by the help of well-made constructions and good instruments of measurement. There seems to be room for a third view of Geometry as an abstract formal science to which the method always known as geometrical would be proper and natural. In such a view abstraction might be made of all space-intuition, and there would remain a body of logical truths in which the Axioms would occupy the place of Definitions or well-defined Hypotheses. The science would be at the same time founded upon intuition and independent of intuition. If its Definitions and Hypotheses are never in contradiction with themselves, or with each other, or with our space-intuition, then will its conclusions always be verified within the limits of exactness that belong to observation. It will be a formal science ready for practical applications.

The theory of Abstract Geometry in the sense just described is the subject-matter of Prof. Veronese's treatise. He lays down in his Preface the nature of Geometrical Axioms as the simplest truths of space-intuition: he describes the character of a system of Axioms in that they must be independent, as few as possible, and yet sufficient for the establishment of the properties of figures without tacit assumption of other axioms. No definition or axiom is satisfactory which contains any notion not previously cleared up, or anything to be afterwards deduced. Any geometrical figure regarded as existing in the space of intuition may be replaced by a well-defined mental object or "Form," in the sense of the word fully described in the Introduction. The geometrical axioms are replaced by hypotheses serving to discriminate among possible forms or possible formal relations. Intuition is taken as a guide to the choice of hypotheses. The distinction is drawn between Abstract Geometry and its practical applications, and it is pointed out that there may be axioms of great importance for the latter which are useless restrictions in the former: such axioms are that the space of intuition is the Euclidean space form, and that the space of intuition has three dimensions. For our author all conceivable space forms are in theory equally admissible, and the number of dimensions of space is unlimited. The straight line, the plane, space of three or n dimensions, are all regarded as existing in the General Space. His method is the method of Pure Geometry, and his work is free from any trace of axes, coordinates, and Algebraic processes. Apparently this method has not previously been applied to the discussion of space of more than three dimensions.

A reader who approached Prof. Veronese's book in the hope of finding a logical development in purely Geometrical form of the theories of the non-Euclidean Geometry would be disappointed, for the work is throughout subordinated to the Euclidean system; nor would the reader be better satisfied if he sought merely for the logical establishment of the Euclidean system, for it is throughout treated as a limit included in a more general possible system. It is well known that the Euclidean Geometry is the limiting form between the Hyperbolic and Elliptic Geometries, and this is the case whatever more particular character we attribute to either of these Geometries. Hyperbolic Geometries differ with the form chosen for the "Absolute," there are two Elliptic Geometries according as two straight lines have one or two common points. All these systems have Euclid's system as a limit. In the elements of an Abstract Geometry developed in an orderly way we shall be presented time after time with a choice of hypotheses. Our choice at any time will determine to some extent the space form of which we treat. Our series of hypotheses will limit us to a particular space form. If one of our hypotheses is the existence of straight lines, we shall come upon the Euclidean system or a non-Euclidean system having the Euclidean as its limit. We may state at once that Prof. Veronese's hypotheses lead him to a system which, in an absolute sense, is the so-called Spherical Geometry, as distinguished from the Elliptic Geometry proper. According to this system two straight lines cut in two "opposite" points, and the length between opposite points is constant. This, however, is only true in an "absolute sense," the length in question being actually infinite in comparison with any perceivable length treated as a unit. The doctrine of the "actually infinite" is that laid down in the Introduction. The artifice of using two units, the finite or Euclid's unit, and the infinitely great or Riemann's unit, is an essential part of the theory, and is referred to in the title of the book.

Let us now look a little more closely at the abstract development of Geometry as treated by Prof. Veronese. Such notions as "point" and "line" are suggested by simple intuitions; abstractly considered what are they? The point is simply the fundamental element of geometrical forms. It is an axiom that there are different points, but all points are identical. A straight line is a continuous point-system of one dimension, identical in the position of its parts, and determined by two of its points. Here it is to be observed that the straight line is not necessarily determined by *any* two of its points. It is an axiom that any point on the line and any point off the line determine only a single straight line. Hence if there are two or more points on a straight line by which it is not determined, any straight line through one goes through all. So far the Euclidean and non-Euclidean systems are not in any way discriminated. The choice of a system, excluding the Hyperbolic Geometry, is made by means of an hypothesis concerning different units. Let straight lines be drawn from a point, and any length in one of them chosen as a unit. On each of them there will be a "range of the scale" with that line as unit, and, as in the Introduction, there will be points outside the range of the scale. The points within the range of the scale form the finite domain about the point. The points at an actually infinite distance of the first order form the domain of the infinitely great of the first order. There can thus be a number of domains of infinitely great or infinitely small order of the space about a point. Suppose a point A taken on a straight line, and a point R outside it, and let the distance between them be chosen as a unit. Then if we join R to a point B on the line at a finite distance from A, the lines R B, A B are different relatively to the unit; if the distance A B is infinitely great in comparison with A R, they coincide relatively to the unit. The hypothesis which excludes the Hyperbolic Geometry is that two straight lines going from a point which in any domain are different relatively to the unit of that domain will not in any other domain coincide relatively to the unit of that domain, and it is proved that, on this hypothesis, two straight lines joining a point R to points at infinity in opposite directions on a line A B lie in the same straight line through R.

A point-system, defined as a straight line is defined, may be closed or open. In the former case starting from one point, and going through the system continuously in one direction, the point of starting will be ultimately arrived at; in the latter it will never be arrived at. If we assume the straight line open, and make the hypothesis just now described to exclude the Hyperbolic Geometry, we shall come to an absolute Euclidean Geometry. If we assume the straight line closed, but its entire length actually infinite in comparison with a perceivable unit, we shall come to a Spherical or Elliptic Geometry which coincides with the Euclidean in the domain of the perceivable unit about any point. This is the assumption chosen by Prof. Veronese. But there is still a choice open between the Spherical and the properly Elliptic Form. As mentioned above, the former is chosen by means of the hypothesis that a straight line contains pairs of points by which it is not determined. This hypothesis is adopted to avoid the kind of complication which occurs in the Elliptic Geometry, and which may be associated with the statement that the plane of the Elliptic Geometry is "unifacial" in the sense in which that word is used in Geometry of Position; but it is pointed out that for the purpose of obtaining a system including Euclid's as a limit, the hypothesis is a pure convention.

We have described the foundations of Prof. Veronese's system at considerable length, because it is by these that his system must be judged. For the subsequent developments it will be almost sufficient to say that they are clear and orderly, and, in places, very interesting. The construction of the plane by means of a pencil of rays meeting a straight line, leads to the essential properties of the plane and of plane figures. The like method by means of the "star" of rays from a point outside a plane to points on the plane, leads to the properties of figures in space of three dimensions. The word Star (*Stern*) is introduced in place of the older Sheaf of rays (*Strahlen-Bündel*). The construction of space of four dimensions is made by means of a star of rays from a point outside a space of three dimensions to the points within it, and so on for a space of any number of dimensions. Abstractly considered there cannot be in the nature of the case any restriction of Geometric Forms to space of three dimensions. All the forms—the straight line, plane, &c.—are treated first as Euclidean and afterwards as "complete" in the sense of the Spherical Geometry above described. The Euclidean forms first considered are regarded as the parts of the complete forms in the domain of the perceivable unit.

The use of more than one unit precludes the application to geometric magnitude of the axiom V of Archimedes; but there is another principle which has frequently been supposed to lie at the basis of Geometry with which our author also dispenses, we refer to the Principle of Superposition, or Motion without Deformation. He points out that, although this principle has been very extensively used as the test of equality, it yet involves in its statement the notion of equality, albeit in a limited form, and, as a test of equality, it is thus without meaning in an abstract sense. By placing the notion of equality of geometric magnitudes, or, as he says, identity of figures, on a different footing, he is enabled to prove the equality of congruent and symmetric figures, and to establish the idea of motion without deformation by means of continuous systems of identical figures.

The reader will see that the purpose of the book is not didactic, but the author hopes to produce a book adapted for learners, founded on the principles laid down, but limited to the Euclidean domain of a single unit. We shall look forward with much interest to its appearance. The indictment of Euclid is perhaps not yet complete, as almost every advance in Geometry throws light on some weakness in his logic, or defect in his method; but it is not too much to say that no well-reasoned didactic treatise on Elementary Geometry has yet appeared. In the meantime those who have studied the subject in the existing defective works will do well to clear their ideas by reading at least some parts of Prof. Veronese's.

A. E. H. L.

THREE GREAT EMPIRES.

Primitive Civilisations; or, Outlines of the History of the Ownership in Archaic Communities. By E. J. Simcox. Two vols. (London: Swan Sonnenschein and Co., 1894.)

THE two stout volumes which represent the work before us cover so wide a field, that it is practically impossible to enter into any detailed criticism of their contents. All that it is possible to do within the limits of a review is to give a summary of the facts and arguments which they contain, and to remark in general terms on the views of the authoress.

Beginning in chronological order, Miss Simcox opens with a description of the civilisation of ancient Egypt, and no plainer evidence can be afforded of the great strides which have of late been made in Egyptology than that which is supplied by her book. Until quite modern times Herodotus may be said to have been the chief authority on Egyptian history; but the recent excavations, and the increased and increasing power which the key of the hieroglyphics has placed in our hands, has opened a new and wide knowledge of much that relates to ancient Egypt. One primary point on which Miss Simcox dwells has yet to be proved to demonstration. This is the question—whence and by what route or routes the earliest Egyptians reached the banks of the Nile? It is generally admitted that they were immigrants from Asia, and three roads leading to the land of the Pharaohs were therefore open to them. Some have supposed that, having wandered to the south of Arabia, they crossed into Egypt in the neighbourhood of the Straits of Bab-el-Mandeb; others hold that the route across the Red Sea to Kosseir was the one which they followed; and yet others are of opinion that they crossed by the Isthmus of Suez. Against this last route there is much to be said; but one fact which Miss Simcox mentions appears to give it some support. As has lately been shown by Dr. Terrien de la Couperie, the Chinese word for "north" originally signified nothing more nor less than "back," and the name of the "south," "the front." In the case of the Chinese these terms are peculiarly appropriate, since having entered the country of their adoption from the north, that point of the compass would be at their back, with the south fronting them. The early Egyptians, Miss Simcox tells us, applied precisely the same terms, "back" and "front," to Lower and Upper Egypt, and these expressions would, at first sight, lend colour to the theory that the Egyptians, like the Chinese, entered the new country from the north. It is possible that some fresh discovery may throw a new light on this problem, and until it does we must be content to possess our souls in patience.

We may say at once that Miss Simcox's book is extremely interesting. The facts are marshalled in good order, and her literary style is clear and graphic. The portion of her work which will probably attract the greatest share of attention is that in which she draws comparisons between the early histories of Egypt and China. Many of the details of Egyptian history in the earliest times find parallels among the primitive Chinese States. The hereditary princes of Egypt find their counterparts in the feudal princes of China; while the book of Kaquimna and the lessons of Ptah-hotep remind one irresistibly, both in matter and manner, of the Chinese classics. Both countries were essentially democratic in their institutions; in both high offices were open to all, and the voice of the people was in matters of administration the ultimate court of appeal. These and many other points of agreement are dwelt upon by Miss Simcox at some length; while, at the same time, she has reproduced from the pages of Maspero, Lepsius, Erman, Birch, Eisenlohr, Griffith, and others, a full and graphic account of the manners and customs of the ancient dwellers by the Nile.

The civilisation of Babylonia follows after that of Egypt, and much that the authoress says about it points inevitably to a close connection between the two empires.

As yet we are not in a position to say which is the earliest; and this is another point upon which it is necessary to suspend one's judgment. Comparatively little at present is known of that great centre of culture in Babylonia. And it may be, as Miss Simcox seems to imply, that the primitive civilisations all sprang from a common nursery between Khotan on the east and the sources of the Karun on the west. So far as China is concerned, we have preserved in the literature of the country far fuller and more complete information, and Miss Simcox has therefore been able to fill a whole volume with matters pertaining to the people of the Flowery Land. Of course, all her information is second-hand, and, fortunately, she has for the most part consulted trustworthy authorities. So much, however, cannot be said of some few of the works from which she occasionally quotes, and the result is that the picture she draws is on some points more ideal than real. She has taken the Chinese too much at their own estimate, and has accepted their high-sounding professions as representing solid verities. In this way she has succeeded in throwing a *couleur de rose* over everything Celestial.

According to her, the people are everywhere well-to do, justice is evenly administered, honesty prevails, education is universal, and even girls up to a certain age enjoy the same educational privileges as their brothers. A practical acquaintance with the country makes large inroads on these deductions. To anyone who has passed beyond the neighbourhoods of the treaty ports into the interior, it is manifest that the great bulk of the people live perpetually on the verge of starvation. The least failure of crops or disturbance of trade produces wide spread misery and destitution, and the want of intercommunication, which Miss Simcox does not regard as serious, is consequently one of the most pressing needs of the empire. The administration of justice is an open shame, and the provision, of which Miss Simcox approves, by which criminals are compelled to confess their guilt before punishment can be inflicted upon them, is productive of great cruelty and flagrant wrong. As to education, it has recently been officially stated by the Commissioner of Imperial Customs at Chefoo, that in the surrounding province—the province of Confucius and Mencius—only about 30 per cent. of the men can read and write; "of these, 2 per cent. can compose well, 8 per cent. fairly well, and 10 per cent. conduct commercial correspondence, while the knowledge of the remaining 10 per cent. is very slight. Of the women, a very few, belonging to the richest families (perhaps 500 in the whole province), can read and write a little, but the number of those who can even read at all is small, being, if anything, over-estimated at 1 in 1000."

In a work dealing with such wide and far-reaching subjects, it is quite impossible that an author should not occasionally be led astray. Truth compels us to admit that Miss Simcox is not an exception to this rule, but she has yet succeeded in producing an extremely interesting and able work, and one which sums up with clearness the current knowledge we possess of the civilisations of these three great empires.

OUR BOOK SHELF.

Celestial Objects for Common Telescopes. Vol. ii. By the late Rev. T. W. Webb. Fifth edition. Revised and enlarged by the Rev. T. E. Espin, M.A., F.R.A.S. Pp. 280. (London: Longmans, Green, and Co., 1894.)

WE have already noticed (NATURE, vol. xlix. p. 339) the first volume of this edition of Webb's famous "Celestial Objects." The volume under review completes the work. All astronomers are familiar with this guide to the starry heavens, and most are agreed in thinking that the preparation of a new edition could not have been placed in better hands than Mr. Espin's. It is always a risky proceeding to put new wine into old bottles, nevertheless, in the case before us, an analogous task has been successfully accomplished. Substantial additions have been made in the new volume. All double stars having primaries above magnitude 6·5, and distances less than twenty seconds of arc, have been included. After lists of the binary and double stars in each constellation stars with remarkable spectra are placed. With the latter are arranged variable stars, and then follow the positions and descriptions of conspicuous nebulæ and clusters. Altogether the volume contains the places of 2272 double stars, 629 stars with remarkable spectra, and 276 nebulæ; a total of 3177 objects. The Right Ascensions and Declinations have been brought up to 1900.

It is almost unnecessary to commend the book to practical astronomers, for they are all acquainted with its merits. Certainly no possessor of a workable telescope can dispense with this trustworthy guide to celestial sights.

Ponds and Rock-Pools, with Hints on Collecting for, and the Management of, the Micro-Aquarium. By Henry Scherren. (London: The Religious Tract Society, 1894.)

THE chapters of this little book appeared originally in the *Leisure Hour*, but have been, we are told, "considerably enlarged and very carefully revised." The work is divided into six chapters, devoted respectively to the subjects of "Pond and Rock-Pool Hunting," "The Beginnings of Life," "Sponges and Stinging Animals," "Worms," "Starfish, Anthropods, and Molluscs," and "The Micro-Aquarium." The author has a pleasant, straightforward style, and has avoided as far as possible the use of high-sounding names and language calculated to deter his unscientific readers from taking up the study of the contents of "Ponds and Rock-Pools." His task has been made considerably easier by the insertion in the text of some sixty-six very creditable figures, and he has produced a book full of helpful hints to the young collector, and one which should, we think, have the effect of causing many to strive to know more about the hidden beauties of nature. The general get-up of the book is everything that could be wished.

Newfoundland as it is in 1894: A Handbook and Tourist's Guide. By Rev. M. Harvey, LL.D., F.R.S.C. (London: Kegan Paul, 1894.)

THIS book does not require a lengthy notice in these columns, being interesting more from a commercial than a scientific point of view. The author, who has lived for more than forty years in the colony, is evidently quite an enthusiastic lover of Newfoundland, and has written this handy volume for the purpose of making the country better known, and attracting to it the attention which it deserves, and which the author considers it has failed to receive in the past. Mr. Harvey has certainly done his best to alter this condition of things, and has brought together in a readable form a great deal of information respecting the physiography and topography of the island, its roads and railways, agricultural resources and forest wealth, minerals, fisheries, characteristics of the people, and other facts likely to be of service to the intending visitor or settler.

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 Logic of Weismannism.

SOME time ago, when I read an account of Prof. Weismann's experiment on the larvæ of blow-flies, as described in his Romanes lecture, a criticism of it occurred to me, which I have recently communicated to Mr. Herbert Spencer. This was that in the experiment the quantity of food (flesh) was diminished, while the nature of it remained the same; whereas in the case of bees it is well known that the difference between the food of the worker larvæ and the royal larvæ is one of quality, not of quantity. The royal food is pollen, and is highly nitrogenous, while the food of the worker larvæ is chiefly honey. In the case of Termites, Grassi has found that the fertile individuals are fed during development on the secretion of the salivary glands of other individuals, while the sterile forms are supplied only with macerated wood-dust.

But I was not aware, until I procured the printed version of the lecture, that Weismann had actually mentioned facts proving the importance of nitrogenous food in relation to the reproductive organs of the blow-fly. He seems serenely unconscious that these facts, mentioned in the notes to his lecture, entirely neutralise the force of his argument in the text. In note 11 he states that his blow-flies when abundantly fed on carrots and sugar, laid no eggs for more than a month, but as soon as meat was supplied they sucked it greedily, and laid a great number of eggs a week afterwards. In later experiments, when the flies were fed from the first with sugar and meat juice, the deposition of eggs commenced ten days after the metamorphosis. Weismann infers that rich food is necessary in the imago stage if the egg-cells are to ripen, and adds that in the case of bees the queen lays eggs because supplied with nitrogenous food in the imago state, while the workers are poorly fed. These remarkable facts concerning the relation between egg-laying and nitrogenous food in the adult blow-fly strongly suggest that if the larvæ were deprived of nitrogenous food during development, the ovaries would not be perfectly developed.

Weismann contends that the bee has the specific property of responding to imperfect nutrition in the larval state by the imperfect development of the ovaries. As proof of this, he states that blow-fly maggots occasionally starved, but fed exclusively on meat like those which were not starved, laid normal eggs in normal abundance, and were only smaller in size. The evidence is quite irrelevant. The point is that the larva of the worker-bee is supplied with a non-nitrogenous diet, that of the queen bee with one highly nitrogenous. What is required is evidence that the larva of the blow-fly can fully develop its ovaries when deprived of nitrogenous food. Instead of this, Weismann supplies the information that the blow-fly when reared on a restricted quantity of nitrogenous food, can lay eggs if further fed with proteids in the imago stage, but if deprived of proteids in the imago stage it lays no eggs. Of the anatomical condition of the reproductive organs in the flies experimentally reared no evidence is vouchsafed.

Plymouth, September 15. J. T. Cunningham.

"Darwinism is not Evolution."

I was very much struck—having heard the admirable reply which Prof. Huxley gave to Lord Salisbury on the evening of August 8—to find a passage in "Darwin's Life and Letters" (vol. iii. p. 13) which is the exact counterpart of the chief point in Huxley's retort. Darwin writes to Lyell (March 12, 1863): "I must feel convinced that at times . . . you have as completely given up belief in immutability of specific forms as I have done. . . . The more I work the more satisfied I become with variation and natural selection, but that part of the case I look at as less important, though more interesting to me personally."

It was whispered in Oxford that Huxley had spoken of Darwinism rather lightly in comparison with evolution. The above-quoted passage shows that even in this respect Darwin himself had set the example.

I have reason to believe that these illustrious examples will not be very generally followed. A. A. W. H.

Utrecht, September 11.

Extraordinary Phenomenon.

Having recently had before me your number of the 6th inst.,[1] I feel very desirous to bring under your notice, for insertion in your journal, the description of a most extraordinary and singular phenomenon as was observed by me at Llanberis, N. Wales, on Sunday, August 26 last, about 10.30 p.m.; especially as I perceive that the time of my observation coincides precisely with the time recorded in that number by John W. Earle, at Gloucester, describing his observation of a remarkable meteor which he discovered.

I was outside the hotel in Llanberis at 10.30 p.m. admiring the lustre of the stars—for it was a cloudless night—when, gazing upwards into the region of Cassiopeia, I was startled by a sudden flash from a brilliant effulgence of white light situated proximately to the two stars of greatest magnitude in that constellation, which immediately resolved itself into a clearly defined disc, about three times the diameter of Jupiter. After a brief interval I observed a body of brilliant orange colour discharged from the disc, which was projected directly towards Perseus. This body assumed a form resembling an elongated flatfish, but terminating in a point, the disc forming a nucleus to the apparition, which was marvellous to behold; but its visibility proved to be only of short duration, for the white disc, or nucleus, suddenly disappeared, leaving the orange-coloured mass quiescent for about half a minute, and then I saw it fade away gradually, and it vanished out of my sight.

The appearance of this strange body did not occupy more than five minutes of time; its dimensions in length I estimated was about fifteen degrees of arc. I likewise noticed an important fact—that it evidenced no motion in space.

During my professional career, including Arctic and Equatorial services, a great part was spent in nightly watchings, in which all sorts of meteoric phenomena came under my notice, yet I never beheld one which manifested such marked singularity and distinctiveness combined. I could only regret that no one was at hand to affirm what I saw.

With reference to the meteor observed by John W. Earle in Ursa Major, I wish to mention that a building excluded that constellation from my sight, therefore it establishes a very interesting and important fact that these two extraordinary phenomena, one in Ursa Major, the other in Cassiopeia, were so distinctly noticed by two observers so remote from each other at the very same moment.

Erasmus Ommanney, Admiral.

29 Connaught Square, W., September 24.

"Aurelia aurita."

At the Plymouth Laboratory, in July last, I examined 383 adult specimens of *Aurelia aurita*, and found eight specimens (2·08 per cent.) showing a numerical variation in the generative sacs and buccal arms.

One specimen with 3 generative sacs, 3 buccal arms, and 9 tentaculocysts. Three specimens with 3 generative sacs, 3 buccal arms, and each one has traces of a fourth generative sac and a fourth arm. Two have 8 tentaculocysts, and one has 10 tentaculocysts. One specimen with 5 generative sacs, 5 buccal arms, and 8 tentaculocysts. Three specimens with 6 generative sacs, 6 buccal arms; two have 11 tentaculocysts, and one has 12 tentaculocysts. Six specimens with the normal number of buccal arms and generative sacs show a variation in the size and shape of the sacs. There appears to exist a correlation between the generative sacs and buccal arms, but the tentaculocysts vary independently of the other organs.

I found 87 specimens (22·8 per cent.) showing a variation in the number of tentaculocysts. Twenty specimens possess less than the normal number, and the remainder show an excess. The range of variation extends from 6 to 15 tentaculocysts.

Edward T. Browne.

University College, London, September 15.

Science in the Medical Schools.

In the issue of Nature of September 20, I notice a table of the scientific classes which are to be given in the medical schools of Great Britain during the session 1894–95. In this table I find that the subject of "biology or zoology" is indicated by a cross (×) as being taught in all the medical schools of Scotland with the exception of the University of Aberdeen. You will, doubtless, allow me to point out that in this matter Aberdeen is in precisely the same position as Edinburgh and Glasgow. A course of zoology is delivered in the University of Aberdeen in the winter session, and a second course in the summer session, and there is, in addition, a course of practical zoology.

University, Aberdeen. H. Alleyne Nicholson.

ON THE DOCTRINE OF DISCONTINUITY OF FLUID MOTION, IN CONNECTION WITH THE RESISTANCE AGAINST A SOLID MOVING THROUGH A FLUID.

§ 1. The doctrine that "discontinuity," that is to say finite difference of velocity on two sides of a surface in a fluid, would be produced if an inviscid incompressible fluid were caused to flow past a sharp edge of a rigid solid *with no vacant space between fluid and solid* was, I believe, first given by Stokes in 1847.[1]

It is inconsistent with the now well-known dynamical theorem that an incompressible inviscid fluid initially at rest, and set in motion by pressure applied to its boundary, acquires *the* unique distribution of motion throughout its mass, of which the kinetic energy is less than that of any other motion of the fluid with the same motion of its boundary.

§ 2. The reason assigned for the formation of a surface of finite slip between fluid and fluid was the infinitely great velocity of the fluid *at* the edge, and the corresponding negative-infinite pressure, implied by the unique solution, *unless the fluid is allowed to separate itself from contact with the solid.* This an inviscid incompressible fluid certainly would do, unless the pressure of the fluid were infinitely great everywhere except at the edge. In nature the tendency to very great negative pressure arising from greatness of velocity of a fluid flowing round a corner is always obviated by each one of three defalcations from our ideal:—

(I.) Viscosity of the fluid, preventing the exceeding greatness of the velocity.

(II.) Compressibility of the fluid.

(III.) Yielding-ness of the outer boundary of the fluid.

§ 3. Defalcation (I.) is in many practical cases largely operative when air is the fluid; but (II.) is also largely operative in some very interesting cases, such as the whistling of a strong wind blowing round a sharp corner or through a chink; the blowing against the sharp edge in the embouchure of an organ-pipe, and in the mouth-

[1] "Collected Papers," vol. i. pp. 310, 311.

piece of a flageolet or of a small "whistle"; and the blowing across the end of a tube or a hole in the side of a tube, to cause a key or a flute to sound.

§ 4. Defalcation (III.) is largely operative, and (II.) but little, in many practical cases of most common occurrence in the flow of water. It is probable that much of the foam seen near the sides and in the wake of a screw steamer going at a high speed through glassy-calm water, is due to "vacuum" behind edges and roughnesses causing dissolved air to be extracted from the water. A stiff circular disc of 10-inch diameter, and 1/10 of an inch thick in its middle, shaped truly to the figure of an oblate ellipsoid of revolution would cause a vacuum[1] to be formed all round its edge, if moved at even so small a velocity as 1 foot per second under water of any depth less than 63 feet; if water were inviscid: and at greater depths the motion would, on the same supposition, be wholly continuous, with no vacuum, and would be exactly in accordance with the unique minimum energy solution.[2]

While the velocity of the fluid across the equator is 63·7 feet per second, the velocity across each of the two parallel circles whose radii are 4·218 inches (the radius of the equator being 5 inches) is only 1 foot per second.

§ 5. The exceedingly rapid change of shape of the fluid flowing across the equatorial zone between these circles, with velocity at the surface augmenting from 1 foot per second to 63 feet per second in advancing over a distance of less than ·85 of an inch of the surface from one of the small circles to the equator, and diminishing again from 63 to 1 from the equator to the other parallel, in a small fraction of a second of time would, if the fluid is water or any other real liquid, give rise, through viscosity, to forces greatly diminishing the maximum velocity, and causing, through fluid pressure, the motion of the water to differ greatly from that of the minimum-energy solution, not only near the equator, or in its wake, or over the rear side of the disk; but over all the front side also, though no doubt much more on the rear side and in the wake, than on the front side, and in the fluid before it.

The viscosity would also, at less depths than 63 feet, have great effect in keeping down the maximum velocity; and it is possible that even at 10 or 20 feet a greater velocity than 1 foot per second might be required to make vacuum round the equator of our disc of 10 inches diameter and the $\frac{1}{2000}$ of an inch radius of curvature which its elliptic meridianal section gives it. But it seems quite certain that there must be much forming of vacuum, and consequent extraction of air and rising of bubbles, to the surface, from the somewhat sharp corners, and roughnesses, of iron, in the hull of an ordinary iron sailing ship or steamer, going through the water at twelve knots (that is, 20 ft. per second). KELVIN.

(*To be continued.*)

[Correction on previous short article, "Towards the Efficiency of Sails, &c." In last line but two, for 2π substitute $\frac{1}{2}\pi$. In last line but one, delete 4, and for 8 substitute 32.]

[1] Single word to denote space vacated by water.

[2] From the elementary hydrokinetics of the motion of an ellipsoid through an inviscid incompressible fluid, originated by Green, who first gave the solution for the case of translational motion of the ellipsoid, we know that, if θ denoting the angle between the axis of an oblate ellipsoid of revolution, of which the equatorial and polar areas are a, b, the velocity of the fluid flowing over this point of the surface is

$$\frac{(a^2 - b^2)V \sin\theta}{b\left\{b + \frac{a^2}{\sqrt{(a^2 - b^2)}} \sin^{-1}\frac{\sqrt{(a^2 - b^2)}}{a}\right\}},$$

if the velocity of the fluid at great distances from the solid is V, and in parallel lines, and the solid is held fixed in the fluid, with its axis parallel to these lines. Taking $a = 100b$ in this formula, we reduce it to $\frac{200}{\pi} V \sin\theta$ approximately within 1 per cent.; and taking $\sin\theta = 1$, and $V = 1$ foot per second, we find 63·7 feet per second for the velocity across the equator. Hence the gravitational head corresponding to the "negative-pressure" is $(63{\cdot}7^2 - 1^2)/64{\cdot}4$, or very approximately 63 feet, which proves the statement in the text.

SCIENCE, IN SCHOOL AND AFTER SCHOOL.

IT is an unfortunate accident of the conditions under which instruction in science has grown up, that in speaking of science teaching two essentially dissimilar things should be confused. This confusion has very seriously affected—and still affects—the development of method in this country. It arises from the fact that, twenty or thirty years ago at least, the ordinary schoolmaster was quite without the knowledge necessary to teach science, and that even when his scientific knowledge was a measurable quantity, that ignorance of psychology which was and which remains one of his most constant characteristics, rendered him incapable of innovations upon the tradition of mental training he cherished. Consequently what knowledge people obtained of the growing body of science came after the elementary stage of education was over, when their minds and senses had already received a considerable amount of cultivation and were, for good or evil, definitely developed in a prescribed way. The teaching given, therefore, did not aspire to be so much educational as *instructive*; it made the best of a bad job, and without any belated attempts to alter the fundamental intellectual mechanism, placed therein so much of the new facts and views as the circumstances permitted. It was addressed primarily to adolescence and to the adult, its methods were by lecture, diagram and text-book, and the written examination or a practical examination, turning chiefly on the identification of specimens or the interpretation of diagrams, was the adequate measure of its value. Such teaching can affect the taught only through their opinions and knowledge; it can discover scientific capacity, but it can neither develop nor very largely increase it, because it comes too late in the mental life. It is typically represented by the innumerable classes over which the Science and Art Department presides.

On the other hand, we have the science teaching that is *educational*, that takes the pupil still undeveloped and trains hand, eye, and mind together, enlarges the scope of the observation, and stimulates the development of the reasoning power. Such science teaching occurs at present most abundantly in theoretical pedagogics. It is, however, undoubtedly the proper science teaching for the school, if science is to have a place in the school. For it is universally conceded nowadays that the school is a training place, that there the vessel is moulded rather than filled, and that the only justification for the introduction of science is its educational value. Equally indubitable is it that it should be confined to school limits. An attempt to make the adult science teaching educational in the same sense, would be—to complete the image—extremely like putting a well-baked—if imperfect—vessel back upon the potter's wheel.

Now, hitherto the chief influence of this confusion has been to hamper truly educational science teaching in schools. Those who had as adults studied science under the Science and Art Department, or in University lecture theatres, took their text-books and the methods under which they had acquired their knowledge into the school, where the conditions were altogether different. The course of science lessons began as a lecture in which the class listened to colourable imitations at second or third hand of this or that eminent exponent of scientific theory. The more discerning teachers after a time realised the futility of requiring genuine lecture notes from such immature minds, and supplied the deficiency *by dictating* a colourable imitation. They also provided copies on the blackboard for such original sketches as were required, and indeed went to very considerable pains to keep the outward appearance of the lecture system intact. Examiners of schools—being selected without the slightest reference to their capacity to examine—fell very readily into this view, that school science-teaching was adult science-teaching in miniature; as some parents hold that infant costume should be a simple and economical adaptation of the parental garments. And so an elaborate system of lecturing, note dictating, "model answer" grinding, has been evolved, which is not only not educational and a grievous waste of the pupils' energies, but which seriously discredits the claims of science upon the school time, in the eyes of ordinary educated people.

This has been particularly the case in many middle class schools, though the recent abolition of the second class pass in the May examination has done much, as the Forty-first Report of the Department shows, towards mending the mischief. In connection with countless higher grade and small grammar schools, classes, containing as a rule only elementary pupils, and aiming really only at second class passes, have been organised from year to year. Not only was the science-teaching given in the evening classes, but a considerable portion of the daytime was devoted to model answer drill and to mechanical copying out from the text-book. The minimum of apparatus required by the Department formed a picturesque addition to the schoolroom. This discipline resulted in remunerative grants for second class passes, but it resulted in very little else. except perhaps a certain relaxation of the pupil's handwriting and a certain facility in the misuse of scientific phrases. The certificates were framed and glazed, the teacher added a few modest comforts to his home, and there the matter ended.

The examinations of the Science and Art Department were scarcely to blame in this matter, although the blame has been generously awarded them. The Science and Art Department is a large and convenient mark, it is perfectly safe to throw at, and to attack it has something of the romantic effect of David against Goliath. But we must remember that its classes were primarily, as they are still in intention, continuation and adult classes, an outcome of the Mechanics' Institute movement, and it was an unforeseen accident, and one the full bearing of which only became apparent in the course of years, that they should so seriously affect the teaching of middle-class, and even of the higher standards of elementary, schools. For their proper purpose as a test of lecture teaching, the departmental examinations are generally efficient. Far more blameworthy are examining bodies whose work is specially directed to school needs. The College of Preceptors, for instance, while subsidising lecturers upon Educational Theory, has done nothing to promote practical work in schools, and many of its examinations set a premium upon that vicious lecture and text-book cramming which educational theory condemns. And in public schools over which the Department has no influence, young gentlemen from the older universities, beginning educators without of course the faintest knowledge of educational technique, set up precisely the same imitation of the professorial course. We have in consequence such a standing argument against science teaching as that naive testimony of a prominent headmaster, that he found boys who had followed the classical course for some years, and who then took up "science as beginners, speedily outstripped those who, to the exclusion of literary work, had been engaged during the same time in what he regarded as scientific studies.

So far the confusion between the two forms of elementary instruction has hampered science-teaching. But there can be no doubt that the educational reformer is abroad. A large, if somewhat inchoate, body of criticism has grown up, and good resolutions in the matter are epidemic. A really educational scheme of instruction in physics and chemistry now exists, having its base upon the Kindergarten, and developing side by side with elementary work in mathematics. Mr. Earl's recently published book upon Physical Measurements is an admirable exposition of what is here intended by educational science-teaching. In this, information is entirely subordinated to mental development. His course is devoted to the measurement of space, mass and time, and to the observation and methods of recording various changes involving precise determinations. The first exercise requires the pupil to "measure the size or dimensions in inches of the paper on which you are writing, using for your standard a strip of paper one inch in length, and which you have divided into halves, quarters, and eighths"; and the book concludes with experiments upon torsion and the rotation of suspended bodies. The course must inevitably constitute a firm foundation of definite concepts, and develop a clear and interrogative habit of mind. It marks the line along which school science teaching must move in the future, if it is to attain that predominance which its advocates claim for it. Yet at the same time it may not be premature to notice that the new movement has its dangers.

These dangers arise from the confusion between the two distinct forms of science-teaching whose existence is necessitated by the present condition of things. In the past the error has been to treat children like adults; in the future it may be that adults will be treated like children. Such exercises as the one we have noticed, are excellent in developing concepts, but scarcely anything could be devised more irksome and exasperating to a mind already provided with a basis of definite ideas. Nothing, for instance, could be better calculated to discourage an intelligent student of eighteen or nineteen, curious about physics, than a day or so spent in manufacturing an unreliable millemetre scale. The problems of the science are already more or less vaguely in his mind, and there is every reason why these should be made the starting-point. To produce an intellectual parallel to the spiritual re-birth, is as impossible as it would be to refer an unsatisfactory chicken back to the egg to reconsider its ontogeny. We have now, and shall have for an indefinite number of years, to provide for the needs of a great number of people whose intellectual development is nearly or quite at an end, whose curiosity about nature is already aroused, and whose practical needs are also pressing for scientific information, and yet who are ignorant of any but the veriest commonplaces of science. For them the Science and Art Department classes were designed and are well adapted. It will be an unfortunate thing if the criticisms of the educational reformer should so far overshoot the mark as to affect their instruction. Yet one might suggest that a downward age limit, similar to that of the London University Matriculation, might save many a schoolmaster from the temptations of the possibility of grant-earning—a temptation, however, from which the abolition of the second class in the elementary stage has already to some extent relieved him.

H. G. WELLS.

WITH PROF. HEIM IN THE EASTERN ALPS.

THE excursion with Prof. A. Heim, of Zurich, which came to a happy end on September 15 at Lugano, was one full of interest to students of tectonic geology. It afforded those who were fortunate enough to take part a rare opportunity of seeing in the field some of the classic sections with which the name of Heim has been for many years associated, and, better still, of seeing the genial author of the "Mechanismus der Gebirgsbildung" himself climbing his native Alps as nimbly as a chamois, and expounding his own work face to face with the hard facts on which his conclusions have been based. The party, numbering at the outset twenty-three, left Zurich on the 3rd, after the close of the Geological Congress, and took train to Appenzel, spending the first night at Weissbad, a village nestling peacefully beneath the rugged peaks of the Santis Range. This magnificent buttress of the

Eastern Alps consists of a series of steep compressed folds of cretaceous strata rising through the Flysch and Molasse conglomerates that form the lower spurs to the north, and the summit of Säntis is the highest of one of the sharp anticlines of the range. Finer examples of sharp anticlinal peaks and ridges separated by equally acute synclinal gorges it would be difficult to find, and the well-marked petrographical and palæontological character of each zone leave no room for doubt as to the sequence and structure of the different formations. The summit of Säntis (8200 feet) is an overturned anticline of Gault, covered by a thick bed of "Seewerkalk," the highest cretaceous rock in the district, and the structure is exposed in splendid cliff sections on the sides of the peak. Prof. Heim, who is an adept at drawing panoramic sketches, was anxious that we should have an opportunity of verifying his elaborate panorama of the surrounding district, but unfortunately the mist, which had come on, did not clear off the top till the afternoon of the second day, and even then we had only a short glimpse of the glorious view beneath. Two nights were spent in the inn erected by the Alpine Club, a short distance below the observatory on the summit of Santis, and the descent to Wildhaus was made on the north side over a steep path leading across a compressed synclinal fold of Seewerkalk, where a good example was seen of the middle part of a double fold, compressed and drawn out so as to pass almost into a thrust-plane. A better example of the "Verkehrten Mittelschenkel" was, however, seen a few days afterwards in the Mattstock near Amden, where the middle members of a compressed monoclinal fold were found in normal order from Flysch to Neocomian and Gault, but drawn out and evidently much diminished in thickness. At Obstalden, on the Wallen See, a few days were spent among the rocks on either side of the lake, a recent fall of snow having obscured the sections on the higher Alps, which we had intended to visit. One of the most interesting tectonic features of this district is an important thrust-plane, traversing the face of the Leistkamm on the north side of the lake, and repeating the section of cretaceous rocks in the mountain. The thrust-plane forms a barrier to the downward passage of water through the limestones above, and its outcrop is marked by a line of springs, one of which gushes out of the cliff in a large waterfall opposite Muhlehorn. After a visit to the Mürchenstock, with its contorted anticlinal core of Permian Verrucano conglomerate and its wrinkled skin of Jurassic rocks, we made our way southward to Glarus, and the greater part of the last week was devoted to the exploration of the celebrated "Doppelfalte" of the Glärnish, in which the red Verrucano is seen to have been pushed on to the top of Jurassic and Eocene rocks exposed in a series of magnificent mountain sections. At Lochseite, near Schwanden, a few miles south of Glarus, the massive Verrucano is seen projecting in a thick ledge from the hillside over the so-called Lochseitenkalk, a crushed irregular bed of mylonised limestone resembling that found near the great thrust-planes in the North-west Highlands. At Lochseite the thrust-plane is so sharp and clear that a knife could be drawn along between the rocks on either side, and the under-surface of the hard Verrucano is slickened and polished at places as smooth as glass. A full view of this tremendous overthrust was, however, not obtained until we had climbed some 8000 feet to the crest of the Bütistock and Kalkstöckli, between Linthal and Elm, where the sharp-cut and wonderfully straight line of the great displacement was seen in profile crossing from ridge to ridge and peak to peak, and producing a marked feature in the mountain panorama. At one place where the Verrucano has been eroded off, the party rested on the smooth surface of the thrust-plane which forms the crest of the ridge, where they were photographed, with Prof. Heim standing in the midst expounding the classic sections around him. The south wing of the "Doppelfalte," or thrust-plane, was crossed between Elm and Flims at the Segnes Pass, at a height of 8615 feet, and here also the outcrop was seen in stupendous cliff sections. The overlying Verrucano being darker in colour than the limestones below, the line of displacement is everywhere very sharp and distinct. The nummulite limestone, where it approaches the thrust-plane, is drawn out and schistose, and a distinct passage was traced between unaltered nummulites and those only slightly distorted, to a rock in which they were rolled out into ribbons, which, but for the intermediate specimens, could not have been recognised as being of organic origin. The Verrucano itself is also squeezed and schistose, and the pebbles are compressed into augen, surrounded at places by sericite and mica schist. The vast interglacial (?) landslip at Flims, on the Vorder Rhein, was the last of the important objects we visited, and after a passing look at the crystalline rocks of the St. Gotthard Massiv, the party reached Lugano in detachments, where they rejoined the other members of the Congress, all highly pleased with their respective excursions across the Alps, and were greeted on their arrival by a discharge of artillery, followed in the evening by a splendid pyrotechnic display on the lake.

H. M. C.

NOTES.

THE Physical Society, which has for many years met in the Royal College of Science at South Kensington, give notice of some important changes. The Council have, after careful consideration, come to the conclusion that the meetings of the Society would be more accessible to the majority of the members if they were held in some more central situation, and the meetings will therefore henceforward be held on the same day and at the same hour as heretofore, but in the rooms of the Chemical Society, in Burlington House. All communications to the secretaries or other officers of the Society may in future be addressed to Burlington House or to the secretaries at their respective addresses as given in the list of members of the Society. The Council have also decided to initiate the publication of a series of abstracts of papers on physics, but the resources at their command being slender make it necessary to begin cautiously. At first abstracts will only be given of papers which appear in a certain number of the more important foreign magazines. They will for a time be edited by Mr. Swinburne, and will be published regularly at the beginning of each month in the form of a supplement to the Proceedings of the Society. The first number will be issued in January 1895. Should the scheme prove successful it is intended to enlarge its scope. For some time past printed copies of the more important papers have been circulated before the meetings among members who are likely to take part in the discussion on them; it has, however, been felt that cases may arise in which the author may wish that his paper should be published as soon as possible. The Council have therefore decided that, if an author so desires, and if such a course appears desirable, they will take steps to ensure that the publication of a paper is not in any way delayed in order that it may be read before publication, and that they will if necessary postpone the reading and discussion of a paper until after it has been published.

WE are informed that a petition, signed by a number of science masters, has been sent, through Sir Henry Roscoe, to the Secretary of State for War, supporting the Departmental Committee's proposal to introduce a compulsory science subject into the entrance examinations for Woolwich, which, the masters consider, will encourage thorough science teaching in the schools, and be to the advantage of education generally.

The death is announced of Prof. Comm. Ariodante Fabretti, Director of the Historical and Philological Section of the Turin Academy of Science.

The fourteenth annual congress of the Sanitary Institute is taking place this week at Liverpool, and was opened on Monday last by the holding of a reception in the Town Hall by the Lord Mayor of Liverpool, who is also chairman of the local committee. The new president—Sir Francis S. Powell, M.P., —afterwards delivered his inaugural address. In the evening the Lord Mayor opened an exhibition of sanitary appliances. On Tuesday the congress, divided into five sections, resumed its sittings.

The programme for the sixty-sixth annual congress of the German Naturalists and Physicians at Vienna, from September 24 to 30, contained arrangements for no fewer than three addresses by the late Prof. von Helmholtz, all of which were to have been delivered in the general meetings. Dr. F. Klein, the Professor of Mathematics at Göttingen, has undertaken to fill one of the gaps by reading a paper upon Riemann's influence in the development of modern mathematics.

A telegram from St. Paul, Minnesota, through Reuter's special service, on Monday gave notice of the occurrence, on the evening of Friday, September 21, of a very disastrous cyclone in America. A strip of country in Iowa, Minnesota, and Wisconsin, about 200 miles in length, is reported to have been devastated, and not only was immense destruction done to property, but serious loss of life occurred, the number of persons who perished being variously estimated at figures varying from fifty-two to one hundred. The storm was accompanied by hail and torrents of rain, as well as thunder and lightning. Starting ten miles south of Spencer, North-West Iowa, the cyclone swept across the State to the north of Emmetsburg and Algona, almost wiping out of existence the town of Cylinder and laying waste the country districts in its track. Passing by Mason City, it ravaged the country to the north-west of Osage, and then changed its direction somewhat towards the north-east, crossing the Minnesota line and working great havoc in Leroy, where a fire broke out and a whole block of houses was destroyed. The cyclone swept down Spring Valley, and then turned again to the east, wrecking the hamlets of Homer and Lowther. It next crossed the Mississippi and destroyed many farm buildings near Marshland, Wisconsin. Considerable damage was also done at Dodge Centre, though it was not in the path of the main cyclone.

A Central News telegram of September 25 announces that a destructive storm has occurred in Japan, by which the districts of Okita and Twate have been laid waste. Fifteen thousand houses are reported to have been destroyed, and 300 persons to have perished. Great havoc has also been wrought among the shipping.

University College, Dundee, has been benefited to the extent of some £35,000 by the bequest of the late Mrs. Margaret Harris, of Dundee.

Dr. A. Zimmermann has been appointed Extraordinary Professor of Botany at the University of Tubingen; and Dr. Solereder Curator of the Botanical Institute at Munich.

Accounts have been received from Prof. Stirling, F.R.S., of the safe return to Adelaide, South Australia, of the Horn Expedition for the exploration of the central portion of that country, the departure of which was announced in these columns some three months ago (p. 174). We are glad to say that considerable success has attended the whole journey, no doubt in consequence of the foresight with which preparations had been made for it; and though the work of the expedition was at times sufficiently trying, nothing that could be called a misadventure took place. Above all, there was no collision, nor indeed any trouble with the natives; and there had been good rains in the Macdonnell Ranges, the examination of the western termination of which formed the chief work to be done. The course of the expedition is briefly outlined by Prof. Stirling as follows:—From Crown Point the party traversed the Finke River to running water; thence the Palmer River to Tempe Downs, the Levi Range, Petermann Creek, and the George Gilles Range, where one section diverged to Ayers's Rock and Mount Olga, the rest proceeding westward to Lacorie's Creek and northward to Glen Edith, along Carmichael Creek to Mereenie Bluff, thence into the northern watershed following Darwent Creek to Haast's Bluff, and so eastward to Glen Helen. The united party then travelled eastward to Mount Sonder, which was ascended, and thence through the southern ranges of the Macdonnells to the Finke River and Hermannsburg. Here section one again diverged to the Glen of Palms, and another to the North Macdonnells by way of Ellery's Creek and Brinkley's Bluff to Aine Springs, where it was met by the other members of the expedition, some of whom had journeyed thither by Owen's Springs, and others by Stuart's Pass and Burt's Plains. The zoological collections formed are said to be generally good, and it has again been Prof. Stirling's good fortune to discover a new type of Marsupial. This is stated to be about as big as a small rat, with a shrew-like aspect, and a very curious flattened and fat tail. Its scientific description will probably be undertaken by Prof. Baldwin Spencer. Prof. Stirling again met with his old friend *Notoryctes*, but only obtained two examples, one of them being alive, though it soon died, notwithstanding all the care that was taken of it. The rare Alexandra parakeet was also met with; but in one locality only. Some twenty new species of terrestrial mollusks seem also to have been found, and it is expected that about seven or eight new species of plants are contained in the botanical collection, which shows a greatly extended range of many kinds that had before been supposed to be much restricted. An examination of the geological formations is adverse to the hope of metalliferous developments to the southward of the Macdonnell Ranges. It remains to be said that all the journeying was accomplished by the aid of camels, which, as before, proved themselves to be essential agents in the exploration of Central Australia. The mode in which the scientific results of the expedition are to be published is uncertain, and possibly will not be decided until the return to Adelaide of Mr. Horn, who defrayed all, or nearly all, the cost, and is accordingly to be congratulated—together with the several members of the expedition—on the success which has attended an enterprise which has been conducted with so much good spirit.

We learn from the *Botanical Gazette* that an expedition through Eastern Africa for the collection of natural history specimens, and to secure photographs, was intended to start from Pretoria about August 1. Passing through Matabeleland, the extreme western portion of the East African Portuguese possessions, and along the western shore of Lake Nyassa, it expected to reach Zanzibar in about twelve months. The chief attention will be paid to plants and insects.

Dr. A. Baldacci is at present engaged on a botanical expedition in the Balkan Peninsula, with the especial object of exploring the mountain-chains of Albania.

We learn, from the *American Naturalist*, that the University of Illinois is about to open a permanent station on the Illinois River, for the biological study of the flora and fauna of the waters of that State. The laboratory will be established at Havana, and, together with the State Fish Commission, will be under the direction of Prof. S. A. Forbes. Among the problems to be investigated are the effect of the periodical overflow and recession of the river on the abundance, variety, and interaction generally of the various groups of plants and animals represented in those waters.

The following are the subjects for competition for the two Walker Prizes in Natural History, given annually by the Boston (Mass.) Society of Natural History for the next two years:—1895: A study of the "Fall Line" in New Jersey; (2) a study of the Devonian formation of the Ohio Basin; (3) relations of the order Plantoginaceæ; (4) experimental investigations in Morphology or Embryology. 1896: (1) A study of the area of schistose or foliated rocks in the Eastern United States; (2) a study of the development of River Valleys in some considerable area of folded or faulted Appalachian structure in Pennsylvania, Virginia, or Tennessee; (3) an experimental study of the effects of close-fertilisation in the case of some plant of short cycle; (4) contributions to our knowledge of the general morphology or the general physiology of any animal, except man. The memoirs must be written in the English language, and the prizes of the value of 60 and 50 dollars respectively—the competition for which is open to all—will not be awarded unless the memoirs presented are of adequate merit. Each memoir must be accompanied by a sealed envelope enclosing the author's name and superscribed with a motto corresponding to one borne by the manuscript, and must be in the hands of the Secretary on or before the first of April of the year for which the prize is offered.

The French Society for the Encouragement of National Industry has issued a list of prizes to be offered for competition next year in connection with chemical research. The following are among the principal subjects proposed: (1) Recent progress in the manufacture of chlorine; prize, 2000 francs. (2) The utilisation of the residues of manufactories; prize, 1000 francs. (3) A prize of 2000 francs for an experimental study of the physical or mechanical properties of one or several metals or alloys, chosen from those that are in current use. (4) 2000 francs for manufacturing in France, for trade purposes, anhydrous sulphuric acid and "smoking" sulphuric acid. A special note is given with each subject explaining the reasons for which the prize is offered, but it is understood that the money will be withheld in the event of the papers sent in not proving sufficiently interesting.

The Entomological Society will meet on Wednesday, October 3, at 8 p.m., when the following papers will be read:—"Catalogue of the *Pterophoridæ*, *Tortricidæ*, and *Tineidæ* of the Madeira Islands, with notes and descriptions of New Species," by Lord Walsingham, F.R.S.; "Palæarctic Nemouræ," by Kenneth J. Morton.

The majority of the Medical Schools of the metropolis will open on Monday next, and in several instances an introductory address will be dispensed with, and in its place some form of festive gathering will be held. Addresses will, however, be delivered as follows:—At St. George's Hospital, by Dr. Isambard Owen, the dean of the school; at Guy's Hospital, by Mr. Lockhart Stephens; at St. Mary's Hospital, by Dr. Scanes Spicer; at the Middlesex Hospital, by Dr. Boxall; at University College Hospital, by Dr. H. R. Spencer; at Westminster Hospital, by Mr. G. Hartridge; and at the School of Medicine for Women, by Miss M. Sturge. There will be dinners in connection with the following hospitals:—St. Bartholomew's, St. Thomas's, the London, St. George's, King's College, St. Mary's, the Middlesex, and the Westminster. At the Charing Cross Hospital there will be an evening reception, at which the prizes for the year will be distributed by Prof. Alexander Macalister, F.R.S. The Rector of Lincoln College, Oxford, will distribute the prizes at the St. Thomas's Hospital.

Prof. H. Alleyne Nicholson will deliver the Swiney Lectures on Geology on the Mondays, Wednesdays and Fridays of October, taking as his subject "The Making of the Earth's Crust." The lectures, for which no charge for admittance is made, will be delivered at 3 p.m. in the Lecture Theatre of the South Kensington Museum. The Swiney Lecturer for next year is Dr. J. G. Garson.

The eighteenth course of lectures of the Sanitary Institute will be delivered at the Parkes Museum, Margaret Street, W., at 8 p.m. on each Monday, Wednesday, and Friday of this autumn, from Wednesday, October 17, when the opening lecture, which is specially intended for those desirous of becoming sanitary officers, will be delivered. The secretary of the institute will be happy to supply full information respecting the lectures.

The following popular science lectures will be delivered at the Royal Victoria Hall, Waterloo Bridge-road, S.E., during the coming month:—October 2, on "Hearing," by Prof. W. D. Halliburton; October 9, on "Wonders in Nature," by Mr. R. Kerr; October 16, on "The Work of the Air on the Earth," by Mr. F. W. Rudler; October 30, on "Light, what it is and how it is measured," by Prof Carlton Lambert. There will also be a lecture on October 23, but the subject has yet to be decided upon. Each lecture will be illustrated by means of the lantern.

The prospectus has been issued of a very elaborate "Systematic Botany of North America," to be published in seventeen vols., by a Board of editors under the presidency of Prof. N. L. Britton. The account of each natural order will be a monograph by a separate author. The area comprised in the "Flora" will be the American continent north of Mexico.

The *Lancet* states that the Queen has been graciously pleased to intimate to Dr. Thorne Thorne, C.B., the principal medical officer of the Local Government Board, her appreciation of the services which have been rendered by the Medical Department of the Board in taking the measures which it has adopted for preventing the entrance of cholera into this country.

A new chemical laboratory, in connection with the Imperial University of St. Petersburg, will be opened next month. The building will contain, in addition to laboratories and a lecture theatre, dwelling accommodation for the professors and their assistants. The cost of erection has been over £25,000, four-fifths of which have been defrayed by the Minister of Education, and the remainder by the University.

A circular has been sent to us announcing the conditional re-starting of our American contemporary *Science*, the publication of which was on March 23 suspended, owing to lack of support. The journal is to be subsidised by the American Association for the Advancement of Science, and by Prof. A. Graham Bell and the Hon. Gardiner G. Hubbard; and provided there be a liberal response to the circular from intending subscribers, the journal will be resuscitated before long.

Prof. Brunchorst has published an account of the laboratory and scientific appliances of the Marine Zoological Station at Bergen. Established in 1892, the station has always been kept open throughout the entire year, the fjords on the west coast of Norway remaining open throughout the winter, and the air temperature seldom falling much below the freezing-point.

The following ode to Helmholtz appeared in *Punch* of last week, and seems to us so admirable that we reprint it:—

HELMHOLTZ.

What matter titles? Helmholtz is a name
That challenges, alone, the award of Fame!
When Emperors, Kings, Pretenders, shadows all,
Leave not a dust-trace on our whirling ball,
Thy work, oh grave-eyed searcher, shall endure,
Unmarred by faction, from low passion pure.
To bridge the gulf 'twixt matter-veil and mind
Perchance to mortals, dull sensed, slow, purblind,
Is not permitted—yet; but patient, keen,
Thou on the shadowy track beyond the Seen,
Didst dog the elusive truth, and seek in sound
The secret of soul-mysteries profound,
Essential Order, Beauty's hidden law!
Marvels to strike more sluggish souls with awe,
Great seekers, lonely-souled, explore that track,
We welcome the wild wonders they bring back
From ventures stranger than an earthly Pole
Can furnish. Distant still that mental goal
To which great spirits strain; but when calm Fame
Sums its bold seekers, Helmholtz, thy great name
Among the foremost shall eternal stand,
Science's pride, and glory of thy land.

From time to time paragraphs appear in the daily papers informing the public that a cure for consumption has been discovered. The last of these so-called discoveries has been heralded in the *Times* (September 14), where it is stated on the authority (?) of the Havas Agency, that a Genoese physician has been able to cure twenty-five out of twenty-seven hopeless cases of consumption by the subcutaneous injection of asses' blood. Strangely enough, the medical papers have remained silent, and we cannot help thinking that it would have been well had the *Times* not been so eager to advertise this mode of treatment before it had gone through the ordeal of medical criticism. The subcutaneous injection of serum of animals into phthisical patients has been extensively tried already and has failed, and it is not likely that asses' serum would have more therapeutic properties than that of dogs or goats, which has proved a failure. It is likely, moreover, that such a premature announcement will do a great deal of harm by raising the hopes of patients and their friends—hopes which are almost sure to be disappointed.

According to news received by the Agent-General for Tasmania, the whale fishery industry of that colony, which for some years past has been in a feeble condition, has recently undergone a revival, whales having been frequently seen on the Tasmanian coasts within the last month or so.

The third annual report of the Department of Agriculture of the Yorkshire College, Leeds, has reached us, and tells of a vast amount of work accomplished during the period under review.—1893–94. The courses of lectures for farmers, &c., and classes for elementary teachers and dairy teachers, and the travelling dairy schools, seem, on the whole, to have been well attended, and the committee has reason for the feeling of satisfaction to which it gives expression. A prospectus of the courses in agriculture for the session 1894–95 is now ready, and may be had of the secretary.

A series of new boron compounds containing fluorine and alcohol radicles, derived from the interaction of boron fluoride and alcohols, are described by M. Gasselin in the September number of the *Annales de Chimie et de Physique*. The mono- and di-fluorine compounds derived from methyl and ethyl alcohol have been isolated in the pure state, and prove to be substances of great chemical activity, affording numerous interesting reactions. When boron trifluoride gas is passed into methyl or ethyl alcohol, strongly cooled by a freezing mixture, the gas is rapidly absorbed and the liquid becomes considerably heated. The reaction occurs in exactly equal molecular proportions, and upon subsequent distillation of the liquid product two main substances are eventually isolated. The first is the di-fluorine compound $B\begin{smallmatrix}F_2\\ OCH_3\end{smallmatrix}$ or $B\begin{smallmatrix}F_2\\ OC_2H_5\end{smallmatrix}$, while the second is a remarkable molecular compound of boron trifluoride with methyl or ethyl ether, $BF_3.(CH_3)_2O$ or $BF_3.(C_2H_5)_2O$. The reaction is quantitatively expressed by the following equation, in which R represents the alkyl radicle:

$$7\,BF_3 + 7\,ROH = B\begin{smallmatrix}F_2\\ OR\end{smallmatrix} + 3\,(BF_3 . R_2O) + 2\,BF_4H + 2\,HF + B(OH)_3.$$

Di-fluor methyl borate $B\begin{smallmatrix}F_2\\ OCH_3\end{smallmatrix}$ distils over as a colourless liquid boiling at 89°. It solidifies in the receiver in the form of long crystals which melt at 41°·5. The analogous ethyl compound boils at 82°, and the crystals melt at 23°. The liquids fume strongly in the air, disseminating suffocating vapours. Water decomposes them with great energy, producing boric acid, fluoboric acid, and the free alcohol. They are insoluble in hydrocarbons, but dissolve with decomposition in alcohol. They are quite permanent in contact with metallic sodium, even under pressure at 100°. Sodium methylate or ethylate, however, react with great energy when brought in contact with them, and if equal molecular proportions are employed, the mono-fluorine compounds are produced.

$$B\begin{smallmatrix}F_2\\ OR\end{smallmatrix} + RONa = B\begin{smallmatrix}F\\ (OR)_2\end{smallmatrix} + NaF.$$

The methyl compound $B\begin{smallmatrix}F\\ (OCH_3)_2\end{smallmatrix}$ boils at 53°, and is a particularly mobile and strongly fuming liquid, which burns with a brilliant green flame, surrounded by a dense white cloud. The ethyl compound is a liquid of similar properties, which boils at 78°. Water decomposes both compounds with some violence and considerable evolution of heat. The molecular compounds of boron trifluoride with methyl and ethyl ether are fuming liquids boiling, respectively, at 126° and 123°, which are likewise energetically decomposed by water. They have been independently prepared by direct union of gaseous boron fluoride with gaseous methyl ether in the one case, and ordinary ethyl ether in the other. The union is instantaneous, and accompanied by considerable rise of temperature in each case. In the case of the formation of the methyl compound a dense cloud is produced the moment the constituent gases come in contact, and the sides of the vessel become covered by hot drops of liquid which rapidly coalesce to form a considerable bulk of the new substance.

The additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis*, ♂) from East Africa, presented by Miss Marion L. Leitch; a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Captain W. Townsend; two Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Mr. L. Watson; two Giant Toads (*Bufo marinus*) from Brazil, presented by F. E. Blaaw, Esq.; twenty European Tree Frogs (*Hyla arborea*) European, presented by Mr. G. B. Coleman; an Ostrich (*Struthio camelus*, ♂) from Africa, a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; a Red-sided Eclectus (*Eclectus pectoralis*) from New Guinea, a Toco Toucan (*Rhamphastos toco*) from Guiana, a Diamond Snake (*Morelia spilotes*) from New South Wales, received in exchange; an African Wild Ass (*Equus taeniopus*, ♂), an Axis Deer (*Cervus axis*, ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

The Accuracy of Astronomical Observations.—At the tenth general meeting of the Association Géodésique Internationale, Prof. Cornu read a paper on the necessity of introducing additional precautions in astronomical observations requiring great accuracy. The subject of the paper was suggested by the interpretation put upon observed variations of latitude. Prof. Cornu first remarked that, while carrying out their experiments on the earth's density some time ago, J. B. Baille and himself found that the constant of gravitation appeared to undergo an annual variation, being a little greater in spring than in autumn. A minute examination of the experimental conditions showed the investigators that this periodic anomaly was purely an apparent phenomenon, and that it was caused by an annual variation in the temperature of the room in which the apparatus was placed. It is impossible not to be struck with the analogy of these results and those of the variations of latitude. In both cases the period is approximately an annual one, and the maxima and minima occur in spring and autumn respectively. The question arises, therefore, whether astronomers have been careful to eliminate all the meteorological causes affecting their results, and whether their claims for marvellous accuracy are not, to some extent, exaggerated. Prof. Cornu has applied the reasoning of the physicist to astronomical observations and instruments. Beginning with the meridian circle, he points out that, on a divided circle one metre in diameter, one-tenth of a second of arc corresponds in round numbers to $\frac{1}{2000000}$ of a metre, or 0.0005 mm., that is, a semi-micron. But numerous metrological experiments have shown that, even under the most favourable conditions, a semi-micron is the limit of precision in differential linear measures on scales one metre long; and to attain this limit, it is necessary to put the scales side by side in a bath having a practically constant temperature. But the circles of meridian instruments are subjected to all sorts of variations, hence it seems affectation to assume that observations made with them are true to one-tenth of a second of arc; yet that assumption is made in the discussion of observations of latitudinal variations. When the spirit-level, the telescope, and the micrometer are criticised from this physical point of view, they are found wanting in the extreme accuracy usually ascribed to them. And, in addition to the innate defects in the parts of a meridian instrument, there are the temperature variations which almost baffle estimation. Several additional precautions should be taken to reduce this vitiating cause. In the first place, the distribution of temperature around and inside the instrument should be frequently determined, so that the proper corrections for refraction could be made. The conductivity of the parts of the instrument ought also to be increased, and made as nearly equal as possible, in order to reduce flexional and torsional effects produced by inequality of temperature. Another improvement would be to reduce the quantity of heat emitted by light-sources in observatories, and, finally, attempts should be made to give the air in the telescope tube the same temperature as that outside; so that systematic errors of refraction might be eliminated. Prof. Cornu thinks it is only by having recourse to precautions of this kind that definite results on the variability of latitudes can be obtained. In the actual state of the observations, he says, two purely physical objections exist against the reality of the phenomenon. They are:—(1) Is it certain that observations of latitude by the Talcott method are free from periodic annual errors due to meteorological influences, particularly to the variation of temperature during different seasons? (2) Can it be demonstrated that the astronomical data used in the preparation of the catalogues of the stars employed in these observations are also free from the errors referred to?

Liverpool Observatory.—In a small pamphlet, published by order of the Mersey Docks and Harbour Board, we have placed before us some extracts from the report of the Director of the Observatory, Mr. W. E. Plummer, to the Marine Committee. The excessive briefness of the extracts in question curtail our remarks very considerably. The transit instrument, for time determinations, has been used on every possible occasion, and the normal clock has been maintained more accurately during cloudy weather by the adoption of separate clock errors and rates for the Bond and Molyneux clocks. The determination of the longitude (not *longtitude*, as is twice printed) of the Observatory has not yet been completed, as the repetition of the signals has not yet been effected, but the inquiry at present indicates a change from previous values, the Observatory acquiring a new position some 400 yards west of the old one. The latitude observations, by the method of transits of zenith stars over the prime vertical, although said to give this quantity with great exactness, are likely to be disappointing when used for discussing the small variation in latitude, for the instrument and its mounting have shown signs of a slight instability. Besides the observations of comets, stellar parallaxes, by the method of chronographic record of meridian transits, have been investigated. The meteorological observations have, as usual, been continued, and the present report contains numerous tables of the results obtained.

The Variable R Lyræ.—The variability of this star was first pointed out by Baxendall in 1856, and its period was stated to be one of forty-eight days. At a somewhat later date Schonfeld, from a few more observations, deduced a forty-six-day period. Generally the observations have been somewhat scarce, but more recently their number has been considerably increased Yendell, Sawyer, Plassmann, and Knopf having been chiefly responsible for these. That the time had arrived when a more thorough investigation of this "lichtwechsel" might be attempted, is the opinion of Herr A. Pannekoek, and the details of his work will be found in *Astronomische Nachrichten*, No. 3252. In the examination of the observations it was soon found out that the period did not appear to remain constant. In the earlier epochs, commencing in 1887 and continuing up to the past year, the numbers indicated clearly a period of about forty-six days, but recently they have somewhat increased. In general, also, it has been noticed that the time for the increase in the light curve is shorter than that for the decrease. Herr Pannekoek concludes, however, from his work, that R Lyræ does not vary its brightness so irregularly as is supposed. He suggests that the observed apparent deviations recorded can be attributed to special errors of observation. He is of opinion, however, that perhaps when many more observations are at hand, we shall be in a far better position to investigate the subject more thoroughly, and to state more definitely through what amplitudes these light variations swing.

The Cleaning of Object-glasses.—Owners of telescopes (refractors) will no doubt be glad to have a few words of practical advice, from one who can speak from long experience, with regard to the cleaning of object-glasses. The advice in question is extracted from an article, by Mr. Brashear, in the September number of *Popular Astronomy*, and we do not hesitate in helping to distribute it. The reader may be rather surprised to hear that the use of fine chamois-skin, tissue-paper, or an old soft silk handkerchief, or "any other such material to wipe lenses, as is usually advised," are not advocated. The reason for this is, not that the materials themselves do the mischief, but that the chief enemy to an object-glass, "dust particles," and these most likely of a siliceous nature, must not on any account be rubbed on the glassy surface. The receipt, in a few words, may be summed up as follows:—If the lenses be dirty or dusty, a tuft of cotton or a camel's-hair brush may be at first applied, but pains should be taken that no pressure be given to either. For further cleaning, a *wooden* bowl, previously washed out with soap and water, should be filled with clean water of approximately the same temperature as the objective. A little ammonia (quantity, a teaspoonful to half a pail of water) should be added to the water. "Cheese-cloth" is strongly recommended as a means of applying the soap to the glass; but this, first, should be "thoroughly washed with soap and water," and thrown away when done with. Plenty of water must always be used. A third or fourth cloth should be used to wipe the objective dry. "Vigorous rubbing will do no harm if the surfaces have no abrading material on them, and I have yet to injure a glass cleaned in this way." If the objective be not taken from the cell, the camel's-hair brush and the soap-and-water process can be still used, and the work finished with a dry cheese-cloth. Mr. Brashear gives good reasons for taking the lenses apart from time to time, and giving them a thorough clean; and he adds that everyone who owns and uses a telescope should be so familiar with his objective that he can take it apart and put it together just as well as the maker of it. In moist climates particularly this should be done frequently.

ON THE MAGNITUDE OF THE SOLAR SYSTEM.[1]

NATURE may be studied in two widely different ways. On the one hand, we may employ a powerful microscope which will render visible the minutest forms and limit our field of view to an infinitesimal fraction of an inch situated within a foot of our own noses; or, on the other hand, we may occupy some commanding position, and from thence, aided perhaps by a telescope, we may obtain a comprehensive view of an extensive region. The first method is that of the specialist, the second is that of the philosopher, but both are necessary for an adequate understanding of nature. The one has brought us knowledge wherewith to defend ourselves against bacteria and microbes which are among the mostly deadly enemies of mankind, and the other has made us acquainted with the great laws of matter and force upon which rests the whole fabric of science. All nature is one, but for convenience of classification we have divided our knowledge into a number of sciences which we usually regard as quite distinct from each other. Along certain lines, or, more properly, in certain regions, these sciences necessarily abut on each other, and just there lies the weakness of the specialist. He is like a wayfarer who always finds obstacles in crossing the boundaries between two countries, while to the traveller who gazes over them from a commanding eminence the case is quite different. If the boundary is an ocean shore, there is no mistaking it; if a broad river or a chain of mountains, it is still distinct; but if only a line of posts traced over hill and dale, then it becomes lost in the natural features of the landscape, and the essential unity of the whole region is apparent. In that case the border-land is wholly a human conception of which nature takes no cognisance, and so it is with the scientific border-land to which I propose to invite your attention this evening.

To the popular mind there are no two sciences further apart than astronomy and geology. The one treats of the structure and mineral constitution of our earth, the causes of its physical features and its history; while the other treats of the celestial bodies, their magnitudes, motions, distances, periods of revolution, eclipses, order, and of the causes of their various phenomena. And yet many, perhaps I may even say most, of the apparent motions of the heavenly bodies are merely reflections of the motions of the earth, and in studying them we are really studying it. Furthermore, precession, nutation, and the phenomena of the tides depend largely upon the internal structure of the earth, and there astronomy and geology merge into each other. Nevertheless the methods of the two sciences are widely different, most astronomical problems being discussed quantitatively by means of rigid mathematical formulæ, while in the vast majority of cases the geological ones are discussed only qualitatively, each author contenting himself with a mere statement of what he thinks. With precise data the methods of astronomy lead to very exact results, for mathematics is a mill which grinds exceeding fine; but after all, what comes out of a mill depends wholly upon what is put into it, and if the data are uncertain, as is the case in most cosmological problems, there is little to choose between the mathematics of the astronomer and the guesses of the geologist.

If we examine the addresses delivered by former presidents of this Association, and of the sister—perhaps it would be nearer the truth to say the parent Association on the other side of the Atlantic—we shall find that they have generally dealt either with the recent advances in some broad field of science, or else with the development of some special subject. This evening I propose to adopt the latter course, and I shall invite your attention to the present condition of our knowledge respecting the magnitude of the solar system; but in so doing, it will be necessary to introduce some considerations derived from laboratory experiments upon the luminiferous ether, others derived from experiments upon ponderable matter, and still others relating both to the surface phenomena and to the internal structure of the earth, and thus we shall deal largely with the border-land where astronomy, physics, and geology merge into each other.

The relative distances of the various bodies which compose the solar system can be determined to a considerable degree of approximation with very crude instruments as soon as the true plan of the system becomes known, and that plan was taught by Pythagoras more than five hundred years before Christ. It must have been known to the Egyptians and Chaldeans still earlier, if Pythagoras really acquired his knowledge of astronomy from them, as is affirmed by some of the ancient writers, but on that point there is no certainty. In public Pythagoras seemingly accepted the current belief of his time, which made the earth the centre of the universe, but to his own chosen disciples he communicated the true doctrine that the sun occupies the centre of the solar system, and that the earth is only one of the planets revolving around it. Like all the world's greatest sages, he seems to have taught only orally. A century elapsed before his doctrines were reduced to writing by Philolaus of Crotona, and it was still later before they were taught in public for the first time by Hicetas, or, as he is sometimes called, Nicetas, of Syracuse. Then the familiar cry of impiety was raised, and the Pythagorean system was eventually suppressed by that now called the Ptolemaic, which held the field until it was overthrown by Copernicus almost two thousand years later. Pliny tells us that Pythagoras believed the distances to the sun and moon to be respectively 252,000 and 12,600 stadia, or taking the stadium at 625 feet, 29,837 and 1492 English miles; but there is no record of the method by which these numbers were ascertained.

After the relative distances of the various planets are known, it only remains to determine the scale of the system, for which purpose the distance between any two planets suffices. We know little about the early history of the subject, but it is clear that the primitive astronomers must have found the quantities to be measured too small for detection with their instruments, and even in modern times the problem has proved to be an extremely difficult one. Aristarcus of Samos, who flourished about 270 B.C., seems to have been the first to attack it in a scientific manner.

Stated in modern language, his reasoning was that when the moon is exactly half full, the earth and sun as seen from its centre must make a right angle with each other, and by measuring the angle between the sun and moon, as seen from the earth at that instant, all the angles of the triangle joining the earth, sun, and moon would become known, and thus the ratio of the distance of the sun to the distance of the moon would be determined. Although perfectly correct in theory, the difficulty of deciding visually upon the exact instant when the moon is half full is so great that it cannot be accurately done even with the most powerful telescopes. Of course, Aristarcus had no telescope, and he does not explain how he effected the observation, but his conclusion was that at the instant in question the distance between the centres of the sun and moon, as seen from the earth, is less than a right angle by 1/30 part of the same. We should now express this by saying that the angle is 87°; but Aristarcus knew nothing of trigonometry, and in order to solve his triangle he had recourse to an ingenious but long and cumbersome geometrical process which has come down to us, and affords conclusive proof of the condition of Greek mathematics at that time. His conclusion was that the sun is nineteen times further from the earth than the moon, and if we combine that result with the modern value of the moon's parallax, viz. 3422·38 seconds, we obtain for the solar parallax 180 seconds, which is more than twenty times too great.

The only other method of determining the solar parallax known to the ancients was that devised by Hipparchus about 150 B.C. It was based on measuring the rate of decrease of the diameter of the earth's shadow cone by noting the duration of lunar eclipses, and as the result deduced from it happened to be nearly the same as that found by Aristarcus, substantially his value of the parallax remained in vogue for nearly two thousand years, and the discovery of the telescope was required to reveal its erroneous character. Doubtless this persistency was due to the extreme minuteness of the true parallax, which we now know is far too small to have been visible upon the ancient instruments, and thus the supposed measures of it were really nothing but measures of their inaccuracy.

The telescope was first pointed to the heavens by Galileo in 1609, but it needed a micrometer to convert it into an accurate measuring instrument, and that did not come into being until 1639, when it was invented by William Gascoigne. After his death in 1644, his original instrument passed to Richard Townley, who attached it to a fourteen-foot telescope at his residence in Townley, Lancashire, England, where it was used by Flamsteed in observing the diurnal parallax of Mars during its oppo-

[1] Address [illegible] before the [illegible] Association [illegible] at its Brooklyn Meeting, August [illegible], by the retiring President, William Harkness.

sition in 1672. A description of Gascoigne's micrometer was published in the "Philosophical Transactions" in 1667, and a little before that a similar instrument had been invented by Auzout in France; but observatories were fewer then than now, and so far as I know J. D. Cassini was the only person beside Flamsteed who attempted to determine the solar parallax from that opposition of Mars. Foreseeing the importance of the opportunity, he had Richer despatched to Cayenne some months previously, and when the opposition came he effected two determinations of the parallax; one being by the diurnal method, from his own observations in Paris, and the other by the meridian method, from observations in France by himself, Romer and Picard, combined with those of Richer at Cayenne. This was the transition from the ancient instruments with open sights to telescopes armed with micrometers, and the result must have been little short of stunning to the seventeenth century astronomers, for it caused the hoary and gigantic parallax of about 180 seconds to shrink incontinently to ten seconds, and thus expanded their conception of the solar system to something like its true dimensions. More than fifty years previously Kepler had argued from his ideas of the celestial harmonies that the solar parallax could not exceed sixty seconds, and a little later Horrocks had shown on more scientific grounds that it was probably as small as fourteen seconds, but the final death-blow to the ancient values, ranging as high as two or three minutes, came from these observations of Mars by Flamsteed, Cassini, and Richer.

Of course the results obtained in 1672 produced a keen desire on the part of astronomers for further evidence respecting the true value of the parallax, and as Mars comes into a favourable position for such investigations only at intervals of about sixteen years, they had recourse to observations of Mercury and Venus. In 1677 Halley observed the diurnal parallax of Mercury, and also a transit of that planet across the sun's disc at St. Helena, and in 1681 J. D. Cassini and Picard observed Venus when she was on the same parallel with the sun; but although the observations of Venus gave better results than those of Mercury, neither of them was conclusive, and we now know that such methods are inaccurate, even with the powerful instruments of the present day. Nevertheless, Halley's attempt by means of the transit of Mercury ultimately bore fruit in the shape of his celebrated paper of 1716, wherein he showed the peculiar advantages of transits of Venus for determining the solar parallax. The idea of utilising such transits for this purpose seems to have been vaguely conceived by James Gregory, or perhaps even by Horrocks; but Halley was the first to work it out completely, and long after his death his paper was mainly instrumental in inducing the Governments of Europe to undertake the observations of the transits of Venus in 1761 and 1769, from which our first accurate knowledge of the sun's distance was obtained.

Those who are not familiar with practical astronomy may wonder why the solar parallax can be got from Mars and Venus, and not from Mercury, or the sun itself. The explanation depends on two facts—firstly, the nearest approach of these bodies to the earth is for Mars 33,874,000 miles, for Venus 23,654,000 miles, for Mercury 47,935,000 miles, and for the sun 91,239,000 miles. Consequently, for us, Mars and Venus have very much larger parallaxes than Mercury or the sun, and of course the larger the parallax the easier it is to measure. Secondly, even the largest of these parallaxes must be determined within far less than one-tenth of a second of the truth; and while that degree of accuracy is possible in measuring short arcs, it is quite unattainable in long ones. Hence one of the most essential conditions for the successful measurement of parallaxes is that we shall be able to compare the place of the near body with that of a more distant one situated in the same region of the sky. In the case of Mars, that can always be done by making use of a neighbouring star, but when Venus is near the earth she is also so close to the sun that stars are not available, and consequently her parallax can be satisfactorily measured only when her position can be accurately referred to that of the sun; or, in other words, only during her transits across the sun's disk. But even when the two bodies to be compared are sufficiently near each other, we are still embarrassed by the fact that it is more difficult to measure the distance between the limb of a planet and a star or the limb of the sun, than it is to measure the distance between two stars; and since the discovery of so many asteroids, that circumstance has led to their use for determinations of the solar parallax. Some of these bodies approach within 75,230,000 miles of the earth's orbit, and as they look precisely like stars, the increased accuracy of pointing on them fully makes up for their greater distance, as compared with Mars or Venus.

After the Copernican system of the world and the Newtonian theory of gravitation were accepted, it soon became evident that trigonometrical measurements of the solar parallax might be supplemented by determinations based on the theory of gravitation, and the first attempts in that direction were made by Machin in 1729 and T. Mayer in 1753. The measurement of the velocity of light between points on the earth's surface, first effected by Fizeau in 1849, opened up still other possibilities, and thus for determining the solar parallax we now have at our command no less than three entirely distinct classes of methods, which are known respectively as the trigonometrical, the gravitational, and the photo-tachymetrical. We have already given a summary sketch of the trigonometrical methods, as applied by the ancient astronomers to the dichotomy and shadow cone of the moon, and by the moderns to Venus, Mars, and the asteroids, and we shall next glance briefly at the gravitational and photo-tachymetrical methods.

The gravitational results which enter directly or indirectly into the solar parallax are six in number, to wit: first, the relation of the moon's mass to the tides; second, the relation of the moon's mass and parallax to the force of gravity at the earth's surface; third, the relation of the solar parallax to the masses of the earth and moon; fourth, the relation of the solar and lunar parallaxes to the moon's mass and parallactic inequality; fifth, the relation of the solar and lunar parallaxes to the moon's mass and the earth's lunar inequality; sixth, the relation of the constants of nutation and precession to the moon's parallax.

Respecting the first of these relations, it is to be remarked that the tide-producing forces are the attraction of the sun and moon upon the waters of the ocean, and from the ratio of these attractions the moon's mass can readily be determined. But unfortunately the ratio of the solar tides to the lunar tides is affected both by the depth of the sea and by the character of the channels through which the water flows, and for that reason the observed ratio of these tides requires multiplication by a correcting factor in order to convert it into the ratio of the forces. The matter is further complicated by this correcting factor varying from port to port, and in order to get satisfactory results long series of observations are necessary. The labour of deriving the moon's mass in this way was formerly so great that for more than half a century La Place's determination from the tides at Brest remained unique, but the recent application of harmonic analysis to the data supplied by self-registering tide gauges is likely to yield abundant results in the near future.

Our second gravitational relation, viz. that connecting the moon's mass and parallax with the force of gravity at the earth's surface, affords an indirect method of determining the moon's parallax with very great accuracy if the computation is carefully made, and with a fair approximation to the truth even when the data are exceedingly crude. To illustrate this, let us see what could be done with a railroad transit such as is commonly used by surveyors, a steel tape, and a fairly good watch. Neglecting small corrections due to the flattening of the earth, the centrifugal force at its surface, the eccentricity of its orbit, and the mass of the moon, the law of gravitation shows that if we multiply together the length of the seconds pendulum, the square of the radius of the earth, and the square of the length of the sidereal month, divide the product by four, and take the cube root of the quotient, the result will be the distance from the earth to the moon. To find the length of the seconds pendulum we would rate the watch by means of the railroad transit, and then making a pendulum out of a spherical leaden bullet suspended by a fine thread, we would adjust the length of the thread until the pendulum made exactly 300 vibrations in five minutes by the watch. Then, supposing the experiment to be made here, or in New York city, we would find that the distance from the point of suspension of the thread to the centre of the bullet was about 39 and 1/8 inches, and dividing that by the number of inches in a mile, viz. 63,360, we would have for the length of the seconds pendulum one-sixteen hundred and twentieth of a mile. The next step would be to ascertain the radius of the earth, and the quickest way of doing so would probably be, first, to determine the latitude of some point in New York city by means of the railroad transit; next, to run a traverse survey along the old Post Road from New York to Albany, and finally, to determine the latitude of some point in Albany. The traverse survey should surely be correct to one part in three hundred, and as the distance between the two cities is about two degrees, the difference of latitude might be determined to about the same percentage of accuracy. In that way we would find the length of two degrees of latitude to be about 138 miles, whence the earth's radius would be 3953 miles. It would then only remain to observe the time occupied by the moon in making a sidereal revolution around the earth, or, in other words, the time which she occupies in moving from any given star back to the same star again. By noting that to within one-quarter of her own diameter we should soon find that the time of a revolution is about 27·32 days, and multiplying that by the number of seconds in a day, viz. 86,400, we would have for the length of the sidereal month 2,360,000 seconds. With these data the computation would stand as follows:—The radius of the earth, 3953 miles, multiplied by the length of a sidereal month, 2,360,000 seconds, and the product squared, gives 87,060.000,000,000,000,000. Multiplying that by one-fourth of the length of the seconds pendulum, viz. 1 6480 of a mile, and extracting the cube root of the product, we would get 237,700 miles for the distance from the earth to the moon, which is only about 850 miles less than the truth, and certainly a remarkable result considering the crudeness of the instruments by which it might be obtained. Nevertheless, when all the conditions are rigorously taken into account, these data are to be regarded as determining the relation between the moon's mass and parallax rather than the parallax itself.

Our third gravitational relation, to wit, that existing between the solar parallax, the solar attractive force and the masses of the earth and moon, is analogous to the relation existing between the moon's mass and parallax and the force of gravity at the earth's surface, but it cannot be applied in exactly the same way, on account of our inability to swing a pendulum on the sun. We are therefore compelled to adopt some other method of determining the sun's attractive force, and the most available is that which consists in observing the perturbative action of the earth and moon upon our nearest planetary neighbours, Venus and Mars. From this action the law of gravitation enables us to determine the ratio of the sun's mass to the combined masses of the earth and moon, and then the relation in question furnishes a means of comparing the masses so found with trigonometrical determinations of the solar parallax. Thus it appears that notwithstanding necessary differences in the methods of procedure, the analogy between the second and third gravitational relations holds not only with respect to their theoretical basis, but also in their practical application, the one being used to determine the relation between the mass of the moon and its distance from the earth, and the other to determine the relation between the combined masses of the earth and noon and their distance from the sun.

Our fourth gravitational relation deals with the connection between the solar parallax, the lunar parallax, the moon's mass and the moon's parallactic inequality. The important quantities are here the solar parallax and the moon's parallactic inequality, and although the derivation of the complete expression for the connection between them is a little complicated, there is no difficulty in getting a general notion of the forces involved. As the moon moves around the earth she is alternately without and within the earth's orbit. When she is without, the sun's attraction on her acts with that of the earth; when she is within, the two attractions act in opposite directions. Thus in effect the centrifugal force holding the moon to the earth is alternately increased and diminished, with the result of elongating the moon's orbit towards the sun and compressing it on the opposite side. As the variation of the centrifugal force is not great, the change of the form of the orbit is small, nevertheless the summation of the minute alterations thereby produced in the moon's orbital velocity suffices to put her sometimes ahead, and sometimes behind her mean place to an extent which oscillates from a maximum to a minimum as the earth passes from perihelion to aphelion, and averages about 125 seconds of arc. This perturbation of the moon's node is known as the parallactic inequality because it depends on the earth's distance from the sun, and can therefore be expressed in terms of the solar parallax. Conversely, the solar parallax can be deduced from the observed value of the parallactic inequality, but unfortunately there are great practical difficulties in making the requisite observations with a sufficient degree of accuracy. Notwithstanding the ever-recurring talk about the advantages to be obtained by observing a small well-defined crater instead of the moon's limb, astronomers have hitherto found it impracticable to use anything but the limb, and the disadvantage of doing so as compared with observing a star is still further increased by the circumstances that in general only one limb can be seen at a time, the other being shrouded in darkness. If both limbs could always be observed, we should then have a uniform system of data for determining the place of the centre, but under existing circumstances we are compelled to make our observations half upon one limb and half upon the other, and thus they involve all the systematic errors which may arise from the conditions under which these limbs are observed, and all the uncertainty which attaches to irradiation, personal equation, and our defective knowledge of the moon's semi-diameter.

Our fifth gravitational relation is that which exists between the solar parallax, the lunar parallax, the moon's mass, and the earth's lunar inequality. Strictly speaking, the moon does not revolve around the earth's centre, but both bodies revolve around the common centre of gravity of the two. In consequence of that an irregularity arises in the earth's orbital velocity around the sun, the common centre of gravity moving in accordance with the laws of elliptic motion, while the earth, on account of its revolution around that centre, undergoes an alternate acceleration and retardation which has for its period a lunar month, and is called the lunar inequality of the earth's motion. We perceive this inequality as an oscillation superposed on the elliptic motion of the sun, and its semi-amplitude is a measure of the angle subtended at the sun by the interval between the centre of the earth and the common centre of gravity of the earth and moon. Just as an astronomer on the moon might use the radius of her orbit around the earth as a base for measuring her distance from the sun, so we may use this interval for the same purpose. We find its length in miles from the equatorial semi-diameter of the earth, the moon's parallax and the moon's mass, and thus we have all the data for determining the solar parallax from the inequality in question. In view of the great difficulty which has been experienced in measuring the solar parallax itself, it may be asked why we should attempt to deal with the parallactic inequality which is about twenty-six per cent. smaller? The answer is, because the latter is derived from differences of the sun's right ascension which are furnished by the principal observatories in vast numbers, and should give very accurate results on account of their being made by methods which insure freedom from constant errors. Nevertheless, the sun is not so well adapted for precise observations as the stars, and Dr. Gill has recently found that heliometer measurements upon asteroids which approach very near to the earth yield values of the parallactic inequality superior to those obtained from right ascensions of the sun.

Our sixth gravitational relation is that which exists between the moon's parallax and the constants of precession and nutation. Every particle of the earth is attracted both by the sun and by the moon, but in consequence of the polar flattening the resultant of these attractions passes a little to one side of the earth's centre of gravity. Thus a couple is set up, which, by its action upon the rotating earth, causes the axis thereof to describe a surface which may be called a fluted cone, with its apex at the earth's centre. A top spinning with its axis inclined describes a similar cone, except that the flutings are absent, and the apex is at the point upon which the spinning occurs. For convenience of computation we resolve this action into two components, and we name that which produces the cone the luni-solar precession, and that which produces the flutings the nutation. In this phenomenon the part played by the sun is comparatively small, and by eliminating it we obtain a relation between the luni-solar precession, the nutation and the moon's parallax, which can be used to verify and correct the observed values of these quantities.

In the preceding paragraph we have seen that the relation between the quantities there considered depends largely upon the flattening of the earth, and thus we are led to inquire how and with what degree of accuracy that is determined. There are five methods, viz. one geodetic, one gravitational, and three astronomical. The geodetic method depends upon measurements of the length of a degree on various parts of the earth's surface, and with the data hitherto accumulated it has proved quite unsatisfactory. The gravitational method consists in determining the length of the seconds pendulum over as great a range of latitude as possible, and deducing therefrom the ratio of the earth's polar and equatorial semi-diameters by means of Clairaut's theorem. The pendulum experiments show that the earth's crust is less dense on mountain plateaux than at the sea coast, and thus for the first time we are brought into contact with geological considerations. The first astronomical method consists in observing the moon's parallax from various points on the earth's surface, and as these parallaxes are nothing else than the angular semi-diameter of the earth at the respective points as seen from the moon, they afford a direct measure of the flattening. The second and third astronomical methods are based upon certain perturbations of the moon which depend upon the figure of the earth, and should give extremely accurate results, but unfortunately very great difficulties oppose themselves to the exact measurement of the perturbations. There is also an astronomico-geological method which cannot yet be regarded as conclusive, on account of our lack of knowledge respecting the law of density which prevails in the interior of the earth. It is based upon the fact that a certain function of the earth's moments of inertia can be determined from the observed values of the coefficients of precession and nutation, and could also be determined from the figure and dimensions of the earth if we knew the exact distribution of matter in its interior. Our present knowledge on that subject is limited to a superficial layer not more than ten miles thick, but it is usual to assume that the deeper matter is distributed according to La Grange's law, and then by writing the function in question in a form which leaves the flattening indeterminate, and equating the expression so found to the value given by the precession and nutation, we readily obtain the flattening. As yet these six methods do not give consistent results, and so long as serious discrepancies remain between them, there can be no security that we have arrived at the truth.

It should be remarked that in order to compute the function of the earth's moments of inertia, which we have just been considering, we require not only the figure and dimensions of the earth and the law of distribution of density in its interior, but also its mean and surface densities. The experiments for determining the mean density have consisted in comparing the earth's attraction with the attraction either of a mountain, or of a known thickness of the earth's crust, or of a known mass of metal. In the case of mountains, the comparisons have been made with plumb-lines and pendulum ; in the case of known layers of the earth's crust, they have been made by swinging pendulums at the surface and down in mines ; and in the case of known masses, they have been made with torsion balances, fine chemical balances, and pendulums. The surface density results from a study of the materials composing the earth's crust; but notwithstanding the apparent simplicity of that process, it is doubtful if we have yet attained as accurate a result as in the case of the mean density.

Before quitting this part of our subject, it is important to point out that the luni-solar precession cannot be directly observed, but must be derived from the general precession. The former of these quantities depends only upon the action of the sun and moon, while the latter is affected in addition by the action of all the planets, and to ascertain what that is we must determine their masses. The methods of doing so fall into two great classes, according as the planets dealt with have or have not satellites. The most favourable case is that in which one or more satellites are present, because the mass of the primary follows immediately from their distances and revolution times, but even then there is a difficulty in the way of obtaining very exact results. By extending the observations over sufficiently long periods the revolution times can be ascertained with any desired degree of accuracy, but all measurements of the distance of a satellite from its primary are affected by personal equation, which we cannot be sure of completely eliminating, and thus a considerable margin of uncertainty is brought into the masses. In the cases of Mercury and Venus, which have no satellites, and to a certain extent in the case of the earth also, the only available way of ascertaining the masses is from the perturbations produced by the action of the various planets on each other. These perturbations are of two kinds, periodic and secular. When sufficient data have been accumulated for the exact determination of the secular perturbations, they will give the best results, but as yet it remains advantageous to employ the periodic perturbations also.

Passing now to the photo-tachymetrical methods, we have first to glance briefly at the mechanical appliances by which the tremendous velocity of light has been successfully measured. They are of the simplest possible character, and are based either upon a toothed-wheel, or upon a revolving mirror.

The toothed-wheel method was first used by Fizeau in 1849. To understand its operation, imagine a gun-barrel with a toothed-wheel revolving at right angles to its muzzle in such a way that the barrel is alternately closed and opened as the teeth and the spaces between them pass before it. Then, with the wheel in rapid motion, at the instant when a space is opposite the muzzle, let a ball be fired. It will pass out freely, and after traversing a certain distance, let it strike an elastic cushion and be reflected back upon its own path. When it reaches the wheel, if it hits a space it will return into the gun-barrel, but if it hits a tooth it will be stopped. Examining the matter a little more closely, we see that as the ball requires a certain time to go and return, if during that time the wheel moves through an odd multiple of the angle between a space and a tooth the ball will be stopped, while if it moves through an even multiple of that angle the ball will return into the barrel. Now imagine the gun-barrel, the ball, and the elastic cushion to be replaced respectively by a telescope, a light wave, and a mirror. Then if the wheel be moved at such a speed that the returning light wave struck against the tooth following the space through which it issued, to an eye looking into the telescope all would be darkness. If the wheel moved a little faster and the returning light wave passed through the space succeeding that through which it issued, the eye at the telescope would perceive a flash of light ; and if the speed was continuously increased, a continual succession of eclipses and illuminations would follow each other according as the returning light was stopped against a tooth, or passed through a space further and further behind that through which it issued. Under these conditions the time occupied by the light in traversing the space from the wheel to the mirror and back again would evidently be the same as the time required by the wheel to revolve through the angle between the space through which the light issued and that through which it returned, and thus the velocity of light would become known from the distance between the telescope and the mirror together with the speed of the wheel. Of course the longer the distance traversed, and the greater the velocity of the wheel, the more accurate would be the result.

The revolving mirror method was first used by Foucault in 1862. Conceive the toothed-wheel of Fizeau's apparatus to be replaced by a mirror attached to a vertical axis, and capable of being put into rapid rotation. Then it will be possible so to arrange the apparatus that light issuing from the telescope shall strike the movable mirror and be reflected to the distant mirror, whence it will be returned to the movable mirror again, and being thrown back into the telescope will appear as a star in the centre of the field of view. That adjustment being made, if the mirror were caused to revolve at a speed of some hundred turns per second, it would move through an appreciable angle while the light was passing from it to the distant mirror and back again, and in accordance with the laws of reflection, the star in the field of the telescope would move from the centre by twice the angle through which the mirror had turned. Thus the deviation of the star from the centre of the field would measure the angle through which the mirror turned during the time occupied by light in passing twice over the interval between the fixed and revolving mirrors, and from the magnitude of that angle together with the known speed of the mirror, the velocity of the light could be calculated.

In applying either of these methods the resulting velocity is that of light when traversing the earth's atmosphere, but what we want is its velocity in space which we suppose to be destitute of ponderable material, and in order to obtain that the velocity in the atmosphere must be multiplied by the refractive index of air. The corrected velocity so obtained can then be used to find the solar parallax, either from the time required by light to traverse the semi-diameter of the earth's orbit, or from the ratio of the velocity of light to the orbital velocity of the earth.

Any periodic correction which occurs in computing the place of a heavenly body, or the time of a celestial phenomena, is called by astronomers an equation, and as the time required by light to traverse the semi-diameter of the earth's orbit first presented itself in the guise of a correction to the computed times of the eclipses of Jupiter's satellites, it has received the name of the light equation. The earth's orbit being interior to that of Jupiter, and both having the sun for their centre, it is evident that the distance between the two planets must vary from the sun to the difference of the radii of their respective orbits, and the time required by light to travel from one planet to the other must vary proportionately. Consequently, if the observed times of the eclipses of Jupiter's satellites are compared with the times computed upon the assumption that the two planets are always separated by their mean distance, it will be found that the eclipses occur too early when the earth is at less than its mean distance from Jupiter, and too late when it is further off, and from large numbers of such observations the value of the light equation has been deduced.

The combination of the motion of light through our atmosphere with the orbital motion of the earth gives rise to the annual aberration, all the phases of which are computed from its maximum value, commonly called the constant of aberration. There is also a diurnal aberration due to the rotation of the earth on its axis, but that is quite small, and does not concern us this evening. When aberration was discovered the corpuscular theory of light was in vogue, and it offered a charmingly simple explanation of the whole phenomenon. The hypothetical light corpuscles impinging upon the earth were thought to behave precisely like the drops in a shower of rain, and you all know that their apparent direction is affected by any motion on the part of the observer. In a calm day, when the drops are falling perpendicularly, a man standing still holds his umbrella directly over his head, but as soon as he begins to move forward he inclines his umbrella in the same direction, and the more rapidly he moves the greater must be its inclination in order to meet the descending shower. Similarly the apparent direction of oncoming light corpuscles would be affected by the orbital motion of the earth, so that in effect it would always be the resultant arising from combining the motion of the light with a motion equal and opposite to that of the earth. But since the falsity of the corpuscular theory has been proved that explanation is no longer tenable, and as yet we have not been able to replace it with anything equally satisfactory based on the now universally accepted undulatory theory. In accordance with the latter theory we must conceive the earth as ploughing its way through the ether, and the point which has hitherto baffled us is whether or not in so doing it produces any disturbance of the ether which affects the aberration. In our present ignorance on that point we can only say that the aberration constant is certainly very nearly equal to the ratio of the earth's orbital velocity to the velocity of light, but we cannot affirm that it is rigorously so.

The luminiferous ether was invented to account for the phenomena of light, and for two hundred years it was not suspected to have any other function. The emission theory postulated only the corpuscles which constitute light itself, but the undulatory theory fills all space with an imponderable substance possessing properties even more remarkable than those of ordinary matter, and to some of the acutest intellects the magnitude of this idea has proved an almost insuperable objection against the whole theory. So late as 1862 Sir David Brewster, who had gained a world-wide reputation by his optical researches, expressed himself as staggered by the notion of filling all space with some substance merely to enable a little twinkling star to send its light to us; but not long after Clerk Maxwell removed that difficulty by a discovery coextensive with the undulatory theory itself. Since 1845, when Faraday first performed his celebrated experiment of magnetising a ray of light, the idea that electricity is a phenomenon of the ether had been steadily growing, until at last Maxwell perceived that if such were the fact the rate of propagation of an electromagnetic wave must be the same as the velocity of light. At that time no one knew how to generate such waves, but Maxwell's theory showed him that their velocity must be equal to the number of electric units of quantity in the electromagnetic unit, and careful experiments soon proved that that is the velocity of light. Thus it was put almost beyond the possibility of doubt that the ether gives rise to the phenomena of electricity and magnetism, as well as to those of light, and perhaps it may even be concerned in the production of gravitation itself. What could be apparently more remote than these electric quantities and the solar parallax? And yet we have here a relation between them, but we make no use of it, because as yet the same relation can be far more accurately determined from experiments upon the velocity of light.

Now let us recall the quantities and methods of observation which we have found to be involved either directly or indirectly with the solar parallax. They are the solar parallax, obtained from transits of Venus, oppositions of Mars, and oppositions of certain asteroids; the lunar parallax, found both directly, and from measurements of the force of gravity at the earth's surface; the constants of precision, nutation, and aberration, obtained from observations of the stars; the parallactic inequality of the moon; the lunar inequality of the earth, usually obtained from observations of the sun, but recently found from heliometer observations of certain asteroids; the mass of the earth, found from the solar parallax, and also from the periodic and secular perturbations of Venus and Mars; the mass of the moon, found from the lunar inequality of the earth, and also from the ratio of the solar and lunar components of the ocean tides; the masses of all the planets, obtained from observations of their satellites whenever possible, and when no satellites exist, then from observations of their mutual perturbations both periodic and secular; the velocity of light, obtained from experiments with revolving mirrors and toothed wheels, together with laboratory determinations of the index of refraction of atmospheric air; the light equation, obtained from observations of the ellipses of Jupiter's satellites; the figure of the earth, obtained from geodetic triangulations, measurements of the length of the seconds pendulum in various latitudes, and observations of certain perturbations of the moon; the mean density of the earth, obtained from measurements of the attractions of mountains, from pendulum experiments in mines, and from experiments on the attraction of known masses of matter made either with torsion balances or with the most delicate chemical balances; the surface density of the earth, obtained from geological examinations of the surface strata; and lastly, the law of distribution of density in the interior of the earth, which in the present state of geological knowledge we can do little more than guess at.

Here then we have a large group of astronomical, geodetic, geological and physical quantities which must all be considered in finding the solar parallax, and which are all so entangled with each other that no one of them can be varied without affecting all the rest. It is therefore impossible to make an accurate determination of any one of them apart from the remainder of the group, and thus we are driven to the conclusion that they must all be determined simultaneously. Such has not been the practice of astronomers in the past, but it is the method to which they must inevitably resort in the future. A cursory glance at an analogous problem occurring in geodesy may be instructive. When a country is covered with a net of triangles it is always found that the observed angles are subject to a certain amount of error, and a century ago it was the habit to correct the angles in each triangle without much regard to the effect upon adjacent triangles. Consequently the adjustment of the errors was imperfect, and in computing the interval between any two distant points the result would vary somewhat with the triangles used in the computation—that is, if one computation was made through a chain of triangles running around on the right-hand side, another through a chain of triangles running straight between the two points, and a third through a chain of triangles running around on the left-hand side, the results would usually all differ. At that time things were less highly specialised than now, and all geodetic operations were yet in the hands of first-rate astronomers who soon devised processes for overcoming the difficulty. They imagined every observed angle to be subject to a small correction, and as these corrections were all entangled with each other through the geometrical conditions of the net, by a most ingenious application of the method of least squares they determined them all simultaneously in such a way as to satisfy the whole of the geometrical conditions. Thus the best possible adjustment was obtained, and no matter what triangles were used in passing from one point to another, the result was always the same. That method is now applied to every important triangulation, and its omission would be regarded as proof of incompetency on the part of those in charge of the work.

Now let us compare the conditions existing respectively in a triangulation net and in the group of quantities for the determination of the solar parallax. In the net every angle is subject to a small correction, and the whole system of corrections must be so determined as to make the sum of their weighted squares a minimum, and at the same time satisfy all the geometrical conditions of the net. Like the triangles, the quantities composing the group from which the solar parallax must be determined are all subject to error, and therefore we must regard each of them as requiring a small correction, and all these corrections must be so determined as to make the sum of their weighted squares a minimum, and at the same time satisfy every one of the equations expressing the relations between the various components of the group.

Thus it appears that the method required for adjusting the solar parallax and its related constants is in all respects the same as that which has so long been used for adjusting systems of triangulation; and as the latter method was invented by astronomers, it is natural to inquire why they have not applied it to the fundamental problem of their own science? The reasons are various, but they may all be classed under two heads. First, an inveterate habit of over-estimating the accuracy of our own work as compared with that of others; and second, the unfortunate effect of too much specialisation.

The prevailing opinion certainly is that great advances have recently been made in astronomy, and so they have in the fields of spectrum analysis and in the measurements of minute quantities of radiant heat; but the solution of the vast majority of astronomical problems depends upon the exact measurement of angles, and in that little or no progress has been made. Bradley, with his zenith sector, a hundred and fifty years ago, and Bessel and Struve, with their circles and transit instruments, seventy years ago, made observations not sensibly inferior to those of the present day, and indeed it would have been surprising if they had not done so. The essentials for accurately determining star places are a skilled observer, a clock, and a transit circle, the latter consisting of a telescope, a divided circle, and four micrometer microscopes. Surely no one will claim that we have to-day any more skilful observers than were Bessel, Bradley, and Struve, and the only way in which we have improved upon the telescopes made by Dollond one hundred and thirty years ago, is by increasing their aperture and relatively diminishing their focal distance. The most famous dividing engine now in existence was made by the elder Repsold seventy-five years ago; but as the errors of divided circles and their micrometer microscopes are always carefully determined, the accuracy of the measured angles is quite independent of any small improvement in the accuracy of the division or of the micrometer screws. Only in the matter of clocks has there been some advance, and even that is not very great. On the whole, the star places of to-day are a little better than those of seventy-five years ago, but even yet there is great room for improvement. One of the commonest applications of these star places is to the determination of latitude, but it is very doubtful if there is any point on the face of the earth whose latitude is known certainly within one-tenth of a second.

Looking at the question from another point of view, it is notorious that the contact observations of the transits of Venus in 1761 and 1769 were so discordant that from the same observations Encke and E. J. Stone got respectively for the solar parallax 8·59 seconds and 8·91 seconds. In 1870 no one thought it possible that there could be any such difficulty with the contact observations of then approaching transits of 1874 and 1882, but now we have found from sad experience that our vaunted modern instruments gave very little better results for the last pair of transits than our predecessors obtained with much cruder appliances in 1761 and 1769.

The theory of probability and uniform experience alike show that the limit of accuracy attainable with any instrument is soon reached; and yet we all know the fascination which continually lures us on in our efforts to get better results out of the familiar telescopes and circles which have constituted the standard equipment of observatories for nearly a century. Possibly these instruments may be capable of indicating somewhat smaller quantities than we have hitherto succeeded in measuring with them; but their limit cannot be far off, because they already show the disturbing effects of slight inequalities of temperature and other uncontrollable causes. So far as these effects are accidental, they eliminate themselves from every long series of observations, but there always remains a residuum of constant error, perhaps quite unsuspected, which gives us no end of trouble. Encke's value of the solar parallax affords a fine illustration of this. From the transits of Venus in 1761 and 1769 he found 8·58 seconds in 1824, which he subsequently corrected to 8·57 seconds, and for thirty years that value was universally accepted. The first objection to it came from Hansen in 1854, a second followed from Le Verrier in 1858, both based upon facts connected with the lunar theory, and eventually it became evident that Encke's parallax was about one quarter of a second too small. Now please observe that Encke's value was obtained trigonometrically, and its inaccuracy was never suspected until it was revealed by gravitational methods which were themselves in error about one-tenth of a second, and required subsequent correction in other ways. Here then was a lesson to astronomers, who are all more or less specialists, but it merely enforced the perfectly well-known principle that the constant errors of any one method are accidental errors with respect to all other methods, and therefore the readiest way of eliminating them is by combining the results from as many different methods as possible. However, the abler the specialist the more certain he is to be blind to all methods but his own, and astronomers have profited so little by the Encke-Hansen-Le Verrier incident of thirty-five years ago that to-day they are mostly divided into two great parties, one of whom holds that the parallax can be best determined from a combination of the constant of aberration with the velocity of light, and the other believes only in the results of heliometer measurements upon asteroids. By all means continue the heliometer measurements, and do everything possible to clear up the mystery which now surrounds the constant of aberration; but why ignore the work of predecessors who were quite as able as ourselves? If it were desired to determine some one angle of a triangulation net with special exactness, what would be thought of a man who attempted to do so by repeated measurements of the angle in question, while he persistently neglected to adjust the net? And yet, until recently, astronomers have been doing precisely that kind of thing with the solar parallax. I do not think there is any exaggeration in saying that the trustworthy observations now on record for the determination of the numerous quantities which are functions of the parallax could not be duplicated by the most industrious astronomer working continuously for a thousand years. How then can we suppose that the result properly deducible from them can be materially affected by anything that any of us can do in a lifetime, unless we are fortunate enough to invent methods of measurement vastly superior to any hitherto imagined? Probably the existing observations for the determination of most of these quantities are as exact as any that can ever be made with our present instruments, and if they were freed from constant errors they would certainly give results very near the truth. To that end we have only to form a system of simultaneous equations between all the observed quantities, and then deduce the most probable values of these quantities by the method of least squares. Perhaps some of you may think that the value so obtained for the solar parallax would depend largely upon the relative weights assigned to the various quantities, but such is not the case. With almost any possible system of weights the solar parallax will come out very nearly 8·809 seconds $\pm$ 0·0057 seconds, whence we have for the mean distance between the earth and sun 92,797,000 miles, with a probable error of only 59,700 miles; and for the diameter of the solar system, measured to its outermost member, the Planet Neptune, 5,578,400,000 miles.

THE METEOR AND METEOR-STREAK OF AUGUST 26, 1894.

THE present year will certainly be remarkable for its large meteors. One of the most brilliant class of these phenomena appeared on January 25, and a fortnight later (February 8) a fireball was seen as a conspicuous object even in the presence of the midday sun, for the time was only 28 minutes after noon. The early evening of February 21 furnished another of these brilliant objects, but the observations were neither numerous nor exact, and all that could be definitely gleaned from them was that the body disappeared at a height of 30 miles over Bolton in Lancashire. On April 22, before daylight had gone, a fine meteor descended over the extreme south-east part of England, crossing the Strait of Dover from Hastings in the direction of Amiens in France. On May 18 a large daylight meteor was observed in Scotland and Ireland. Several additional instances of these striking visitors have been recently recorded, and the Perseids presented a few fine specimens, though the season has been a very cloudy and unpropitious one for all kinds of celestial observation.

The magnificent meteor which forms the subject of this paper, appeared on August 26 at 10h. 20m. It did not owe its parentage to the great Perseid system, for it came too late in the month, and, moreover, its direction of flight is not conformable.

Those fortunate persons who happened to be out of doors at the time named, were startled by a bright lightning-like flash,[1] and naturally looking upwards for the cause, they either saw the end part of a fine meteor, or the dense streak it had projected as a glowing column of phosphorescence upon the dark ground of the sky. This streak was quite a remarkable feature in connection with the meteor, for on three grounds it merits careful consideration—viz. for its duration, for the proper motion it soon exhibited under the influence of the atmospheric current in which it was situated, and for the nondescript shapes it assumed. Before giving any particulars it may, however, be interesting to quote from some of the descriptions.

Mr. H. Corder, Bridgwater, writes that on August 26, 10.20, there was a very interesting meteor, but that its actual descent was unfortunately hidden by a wall. He afterwards, however, saw a bright streak in the position 138° + 62° to 137½° + 58½°. This, as seen with a binocular, soon became crooked, and drifted very slowly, until it finally disappeared at 10.50, half an hour afterwards, at the point 98° + 64°. Mr. Corder adds that this is the longest duration of any meteor-streak he has ever seen.[2]

FIG. 1.—Successive appearances of the meteor-streak as observed by Mr. Corder at Bridgwater.

Mr. S. A. Saunder, Crowthorne, near Wokingham, reports the time as 10.19. The length of the meteor's path, as he observed it, was about 20°; it moved quickly, and left a persistent streak of about 3° in length some 5° above its point of disappearance. This remained visible as a distinct trail for 20 or 30 seconds, and as a decreasing luminous patch at about 185° + 44° for two or three minutes. The path must have slightly preceded ε Ursæ Majoris, and probably crossed 190° + 57°.

A correspondent, writing to the *Daily News* from Wood Green, says that at 10.18 he observed an exceptionally brilliant meteor about the size of a cricket-ball and of a pale blue colour. It appeared near to the foremost star in Ursa Major, and was visible for some seconds. The chief peculiarity in addition to its great brilliancy, was that it left a long broad trail of light in the sky, which remained some time after the meteor had vanished, and then faded away very slowly.

Mr. E. W. Coker, writing from Coventry to the *English Mechanic*, states that at 10.20 he observed a nebulous light in the north-west part of the heavens. Its form was elongated, and he compares it with a dense cluster of star-dust. He saw it first through a window with the naked eye, and brought a telescope to bear upon it, but it had evidently passed its brightest, and was then fading rapidly. Its situation was in 213° + 48°.

Colonel G. L. Tupman has kindly sent me two observations from Harrow, which mutually corroborate each other as to the end point near α Boötis (Arcturus) in azimuth 110° west of south, and altitude 11° or 12°. The streak endured so long that one of the observers got a telescope and watched it for some time. He remarked that the lower part of the streak and Arcturus would have been in the field of his finder together.

Mr. T. M. Dunmur, writing from Trefriw, says:—"The meteor, while excelling in brightness though not in duration of flight any that I have had the good fortune to witness, was in respect of the glowing trail which succeeded quite unprecedented in my experience. It was vividly luminous, and the denser portion at once began to collect in a semicircular shape. This breaking-up absorbed the remainder of the trail, and still clearly visible slowly drifted toward, across, and beyond the 'Milky Way,' when it faded from sight not less than eight minutes from its first appearance."

There are some other descriptions from the Midlands and South of England, but it is singular that no reports have come to hand from North Wales, Cheshire, and Lancashire, over which the region the meteor appeared, and where its brilliancy must certainly have been very great.

[1] The flash was seen by the writer at [illegible] seeking, but the meteor itself and its streak were hidden by a house which obstructs the view of the north-north-west sky.

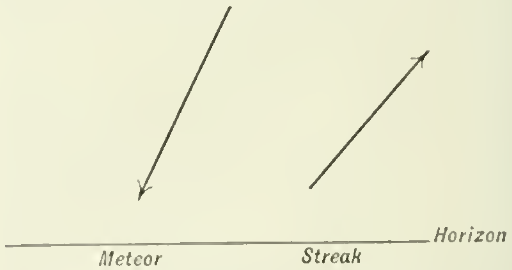
[2] The [illegible] durable streak ever seen by the writer was that of a Leonid fireball which appeared [illegible] November [illegible] at [illegible], and left a visible streak for three-quarters of an hour.

On comparing the various observations together, it is found that they agree much better than is usually the case in a miscellaneous collection of this sort. The real path of the meteor in the air is therefore determinable within very moderate limits of error. The Harrow position near Arcturus for the end part of the streak, offers, however, a discordance with the other observations, and there is reason to suppose that the star α Canum Venaticûm was mistaken for Arcturus. It is necessary for consistency that the azimuth of 110 west of south, as seen from Harrow, should be increased to 132° west of south, when it will be correctly directed towards Denbigh, near which place the meteor streak was situated when first evolved.

When the meteor was first seen it was about 90 miles high and over the river Mersey, at a point 20 miles west of Ormskirk. Passing rapidly almost due south, it ended at a height of 30 miles above Ruthin, Denbighshire. The angle of the meteor's descent was 63°, and the length of its observed path 66 miles. The earth-point is indicated 6 miles south of Llangollen, and the astronomical radiant was at 305° + 79° near the 4½ mag. star κ Cephei. This position is confirmed by a statement of Mr. Corder's, that he saw a few other meteors giving a radiant at 300° + 80°, and believed the large meteor would be found to belong to it, though its direction was not precisely conformable.

The luminous streak was about 9 miles in length, and its central portion 47 miles high over a place 6 miles east-north-east of Denbigh. The direction of its drift was eastwards towards Chester, and it passed over that town at a height of 68 miles, so that it was ascending rapidly in the atmosphere. It disappeared, according to the last view obtained of it by Mr. Corder, at 10.50 with his binoculars, when vertically over a point 2 miles west of Middlewich at a height of 83 miles. The angle of its ascent was 49°, and during the 30 minutes of its visibility it traversed 48 miles, so that its rate of motion was 141 feet per second, or 96 miles per hour. This velocity is about equal to that of one of the most destructive hurricanes possible. The movement of the streak was probably controlled by two influences, the easterly direction being due to a wind current in the upper atmosphere, while its rapid ascent was a necessary consequence of the light gaseous material of which it was composed.

The relative angles of descent of the meteor and ascent of its streak are shown in the following diagram:—



At the time of the meteor's appearance the air appears to have been pretty calm; in the north of England the wind was very slight from east, while in the south the direction was from south. The surface current would therefore appear to have been very different to that at a great altitude.

The radiant of the fireball is not a well-known one for the date, but in 1893 I saw a few meteors during the period from August 4–16 from 310° + 77°, and in 1885, September 4–5, a feeble radiant was seen at 315° + 76°. On September 1, 1878, at 10.20, I observed a very brilliant streak-leaving meteor with a path from 161° + 70° to 155° + 56°, and attributed the radiant as at 315° + 76°. On September 8, 1878, and on September 7, 1888, I saw fireballs, brighter than Venus, that were directed from the same radiant point. There would appear, therefore, to be a well defined shower of large meteors from the northern part of Cepheus at the close of August and beginning of September. Mr. Corder also informs me that on September 8, at 11.3, he saw another fireball descending from 142° + 54° to 144° + 51° in Ursa Major. The same object was seen at Leeds, from which place it was projected on the stars of Aquarius, and there is reason to believe that this brilliant meteor, like that of August 26, and the fireballs of September 1878 and 1888, before referred to, had their derivation from the shower of κ Cepheids.

W. F. DENNING.

THE INDEXING OF CHEMICAL LITERATURE

At the recent meeting of the American Association for the Advancement of Science the Committee on Indexing Chemical Literature presented to the Chemical Section its twelfth annual report. The following is a reprint of an advance copy of the report. During the current year the following bibliographies have been printed in the channels indicated :—

(1) Index to the Literature of Didymium, 1842-1893. By A. C. Langmuir. School of Mines Quarterly (Columbia College, New York). Vol. xv. pp. 33-47. November 1893. In this index the author follows the plan originally proposed by H. C. Bolton in 1870.

(2) The Tannins, a monograph on the history, preparation, properties, methods of estimation and uses of the vegetable astringents. With an index to the literature of the subject. Vol. ii., the Tannins of oak-bark, mangrove, canaigre, chestnut. By Henry Trimble. Philadelphia, 1894. Pp. 172. 12mo. Ill.

This forms the second volume of the work previously noted in our reports. The carefully compiled bibliography contains about 325 titles.

Reports of progress have been received from several chemists. Prof. Arthur M. Comey announces that the first volume of his Dictionary of Chemical Solubilities, devoted to inorganic compounds, has gone to press, and will be published before the close of the year. The second volume is also in active preparation.

Dr. Alfred Tuckerman reports that the United States Section of his Bibliography of Mineral Waters will be ready for the printer in a few months.

Prof. Clement W. Andrews states that he had done much work on a Bibliography of the Polariscopic Determination of Sugar; but, learning that Prof. H. W. Wiley, chief chemist of the U. S. Department of Agriculture, was engaged in a similar undertaking, generously handed over to him all the material he had accumulated. The combined manuscripts have recently been returned to Prof. Andrews, who will continue the work.

Prof. H. W. Wiley reports great activity on the part of the Division of Chemistry of the U. S. Department of Agriculture, in the preparation of bibliographies and special indexes, but he is obliged to admit difficulties in securing the printing of the manuscripts. We quote the following paragraphs from his letter, dated June 29, 1894, addressed to the chairman of the committee :—"The elegant bibliography of heavy metals occurring in canned goods, by Mrs. K. P. McElroy, has not yet found an avenue for publication." . . . "We also have a very complete bibliography of carbohydrates from the point at which they were left by Tollens in his Handbuch, in 1888, up to the close of 1892. This work was partly done by myself, but chiefly by Mr. H. E. L. Horton, and we were assisted greatly by receiving many hundred titles from Prof. C. W. Andrews, of the Massachusetts Institute of Technology. But what we can do with such a bibliography, comprising as it does three or four thousand titles, I do not know. The Department of Agriculture will not publish it, it is too large for the Journal of the American Chemical Society, and so it lies idle." . . . "A very complete bibliography of agricultural chemistry for the year ending 1893 has also been completed by the committee appointed by the Association of the Official Agricultural Chemists, of which Dr. William Frear is chairman. This bibliography I submitted to the Assistant Secretary of Agriculture with the request that it be published as a part of the Proceedings of the Association, but this request was not complied with. The same committee has in preparation a complete bibliography of agricultural chemistry for the year ending June 30, 1894, and this report will be presented to the meeting of the Association of Official Agricultural Chemists in August at Washington. We shall then have unpublished a complete bibliography of all agricultural chemical topics for the two years ending June 30, 1894."

Mr. P. H. Seymour's "Bibliography of Aceto-Acetic Ester" is in the printer's hands, and will be published by the Smithsonian Institution during the summer.

Prof. F. W. Clarke reports that he is engaged on a new edition of his "Recalculation of Atomic Weights."

Prof. H. C. Bolton has begun a "Supplement to his Bibliography of Chemistry," and last winter visited the chief libraries of Italy in search of material.

Dr. H. P. Talbot, of the Massachusetts Institute of Technology, with the co-operation of Dr. H. C. Bolton, has begun a second edition of the "Index to the Literature of Manganese," published by the latter in 1875, with the intention of bringing it down to date.

Prof. James Lewis Howe, of Louisville, Ky., reports progress on a Bibliography of the Platinum Metals.

Dr. W. H. Magee, of Cornell University, has completed Indexes to the Literature of Cerium and of Lanthanum, and the MSS. have been approved by your committee, and, together with Mr. Langmuir's Index to the Literature of Didymium, have been recommended to the Smithsonian Institution for publication. The three Indexes have been accepted by the Smithsonian, and will appear in the Miscellaneous Collections.

Prof. Charles E. Munroe reports that part ii. of his "Index to the Literature of Explosives" does not complete his work, as stated in the Eleventh Annual Report; he is engaged on a continuation.

Dr. Claude Augustus Oscar Rosell's thesis, presented to the Columbian University, Washington, D. C., in June, entitled "Investigation of the Properties of Ferric Acid," contains an exhaustive bibliography of the Ferrates and Ferric Acid; the channel of publication is not yet determined.

Prof. J. Christian Bay reports progress on a bibliography of alcoholic fermentation, and has commenced a bibliography of glycogen.

The annual reports of this committee are properly confined to the productions of Americans; but the chairman begs leave to direct attention to indications of a growing appreciation of the value of special bibliographies on the part of European chemists, confirming by their recent and proposed activities the work begun in America, at the chairman's suggestion, now more than twelve years ago. Several European countries have long published periodical bulletins of all books issued in their own lands, but they are, as a rule, too comprehensive in scope for the convenience of the specialist in science. Since the "Biblioteca Historico Naturalis," published at Göttingen, dropped chemistry from its pages (in 1887) the most useful bibliography of current scientific works has been the well-known "Naturæ Novitates" (Friedlaender, Berlin), now in its sixteenth year; however, this trade serial is stronger in German than in other languages, and falls short of the completeness desirable.

In technology and technical chemistry the admirable "Repertorium der technischen Literatur" (Leipzig), in its continuation, affords invaluable assistance to the industrial chemist. Recently, too, the following periodical has been established: "Bibliotheca polytechnica; internationale Bibliographie der gesammten neuen technischen Literatur, herausgegeben von Fritz von Szczepanski." (St. Petersburg and Leipzig, 1893.) 8vo. 12 numbers per annum. This includes chemistry pure and applied.

The need of an exhaustive authoritative bibliography of current chemical books of the world is still felt.

In a private letter to the chairman of your committee, Dr. Bechhold, of Frankfort-on-Maine, announces his intention of publishing a full and complete Index to Current Chemical Literature in all languages, on a most comprehensive plan; the first number of this serial will be awaited by chemists with great interest.

Heinrich Wien (Vienna) and F. A. Brockhaus (Leipzig), announce the publication of a "Universal Index to the World's Technical and Scientific Literature." This ambitious undertaking is intended to embrace both books and periodicals, and to represent all the known literature that has appeared in every part of the world; five parts are projected, viz. chemistry, medicine, mining, photography, electricity.

As most of the members of the Chemical Section are aware, a call has been issued for an International Congress of Applied Chemistry, to be held, under the patronage of the Belgian Government, at Brussels in August 1894. At that meeting it is proposed to found a Review of Reviews of Applied Biological Chemistry in several languages, to contain a *résumé* of chemical work in that branch from all parts of the world. The Secretary General of the Congress is M. Sachs, 58 Rue d'Allemagne, Brussels.

At the Congress of Chemists held in Chicago, in August 1893, your chairman had the honour to read an address on an "International Index to Chemical Literature" (*J. Am. Chem. Soc.*, xv. Oct. 1893), in which he proposed a simple scheme for indexing current periodical chemical publications by international co-operation. It is extremely gratifying to record that the necessity of international co-operation has since been suggested by so weighty an authority as the Royal Society (London). That splendid monument of the bibliography of science, "The Catalogue of Scientific Papers," published by the Royal Society, has failed to satisfy the requirements of students in science, owing to the lack of a subject-index to the prodigious material classified under the names of the authors; but according to a circular issued by the Royal Society in April, "it is hoped that a key to the volumes already published may be eventually issued." The Royal Society further announces its intention of continuing the "Catalogue of Scientific Papers" after Jan. 1, 1900, on an enlarged and improved plan, with the aid of international co-operation, and asks for suggestions as to the best methods of inaugurating such a scheme.

Although this report deals with chemistry, it may be proper to mention here an important undertaking in another branch of science, as it affords an additional instance of the progress now making towards international co-operation in bibliography. At the Washington meeting of the International Congress of Geologists a committee on the Bibliography of Geology was appointed for the purpose of preparing a list of the geologic bibliographies now in existence. This work is now approaching completion under the direction of M. Emmanuel de Margerie (Paris), the Secretary of the International Committee.

American botanists also are showing their appreciation of bibliographical work. A committee of the Torrey Botanical Club publishes in the Bulletin of the Club an "Index to recent Literature relating to American Botany." This Index was begun in January 1894, and is continued each month; the arrangement is alphabetically by authors.

At the Chicago Congress of Chemists a committee was appointed to bring about the organisation of a triennial (or quinquennial) international meeting of chemists. Prof. Frank W. Clarke, one of the members of your committee, is chairman of that body. Perhaps the future World's Chemical Congresses may arrange the publication of an exhaustive Index to the Chemical Literature of the World by international co-operation, either in accordance with the scheme proposed by your chairman in his address at Chicago, or in some more efficient way.

Thus, it is evident that immense progress is being made in the compilation of indexes and bibliographies in many branches of science, in both Europe and America; it is to be hoped that American chemists, who have been in some measure pioneers in the matter, will feel stimulated to still greater exertions than before.

The chairman has a limited number of copies of the Tenth Report, containing a list of forty-five Indexes to Chemical Literature, which he will be glad to send to applicants. Communications should be addressed to the Chairman, at the University Club, New York City.

Committee,
H. CARRINGTON BOLTON, *Chairman*,
F. W. CLARKE,
ALBERT R. LEEDS (in Europe),
ALEXIS A. JULIEN,
JOHN W. LANGLEY,
ALBERT B. PRESCOTT (in Europe),
ALFRED TUCKERMAN.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 17.—M. Lœwy in the chair.—A note was presented by M. Faye concerning the International Geodetic Association at Innspruck, and intimating the probability of a certain number of geologists being requested to join its permanent Commission.—Shooting-stars observed in Italy in August 1894; a note by P. François Denza. The numbers of shooting-stars observed at some four-and-twenty stations scattered all over Italy are recorded. The swarm was thicker on the night of 10–11 than on other nights. By observations made at the Vatican, the principal radiant point had the co-ordinates $\alpha = 45°$, $\delta = 54°$.—On the problems of dynamics of which the differential equations allow an infinitesimal transformation, by M. P. Stackel. An infinitesimal transformation P_f, which allows $n - 1$ differential equations between the independent variables $p_1, p_2, \ldots, p_n$ which determine the position of the mobile system, does not exist when the variables $p_1, p_2, \ldots, p_n$ are so chosen that: (1) The function of the forces Π depends only on $p_2, p_3, \ldots, p_n$; (2) the expression of the acting force is reduced to

$$\tfrac{1}{2}e^{cp_1}\sum_{\kappa,\lambda} b_{\kappa\lambda}(p_2, p_3, \ldots, p_n)\frac{dp_\kappa}{dt}\frac{dp_\lambda}{dt};$$

c is an arbitrary constant, and the coefficients $b_{\kappa\lambda}$ depend only on the arguments $p_2, p_3, \ldots, p_n$. Then the infinitesimal transformation P_f has the canonic form $P_f = \frac{\partial f}{\partial p_1}$. These conditions are necessary and sufficient.—On the linear equations from the derived partials of the second order, by M. A. Petot.—On the mixture of liquids, by M. J. de Kowalski. The author has endeavoured to obtain experimental confirmation of Van der Waals' theory of the miscibility of liquids if sufficient pressures be applied. Negative results only were obtained in the cases of isobutyl alcohol and water and ether and water. The system ethyl alcohol: isobutyl alcohol: water with a blue colouring matter, completely mixing at 22°·7, gave at 19°·5 mixture at a pressure of 880 to 900 atmospheres. At 19° the same system showed no signs of becoming homogeneous, even under a pressure much greater than 1000 atmospheres.—On the presence of *Thylles gommeuses* in the vine, by M. Louis Mangin.—On a vine disease caused by *Aureobasidium vitis*, by M. P. Eloste. The disease known as the "maladie rouge" has been widely disseminated this year. The author has found the mycelium of *Aureobasidium vitis* in the altered parts of the leaves, but he has not yet found its fructifications, nor is its parasitism completely proved; a full description of the progress of the disease in an attacked plant is given.—A waterspout at sea, by M. Génot.

BOOKS RECEIVED.

BOOKS.—Fertilisers and Feeding-Stuffs: Dr. B. Dyer (C. Lockwood).—Proceedings of the Royal Physical Society, Session 1893–94 (Edinburgh).—University College, Bristol; Calendar for the Session 1894–95 (Bristol, Arrowsmith).—Newfoundland as it is in 1894: Rev. M. Harvey (K. Paul).—Lehrbuch der Bakteriologischen untersuchung und Diagnostik: Dr. L. Heim (Stuttgart, Enke).—The Collected Mathematical Papers of Arthur Cayley, Sc.D., F.R.S., Vol. vii. (Cambridge University Press).

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THURSDAY, OCTOBER 4, 1894.

ANOTHER SUBSTITUTE FOR DARWINISM.

Nature's Method in the Evolution of Life. (London: T. Fisher Unwin, 1894.)

ALMOST every educated man who can write good English, but who cannot understand Darwin's theory of Natural Selection, seems to feel compelled to explain his difficulties and to offer his own preferable theory in the form of a volume on Evolution. We are thankful that the present anonymous volume is a small one; but that is its chief, if not its only merit. The writer has not, in the first place, made any serious attempt to understand the theory he objects to as inadequate; and, in the second place, his own theory is so vague and so entirely unsupported by either fact or argument as to be altogether worthless. A few extracts from the book will serve to support both these statements.

In the first chapters discussing the Darwinian theory we have this statement:—

"Deviations, although minute, tend, it is alleged, to accumulate, and the accumulations over prolonged periods of time ultimately produce variations from the original type, sufficient to constitute new species." (p. 10.)

Of course no such "tendency" was ever alleged by Darwin. The difference in size between the Shetland pony and the dray-horse is said to be due to difference of climate and food—

"There is no reason to doubt that the size of the former is due to an unfavourable climate and insufficient quantity and quality of food, and that of the latter to comfort combined with a generous diet."

But he ignores the case of the lap-dog and Italian greyhound on the one hand, and the Dingo or Esquimaux dog on the other, where the same contrasted conditions have apparently acted in a manner precisely opposite. Again, he seems to think that the struggle for existence is only the struggle for food, and that such a struggle must cause deterioration. He supposes the case of rabbits on a small island, and says—

"The rabbits possessing the strongest vitality and able to live on the smallest quantity of food, will have proved themselves the fittest. . . . But have the rabbits of the highest type come through the struggle unscathed? Have the fittest of the survivors become fitter to continue the conflict than the rabbits that were fittest when the conflict began? If so, it would follow that scarcity of food is more favourable to animal life than abundance." (p. 28.)

Here he clearly falls into confusion through some idea of abstract "fitness"—fitness independent of the conditions of existence, as shown by his statement on the next page that the struggle for existence "is evidently inimical to beneficial variation." Again (p. 31) he asks: "Is there any ground for believing that excessive use develops beneficial variation?" showing that he entirely misunderstands the theory of the natural selection of individual variations.

This misconception is further shown by quoting the inability of the ostrich to fly as an example of "the failure of natural selection"; and as a still more glaring example of this failure he refers to the curious Chaparral Cock of California, a ground cuckoo which lives in the open woodlands, runs very quickly, but rarely flies. The alleged "failure" is supposed to exist because the mounted cowboys catch the bird with their whips, and it does not escape by flying! It never seems to have occurred to this writer that both these birds are striking examples of the success of natural selection, since they have both become well adapted to a terrestrial life, as shown by their abundance in individuals. The notion seems to be that every bird which cannot fly as well as a swallow or a falcon must be a failure. Yet on the author's own theory, which, as we shall see, is a modified form of special creation, the failure, if it existed, would be even more deplorable.

This theory, which he calls "Nature's Law of Selection," is thus defined—

"What, for want of a better term, we call the progress of species, is not evolving a new organism out of one previously existing, but by substituting another more closely adapted to the conditions." (p. 62.)

How this other one is substituted is a mystery which is but imperfectly explained further on, in a chapter on "The Method of Evolution," in which we are told that—

"Every organism is the product of a particular combination of force acting on matter according to certain fixed laws, and that the same combination of force, united with matter, has a constant and persistent individuality, which is reproductive."

And this enigmatical proposition is supposed to be made clearer by the next sentence.

"As there are elemental substances, so there may be elemental forces possessing special qualities and affinities, which may have, from time to time, as conditions became favourable, combined with each other to work out evolution." (p. 67.)

If the former statement was obscure, this latter statement, of what "may be" and "may have," renders that obscurity perceptibly greater. Then follow several pages about the Power Loom as compared with the Loom of Life, after which we have a further statement of how the different life forces have acted successively on the simple cell "embodying the first vital force," and thus developed the various organisms. (p. 71.) In order to give us a concrete example of the theory at work, we have this account of the origin of the whale, and the author may well be complimented on his courage in attacking so difficult a problem which almost brought Darwin himself to grief. But a greater than Darwin is here. Read and wonder.

"According to our theory, the life force of the whale proceeds to fashion its skeleton on the type of its terrestrial antecessor, and builds the structure to the junction of the antecedent form with the new, and somewhat beyond the first point of differentiation between them. The bones of the hind limbs begin to be formed, but forthwith the new force special to the whale, coming into play, supersedes the forces that would have completed the antecedent type, and the whale is produced."

That is how it was done! For brilliancy of invention and clearness of exposition this is only comparable with that fascinating account, by Adrianus Tollius, of the origin of stone implements by natural causes, as quoted by Mr. Tylor.

"He gives drawings of some ordinary stone axes and hammers, and tells how the naturalists say that they are generated in the sky by a fulgureous exhalation conglobed in a cloud by the circumfixed humour, and are as it were baked hard by intense heat, and the weapon becomes pointed by the damp mixed with it flying from the dry part, and leaving the other end denser, but the exhalations press it so hard that it breaks out through the cloud, and makes thunder and lightning. But, he says, if this be really the way in which they are generated, it is odd that they are not round, and that they have holes through them, and those holes not equal through, but widest at the ends. It is hardly to be believed he thinks."[1]

Here we have an example of a brilliant and comprehensive theory—a theory able to explain everything, yet subject to petty criticism! And we fear that our anonymous author's equally brilliant theory of the orgin of the whale will be not less unfortunate. Of course we are assured that the theory explains almost everything—homology, embryology, rudimentary organs, &c., though he does, modestly, admit that it does *not* explain why hybrids are sterile. In order not to misrepresent the writer one more passage must be quoted, because he there brings his ideas more nearly into accord with that theory of discontinuous variation which has been recently put forward.

"Evolution proceeded by successive distinct gradations or stages. The differentiation of every new species resulted from forces *ab extra* superimposed on, and, to some extent, superseding or modifying the forces that produced the species or genus immediately preceding in the same line of development. The fecundated ovum of a species was, as it were, fecundated a second time with a new force, and the ovum thus bi-fecundated produced, instead of the species to which it belonged, a new species built upon a modification of its predecessor."

The theory is therefore one of special creation through the ordinary process of descent. The "new forces *ab extra*" which produced a whale from a terrestrial animal were also at work every time one species of tit, or warbler, or beetle, or snail, was modified in adaptation to a slightly different mode of life, and became a new species. Thus all is explained; except why there is any variation of these specially adapted species, why they increase at such an enormous rate necessitating such wholesale destruction, why there is any struggle for existence. All these phenomena, which are the very essence of a theory of descent with modification by natural selection, are entirely out of place in a theory of special creation, and are therefore the condemnation of any such theories.

ALFRED R. WALLACE.

[1] "Early History of Mankind," second edition, p. 227.

THE MEAN DENSITY OF THE EARTH.

(*The Mean Density of the Earth. An Essay to which the Adams Prize was adjudged in* 1893 *in the University of Cambridge.* By J. H. Poynting, Sc.D., F.R.S. London: C. Griffin and Co., Limited, 1894.)

THIS essay, which contains an account of Prof. Poynting's well-known investigation of the mean density of the earth, though the last Adams prize essay, is the first to which that prize has been awarded for experimental work. We hope that it is the first of a long series of essays in which the candidates will attack the questions proposed by experiment as well as by mathematical analysis. We can hardly expect, however, that the level reached by the magnificent experimental work of Prof. Poynting will always be maintained.

The essay consists of two parts, the first containing an account of previous determinations of the mean density, the second an account of Prof. Poynting's own determination by means of the ordinary balance.

The first part begins with an account of the astronomical or geodetical methods, in which the attraction of a mountain was compared with that of the earth, as in the experiments of Bouguer in Peru, of Maskelyne and Hutton on Schehallien, of James and Clark on Andrews Seat, of Carlini on Mount Cenis, and of Mendenhall on Fujiyama; or with that of the slab of matter above the surface of a mine as in Airy's Harton Pit experiments, and von Sterneck's experiments in Pribram and Freiberg The beautiful method employed by von Sterneck in his pendulum experiments ought to be more widely known in England. The object of the astronomical method has undergone a curious reversal. It was originally to deduce the mass of the earth from a supposed knowledge of the distribution of matter in the locality of the experiment, whereas now it is rather to find the distribution of matter in this locality, assuming the mass of the earth to be known.

The other methods are laboratory methods, and depend upon the measurement of the attraction between known masses. Prof. Poynting points out a very interesting under-estimate of this attraction made by Newton. In the Principia, Newton estimated that two spheres of the density of the earth, each a foot in diameter, would, if separated by quarter of an inch and left to their own attractions, take nearly a month to come into contact. Prof. Poynting shows that there is a mistake in the arithmetic, and that in reality the spheres would come into contact in between five and six minutes.

It is now very nearly a century since the first measurements of the attraction between two masses in a laboratory were published by Cavendish ("Experiments to Determine the Density of the Earth," *Phil. Trans.* 1798), who used the torsion balance. Since then this method has been used by Reich, Baily, Cornu and Baille, and Boys; while the ordinary balance has been used by von Jolly, Prof. Poynting himself, and by König, Richarz and Krigar Menzel, working in collaboration, while the method of the pendulum balance has been used by Wilsing. The labour expended over these investigations may be estimated from the fact that, to take only two modern instances, Prof. Poynting's experiments extended over twelve years, while those of Cornu and Baille were commenced in 1870, and are not yet completed. The essay contains a clear and critical account of the preceding experiments. The result of the criticism is to raise, if possible, Cavendish's fame as an experimenter. Of Baily's laborious research, Prof. Poynting says: "The critical examination it has received in later years has entirely destroyed any confidence in the result. It remains, however, as a most remarkable and useful example of the danger of substituting multiplication of observations for consistency." The contrast between the amount of work which has been published on the numerical magnitude of the attraction, with that which has appeared on the effects, if any, which modifications of the surroundings exert on this attraction is very remarkable. Newton's hollow pendulum experiments, repeated with greater accuracy by Bessel, seem to be almost the only investigations which have been published on what may be called the physical properties of gravitational attraction. As far as we know, the attraction between two given masses depends merely upon their geometrical configuration; it is independent of the medium between them, of the physical state of the masses, whether they are solid, liquid or gaseous, amorphous or crystalline; it does not depend upon the temperature of the masses. Indirect evidence, often derived from the Cavendish experiments, shows that the preceding statements must at least be very approximately true. Again, chemical analysis is founded on the hypothesis that the weight of an atom of a chemical element is unaltered whatever chemical combinations it may form, or whatever the temperature to which it may be raised. It is, however, often difficult to tell the degree of approximation to the truth of the preceding statements which is indicated by such indirect evidence, and a direct experimental investigation to determine an inferior limit to the accuracy of some of the preceding statements would not be superfluous. Take the case, for example, of the statement that the weight of an atom cannot be altered by chemical combination: it would be for the advantage of science if this were proved with the utmost possible accuracy attainable by present methods for some definite chemical combinations. The question is of interest in connection with the view that the atoms of elements are aggregations of atoms of some primordial substance not very much lighter than hydrogen. The values of the atomic weights of the elements is inconsistent with this view if each atom of the primordial element retains its weight unaltered in the complex atom. If, however, it suffers a slight change of weight, then we might expect to find traces, though perhaps faint ones, of such a change in ordinary chemical combinations.

Another question which has excited some interest is a possible connection between the magnitude of gravitational attraction and temperature. Prof. Hicks has pointed out that Baily's results gave a value for the mean density of the earth which uniformly diminished as the temperature increased, indicating, if the effect is a real one, that the attraction between two masses increases with the temperature, and von Sterneck, in his experiments at Freiberg, found a remarkable relation between the temperature and the value of gravity. Prof. Poynting discusses these and other results, and comes to the conclusion that they are to be explained by other causes, and do not afford any evidence at all that the attraction between bodies varies with the temperature. The point is one which has a direct bearing on Prof. Poynting's own experiments, as the final value for the mean density is got by taking the mean of two sets of experiments, and as the temperature in the two sets differed by about 3·5° C., an uncorrected temperature effect would affect the result.

We are very glad to find from this essay that Prof. Poynting is engaged on an investigation as to whether the attraction between two crystals depends on the relative position of their axes.

The second part of the essay consists of Prof. Poynting's paper "On a Determination of the Mean Density of the Earth," published in the *Phil. Trans.* for 1891. This, in addition to the actual determination of the mean density, is almost a treatise on the method of using a balance so as to get great sensitiveness. The work is a model of patient care and skill, as well as of clearness of exposition, and we feel as we read it that the utmost has been made out of the apparatus and the method. Prof. Poynting is of opinion that it is only air-currents which prevent the balance being used with an accuracy far beyond anything hitherto approached; the ordinary balance is more sensitive than the torsion balance to air-currents, since these produce the greatest disturbance in the vertical direction, which is the direction of displacement in the ordinary balance. Prof. Boys has shown that to minimise the effect of air-currents the size of the apparatus ought to be reduced as much as possible. Prof. Poynting says that if he were designing his apparatus again, instead of using, as he did, an exceptionally large balance, he would go to the opposite extreme and use a very small one.

Of all the methods hitherto used to determine the mean density of the earth, the arrangement used by Prof. Boys seems to be the one capable of the greatest accuracy. There are, however, certain points about the method of the common balance, such as the simplicity of the most important measurements, and the absence of the necessity to determine a time of swing with great accuracy, which make it worthy of such a work as Prof. Poynting has devoted to it.

The mean density of the earth found by Prof. Poynting is 5·49. Prof. Boys' result is 5·53.

MINING.

A Text-book of Ore and Stone Mining. By C. Le Neve Foster, B.A., D.Sc., F.R.S. 8vo. Pp. 744, with Frontispiece and 716 Illustrations. (London: C. Griffin and Co., Limited, 1894.)

In view of the paramount importance of the production of minerals to Great Britain, and of the constant enterprises for working gold ores and other minerals in most of our colonies, it is certainly remarkable that there has hitherto been no satisfactory systematic treatise on metalliferous mining available. It is a matter of congratulation, therefore, that so eminent an authority as Dr. Le Neve Foster has found time, with his many duties as H.M. Inspector of Metalliferous Mines, and as Professor of Mining at the Royal College of Science and Royal School of Mines, to fill up so important a gap in technical literature. His compendious volume will undoubtedly be warmly welcomed as an invaluable work of reference, not only by mining students, but by all English-speaking mining engineers. The subject is so extensive, that the author's task of keeping his text-book within moderate limits, without erring on the side of omission, was one of considerable difficulty. He has, however, been thoroughly successful; and the extremely methodical arrangement of the material obviates, as 1 did in the case of Rankine's engineering treatises, the possibility of the work becoming rapidly obsolete.

The subject has been divided into the following chapters: (1) Occurrence or manner in which the useful minerals are found in the earth's crust; (2) prospecting or search for minerals; (3) boring; (4) excavation; (5) supporting excavations; (6) exploitation or working away of minerals; (7) haulage or transport along roads; (8) winding or hoisting in shafts; (9) drainage; (10) ventilation; (11) lighting; (12) descent and ascent; (13) dressing; (14) principles of employment; (15) legislation; (16) condition of workmen; and (17) accidents. The mining of coal is not dealt with; a special treatise having been published, as a companion volume, by Mr. H. W. Hughes.

In the first chapter, the time-honoured definition of mineral veins as the contents of fissures is wisely expanded by the author. Veins, he states, are tabular mineral deposits formed since the enclosing rocks, and either occupying cavities formed originally by fissures, or consisting of rock altered in the vicinity of fissures. There can be no doubt that many so-called fissure-veins are really substitutional deposits, and the necessity for some change in the definition is apparent. The author enters a timely protest against the use of the word "gangue" for the veinstone, lode-stuff, or matrix. Mistranslated from the German *Gang* (vein) into French, and thence into English, it has lost its original meaning, and should be consigned to oblivion.

The fascinating but perplexing subject of the formation of mineral veins is clearly and concisely dealt with. Sandberger's lateral secretion theory, assuming that the minerals were leached out of the adjacent rocks and re-deposited in the vein cavity, is regarded by the author as not entirely proven. This view, it is interesting to note, is shared by Posepny, who in a paper read, last year, at the Chicago Congress, published since the appearance of Dr. Le Neve Foster's treatise, expresses the opinion that Sandberger's theory suffers from several fundamental defects, and by being accepted as a simple and welcome explanation of the genesis of ore-deposits, has hindered the progress of knowledge.

In studying the mode of occurrence of minerals, abstract definitions are not sufficient. The student must see how they can be applied in practice. The author, therefore, gives a carefully chosen series of examples of the modes of occurrence of the more important minerals arranged in alphabetical order. The thoroughness with which he deals with this section is evident from the fact that he gives accounts of the occurrence of carbonic acid, of petroleum, and of ice. Liquefied carbonic acid is now a regular article of commerce in Germany, whilst the American ice trade affords employment to 12,000 men, 1000 horses, and 100 steam engines. Full descriptions of the mining of ice, to which the author might usefully have given references, have been published in Helland's Norwegian treatise on mining, and in a paper read in 1883, by Mr W. P. Blake, before the American Institute of Mining Engineers.

The eleven chapters dealing with mining proper cover some 450 pages, and include descriptions and illustrations of all the important appliances used in mining work, including the most recent inventions. Indeed, if fault can be found with this section, it is that the author devotes too much space to inventions so recent that their advantages have not been thoroughly tested. The description of the Franke drill, for example, the smallest and lightest boring machine in practical use, introduced last year at the Mansfeld copper mines, occupies more space than that of the modern stamp battery.

The chapter on dressing, under which term the author includes the processes by which the miner prepares his product for sale, or by which he extracts a marketable product from it, covers 100 pages, and is of special interest. Bearing in mind the needs of teachers, the author supplies useful information enabling the student to construct ingenious models of glass-tubing, &c., to illustrate the principles of motion in water and in air, and the construction of dressing appliances. A mixture of like-sized grains of coal, calcspar and galena, minerals of distinctly different colour and specific gravity, is used in these experiments.

The author's classification of the dressing processes employed is quite novel. There are three main divisions, according as the process is effected solely by mechanical means, or is based upon the physical or chemical properties of the minerals treated. The main divisions are subdivided in the following manner:—

I. *Mechanical processes.*—(1) Washing in order to separate clay, mud, and sand; (2) hand-picking; (3) breaking-up, subdivision, or shaping; (4) agglomeration or consolidation; (5) screening or sifting—that is, classification according to size.

II. *Processes depending upon physical properties.*—(1) Motion in water; (2) motion in air; (3) desiccation; (4) liquefaction and distillation; (5) magnetic attraction; (6) separation according to degree of friability.

III. *Processes depending upon chemical properties.*—(1) Solution, evaporation, and crystallisation; (2) atmospheric weathering; (3) calcination; (4) cementation or precipitation by iron; (5) amalgamation.

This classification cannot fail to be of the utmost value to the student, even if the subdivisions are not strictly defined in reality. A carefully considered classification of this character converts dressing into a rational science, instead of leaving it, as is the case in the existing treatises on the subject, an unsystematic collection of heterogeneous facts. One cannot but regret that the exigencies of space have compelled the author to give but meagre information regarding some of the most important mechanical appliances. Dressing is, however, a special subject of sufficient importance to command a literature of its own, and it is to be hoped that the author may some day be induced to expand his classification into a complete treatise.

The 711 illustrations given by the author are clear and effective; and in all important cases the scale is indicated. The frontispiece, representing an overhand stope at the 274-fathom level at Carn Brea Mine, Cornwall, from a photograph by Mr. J. C. Burrow, is a most artistic piece of work and a triumph in underground photography. With his characteristic minute accuracy in detail and in nomenclature, the author has introduced the expression "274-fathoms level" in place of the usual "274-fathom level." No doubt he can bring forward arguments in favour of this practice, which he adopts throughout the book; but to Cornish ears it will sound as oddly as if he alluded to a 2-feet rule, or to a 2-years old colt, or as if he spoke of a Guardsman as a "six-feeter."

A very full and accurate index greatly adds to the value of the work. The insertion of the names of von Cotta, von Groddeck, and von Sandberger under the letter V is, however, open to objection.

Prof. Le Neve Foster is to be congratulated on having enriched our technical literature with a contribution of substantial value. Undoubtedly the best book on the subject in the English language, it bears comparison with the treatises of Callon and Haton de la Goupillière in French, and with those of Serlo and Koehler in German. It should find a place in every mine office, and, by being carefully studied by mine managers, should help to raise the British ore and stone mining industries from their present depressed condition.

BENNETT H. BROUGH.

DR. ADLER'S OBSERVATIONS ON GALL FLIES.

Alternating Generations: a Biological Study of Oak Galls and Gall Flies. By Hermann Adler, M.D., Schleswig. Translated and edited by Charles R. Straton, F.R.C.S., Ed., F.E.S. With illustrations. (Oxford: Clarendon Press, 1894.)

THE order *Hymenoptera* has never been a popular study, in the sense in which the *Coleoptera* and *Lepidoptera* have become so during the last century, but it probably numbers among its votaries nearly three times as many students as any of the remaining orders. Nor is this surprising, for although it cannot compete with the *Lepidoptera* in beauty of colouring, it surpasses the *Coleoptera* in its variety of form, and is probably more numerous in species than any other order. It supplies us with some of the most valuable products which are yielded by insects, such as honey and ink, and stands at the head of the insect world, both in intelligence and in diversity of habits.

The *Aculeata*, or ants, bees, and wasps, and, after these, the *Tenthredinidæ*, or saw-flies, have generally received most attention from those entomologists who have specially devoted themselves to the study of the *Hymenopteræ*. But within the last twenty or thirty years, several entomologists have occupied themselves with the study of the *Cynipidæ*, or Gall Flies, and have discovered a system of alternate generations in these insects almost as remarkable as that which had previously been observed in the *Aphididæ*, or Plant-lice, which belong to the very different sub-order *Homoptera*.

One of the most important contributions to this subject was Dr. Adler's treatise, "Über den Generationswechsel des Eichen-Gallwespen," which was published in the *Zeitschrift für wissenschaftliche Zoologie* for 1881 (vol. xxxv.), with three coloured plates; and it is this work which Dr. Straton has now brought within the reach of every English entomologist.

As a rule, works on many branches of science become obsolete shortly after publication, and are seldom required except by specialists; but this does not apply to observations on transformations and habits. Men who have sufficient patience, taste and opportunity to make such observations of real value are few and far between, and their results, if sufficiently accurate, remain of permanent value, however much they may be enlarged by future observations. Hence Dr. Straton has rendered a real service to science by publishing an English edition of a work of this description, which was originally issued several years ago in a costly periodical, which would hardly be accessible, even to those who can read the original, except [in metropolitan or university libraries. Dr. Adler's work has been carefully and accurately translated, including his descriptions of the insects observed, his table of alternating generations, and his observations on gall-formation, oviposition, &c.; and the coloured plates have been faithfully reproduced, though the original stones had been destroyed.

Dr. Straton has added an introduction, a chapter on *Cynips Kollari*, synoptical tables of galls, a classification of the *Cynipidæ*, and a bibliography and index. The introduction deals with the history of the study of galls, and the questions of parthenogenesis, alternating generations, &c., in arthropods, and more especially in the *Cynipidæ*, the changes in the ovum and sperm-cells being described in detail, with reference to the views of Weismann and others; and Dr. Straton's own remarks will be found interesting to embryologists in general. Incidental remarks on gall parasites, and other points unconnected with the main subject of the book, are occasionally introduced.

We have only to regret that it has not occurred to Dr. Straton to add the principal bibliographical references to descriptions, &c., of each species, and a note as to whether it is common or rare in England. These additions, which might have been placed between brackets, to distinguish them from Dr. Adler's work, would have added to the usefulness of the book, which may probably penetrate to country places where the information which it contains cannot be supplemented by reference to larger works; to which, however, it is very necessary to refer the student, that he may know what to consult if he wishes to pursue the subject further. This want is only imperfectly supplied by a bibliography, absolutely necessary as this is for advanced students, and also to indicate the extent of an author's reading, and the sources from whence he has derived his information.

W. F. K.

OUR BOOK SHELF.

Hygiene. By J. Lane Notter, M.A., M.D., and R. H Firth, F.R.C.S. Pp. 374. (London: Longmans, Green, and Co., 1894.)

Primer of Hygiene. By Ernest S. Reynolds, M.D. Pp. 158. (London: Macmillan and Co., 1894.)

THOUGH it is not expressly stated that Dr. Notter's book "has been designed to meet the requirements of the syllabus of the Science and Art Department," the work is issued in the series of manuals published by Messrs. Longmans for students working up for South Kensington examinations, from which fact it may be inferred that such students will use it as a text-book. And as the author is an examiner in hygiene under the Department of Science and Art, his book doubtless contains the kind of knowledge that commands marks. Therefore teachers would do well to adopt it for their classes; and all writers of other text-books covering the same ground may regard their works as doomed to rapid extinction. Whether an examiner should prepare a text-book for his own syllabus is a matter of opinion, and much can be said both for and against the system. But, however that may be, it is certain that persons desirous of passing an examination could not do better than read the works of the one who sets the questions. In the case of the book before us, we have no hesitation in saying that it is as clear and connected an exposition of the laws of health and causes of disease as anyone could desire, be he a sordid hunter after certificates or a true seeker after knowledge. The authors have treated their subject scientifically, and yet with few technicalities, hence their work should appeal to a large public. Beginning with a chapter on air, they pass to others on water and food, and then to soils, sites, and buildings. The fifth chapter is concerned with drainage, after which are treated personal hygiene, infection and disinfection, parasites, climate and weather, and finally vital statistics. It will be seen from this that the subject is not treated in all its bearings; nevertheless, what is included in the manual forms an excellent basis for further study. Students who use the book will find it a pleasant road to knowledge, and they may confidently put their trust in its contents.

We note that here and there the authors, like many other writers on hygiene, do not sufficiently distinguish between heat and temperature. For instance, on p. 283 it is written: "At the ordinary temperature of the air, water boils at 212° F., and the moment the temperature falls below that heat, steam condenses." In this sentence the word heat is used in the sense that a cook employs it, not as a scientific man should write it.

Dr. Reynolds' primer deals with those portions of hygiene which concern the health of the household. If its contents were more widely known, the mortality from preventible disease would be greatly diminished. The greatest praise that can be given to a primer is to say that readers of the book will acquire just the kind and amount of knowledge to make them, like Oliver Twist, hunger for more. This commendation can safely be given to Dr. Reynolds' little volume, which is a model of what an introduction to hygiene, suitable for the general reader as well as the elementary student, should be.

Fur and Feather Series.—The Grouse. By Rev. H. A. Macpherson, A. J. Stuart-Wortley, and George Saintsbury. Edited by Alfred E. T. Watson. (London: Longmans, Green, and Co., 1894.)

IN the book before us the grouse is regarded from three different standpoints, and treated accordingly. In the first, the Rev. H. A. Macpherson introduces us to his natural history from the point of view of sport, telling us, after he has devoted a chapter in praise of the bird, the manners and "private life" of the grouse; the enemies with which it has to deal; the variability of the plumage in which it is wrapped, and the methods by which grouse are captured by "becking." These chapters are full of anecdotes and thoroughly readable, and they make one long to hear the cocks uttering their clear ringing "Er—eck—kek—kek! wuk, wuk wuk."

The second part is devoted to the shooting of the bird, and is contributed by Mr. A. J. Stuart-Wortley, who handles the subject in a straightforward manner.

We might here discuss at length the contents of the seven chapters on this subject, but we will leave it to the reader to find out for himself what the author has to say on such subjects as Scotch and English driving, ground stock and poaching, records and remarks, shooting over dogs, &c.

The third and concluding section of the book deals with the last, but by no means the least important, stage of the grouse—his presence on the dinner table. Mr. George Saintsbury completes his task well in laying before the reader the numerous and widely different methods of cooking. Not only is the treatment applied to the bird as a whole, but also to such variations as grouse soup, *quenelles*, *croquettes*, *bouchées*, &c.

Summing up then in a few words, we may say that we have nothing but praise to bestow on the book, which is a very valuable contribution to natural history, and worthily keeps up the reputation of the admirable series of which it forms a part. Every naturalist and every carrier of the gun will find it delightful to read, and at the same time will, no doubt, receive many useful wrinkles. Besides the text being all that could be desired, the illustrations are really excellent. They are after the drawings of Mr. A. J. Stuart-Wortley and Mr. A. Thorburn, and were designed under the supervision of the first named.

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.*]

Has the Case for Direct Organic Adaptation been fully stated?

THE heading of this letter is in the form of a question for the following reasons: (1) It is impossible to keep pace with the literature on the subject of Evolution while engaged on any other absorbing work; and (2) so many giants have been engaged in the discussion, that it requires courage even to suggest that a point has been overlooked. It seems to me that nothing could be added to Herbert Spencer's convincing arguments that acquired characters must somehow be transmitted. I wish merely to suggest a method of describing this transmission which I have never yet seen in print, and which, I must think, is not generally recognised, inasmuch as it modifies Weismann's "contradictory facts" into not insuperable difficulties.

While studying the Phyllopod Crustacean Apus, I came to the conclusion that it might be derived from an Annelid which bent its head segments round ventrally, and pushed the food into its mouth with its parapodia. Simple as the suggestion may seem, the facts are indisputable that Apus *can* be so deduced, and further, that there is a considerable mass of evidence to show that it actually was so deduced.[1] If so, we should have one group of animals, the Crustacea, developed from another, the Annelida, not primarily by the summation of a long series of small variations by the action of Natural Selection, but by the active adoption on the part of a portion of the latter of a special manner of feeding. We may perhaps briefly describe the process as follows. A certain number of Chætopod Annelids found themselves in a region where the most favourable diet was only to be obtained in the manner described; the mouth had to be turned down ventrally so as to open backwards, and the lateral parapodia (bordering it in its new position) raked the food together and pushed it into the mouth. Generations of these Annelids would be produced in the same region, and would, in response to the same stimulus, practise the same method of feeding. Natural Selection would perfect the habit, and also *inevitably perfect it earlier and earlier in the lives of succeeding generations.*

But here, it will be said, we have ultimately to call in the aid of the transmission of acquired characters by inheritance. Yes; but this inheritance comes in at the end of a long series without appreciable break in the regular sequence. The last stage of individual acquirement is when the very youngest animal capable of feeding adopts the perfected habit as it first feeding act—in response, that is, to the same stimulus from the environment which led its parents to adopt it. The very next stage is that in which the young animal places its head segments in the right position prior to being able to feed. Here we may assume either that the "instinct" has been inherited, or, considering that the possible positions of the head segments are not numerous, that Natural Selection winnowed out all those

[1] I have endeavoured to accumulate this evidence in the following publications: "The Apodidæ," NATURE Series, 1892, and "The Systematic Position of the Trilobites," in the *Quarterly Journal of the Geological Society*, August 1894.

whose heads were not ready. I prefer the former hypothesis, for it is not, in this case, the inheritance of characters casually acquired by a few chance individuals, but of characters which have been regularly acquired by the race for several generations as an active organic adaptation to the environment.

It is needless here to multiply illustrations, but this and kindred cases have led me to ask whether too much attention has not been paid to single organisms and the modifications of chance individuals, whereas if a whole colony of similar organisms invade a new region, all have to adopt new habits of life; the young members of the colony and the new young continually born, being plastic, will, before they are adults, show marked structural modifications in adaptation to these new habits. They are actively modified by these functional adaptations to their environment. Natural Selection will winnow out those who do not keep in training, and at the same time infallibly compel the successive generations to perfect themselves earlier and earlier. We should thus have stages (but without appreciable breaks in the sequence) in this evolutionary process. (1) The young are born and continue for some time like the ancestors of the group, while the adults show considerable structural modification; (2) the new-born young resemble the ancestors of the group, but commence early to show the functional adaptations of the adults; (3) the new-born differ slightly from the ancestors of the group, inheriting (or possessing "accidentally") slight modifications in the right direction which enable them still earlier to perfect the necessary adaptation; (4) the young are born with the structures necessary to the immediate adoption of the habits required by the environment.

It seems to me that, in this way, we actually have the transmission of acquired characters by inheritance, this inheritance coming in as a natural term at the end of a long series of individual acquirements. The prime factor in the evolution of new forms is, therefore, the vital response to the environment of living colonies of exquisitely sensitive organisms; Natural Selection not only perfects, but drives the resulting modifications back earlier and earlier in the life-history of each individual of the colony *until they are inherited.*

This principle, it seems to me, explains the degeneration of structures which are "only passively functional," such as a hard shell. If the environment no longer requires a shell, it will not be maintained. It is inherited, say, from ancestors, but each fresh generation, or in the case of the Crustacea, each moult, gives a new start. If the shell owed its origin to the inorganic environment, it would cease to be developed when the special stimulus to its production were withdrawn, for the skin which secretes the shell is passively functional only so far as the organism is concerned; as a living tissue it is actively responsive to its environment. Or again, the shell owed its origin to the protection it afforded from enemies, and thus partly to the survival of those which accidentally had slightly thicker skins; but partly, and I think chiefly, also to the powers of the skin as a complex tissue to resist the attacks of the many small enemies, such as animal and vegetable parasites, which are a constant element in almost all environments. In this case, also, with each generation or moult we have a fresh start; on the removal of the constant irritation from these enemies, the energies of the animal would be otherwise employed than in re-developing its shell.

In order to account for the progressive or retrogressive modifications in the sterile workers of Hymenopterous colonies, we have in the same way to assume the functional modification of the plastic young as the prime factor; Natural Selection not only perfects these modifications, but *drives them back earlier and earlier in the life histories of the individuals.* We can thus understand that a stage might be reached when the difference of the food administered to the larva might modify its course of development. The structural modifications of the workers in this case are not inherited, but they are also not primarily due to Natural Selection, but to the response of organisms *in ever-recurring plastic series* to the requirements of their environment.

Again, the ceaseless efforts of the young individuals of a colony to adapt themselves to a new environment can alone, it seems to me, account for the possible utilisation of congenital variations, which are useless in themselves without concomitant variations. These latter will be acquired by the efforts of the organism, so far, that is, as to render the former functionally useful.

On the other hand, the "time" difficulty in evolution admits of easy solution if it can be shown that groups of organisms actively respond to changes of environment, as plants adapt themselves to a new surface by the plasticity of their growing shoots. Further, the difficulty that organisms are known to have remained practically unchanged through immense geological periods, is explained by the supposition that their environment must have also remained practically unchanged.

For the solution of many of the difficulties in evolution, we have then to look to the functional response of *colonies* of organisms, and of the living parts of such organisms to their respective environments. This power of adjustment accounts not only for the formation, but also for the maintenance of species. The force of Heredity has been overstated, while the power of immediate vital response of delicately balanced organisms to every slight change in the environment has been very much understated. If we keep in view the ever-recurring generations of plastic young, the direct stimulus of the environment is seen almost necessarily to be a force of prime importance perpetually overmastering the somewhat exaggerated rigidity of species attributed to heredity. There is no such thing as rigidity; everything is rather in a state of flux. Is this unending variation, always in adjustment to the environment, due to Natural Selection taking advantage of the occasional accidental slips in an otherwise rigid heredity? or, is it due to the direct response of organisms in a state of finely balanced equilibrium? This latter seems to me the more probable, the resulting structural modifications being, on the one hand, hindered by Heredity; on the other, if the conditions require it, hastened and perfected by Natural Selection. This hastening action of Natural Selection leads inevitably to inheritance.

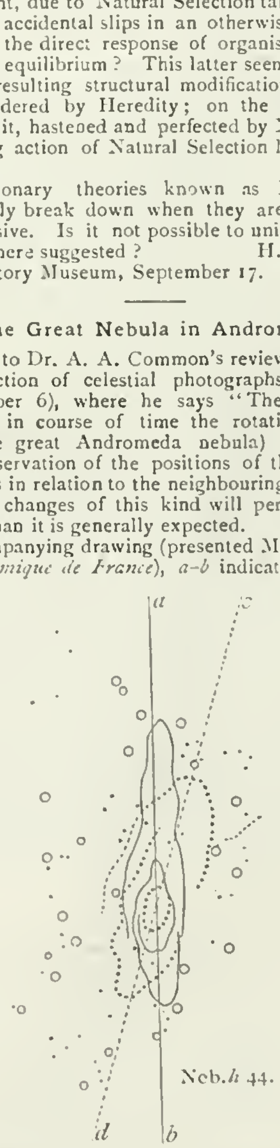
The evolutionary theories known as Lamarckism and Darwinism, only break down when they are supposed to be mutually exclusive. Is it not possible to unite them somewhat in the manner here suggested? H. M. BERNARD.

Natural History Museum, September 17.

The Great Nebula in Andromeda.

IN reference to Dr. A. A. Common's review of Dr. Roberts' beautiful collection of celestial photographs (NATURE, No. 1297, September 6), where he says "There is a fair presumption that in course of time the rotation of the outer portion (of the great Andromeda nebula) may perhaps be detected by observation of the positions of the two outer detached portions in relation to the neighbouring stars." I wish to point out that changes of this kind will perhaps be detected much sooner than it is generally expected.

In the accompanying drawing (presented May 2, 1894, to the *Société Astronomique de France*), *a–b* indicates the outline of



the small elongated nebula *h* 44, as it was seen by Trouvelot at Cambridge (Mass.) in 1874; *c–d* the limits of the nebulosity on Roberts' photograph (1889): the circular spots are stars, recognisable in the drawing. Unless this part of the Trouvelot drawing—the excellence of which is stated by Dr. Roberts himself—be very incorrect, the nebula would seem to have turned about 15° from left to right. The globular nebula (M. 32) to the other side of M. 31, seems also to have slightly shifted its position.

Evidence of the reality of such changes is of course only obtainable by comparing three or more photographs taken at comparatively wide intervals. In the meantime, this short notice in NATURE may call the attention of photo-astronomers to this interesting point.

Dordrecht, September 14. C. EASTON.

On the Identification of Habitual Criminals by Finger-Prints.

A PARLIAMENTARY Blue Book on "The Identification of Habitual Criminals," which has recently been issued, reports on *The Finger-Print System*, stated to have been "first suggested, and to some extent applied practically, by Sir William Herschel."

The chairman of the committee appointed by Mr. Asquith, whose report contains the above statement, refers me for his evidence on this point to Mr. Galton's work on "Finger-Prints" (Macmillan and Co., 1892).

My "careful study" of the subject is mentioned there, and an article of mine in NATURE, October 28, 1880 (vol. xxii. p. 605), is referred to. It is correctly indexed in the "Index Medicus" for the year, published in 1881, although Mr. Galton spells and indexes my name incorrectly. That article, I believe, is absolutely the first notice of the subject contained in English literature, and the conclusion I reached therein was that the patterns of the skin-furrows, with their distinctive loops, whorls, and lines, breaking and blending like the junctions in a railway map, were capable of being readily used as a reliable and permanent basis for the "scientific identification of criminals." I conclude my paper with the statement that "There can be no doubt as to the advantage of having, besides their photographs, a nature-copy of the for-ever unchangeable finger-furrows of important criminals."

Sir William Herschel wrote in NATURE, November 25 of the same year, alleging that he had "been taking sign-manuals by means of finger-marks for now more than twenty years." It does not yet appear that anything had been published on the subject by that gentleman till my contribution called forth his letter a month afterwards. The collections made by Sir W. Herschel were recently placed in Mr. Galton's hands, and that writer states that "they refer to one or more fingers, and in a few instances to the whole hand, of fifteen different persons." ("Finger-Prints," p. 9.)

It is not stated how many of these had been imprinted prior to my first calling attention to the subject. At present it would seem that Sir. W. Herschel had not accumulated the impressions at a more rapid rate than that of one person in two years! As we are informed in the letter to NATURE, referred to above, that the identification of pensioners had been secured in this way, that the method was in use in all the registration offices of the district, and that "on commitment to gaol, each prisoner had to sign with his finger," I should have expected that a somewhat more extensive collection might have been secured. As priority of publication is generally held to count for something, and as I knew absolutely nothing of Sir W. Herschel's studies, nor ever heard of anyone in India who did, some little evidence on the point of priority would be of interest even now.

Mr. Galton says, of Sir W. Herschel, "He informs me that he submitted, in 1877, a report in semi-official form to the Inspector-General of Gaols, asking to be allowed to extend the process; but no result followed." (p. 28.) A copy of that semi-official report would go far to settle the question of priority, as its date is nearly two years previous to my having noticed the finger-furrows. No reference to them was then to be found in any anatomical work that I could find access to, and no writer on identification had ever thought of them as a means to that end. My interest, like that of Purkenje, arose from a special study of the sense of touch, and I was then lecturing to medical students on the "Physiology of the Senses." Having myopic eyes which enable me to write with ease the Lord's Prayer three times in the space of a sixpence, I soon noticed the unique patterns which the papillary ridges formed. I happened to be studying the prehistoric pottery of Japan at the same time, and became interested in observing that these patterns were similar, but, I thought, finer and more slender than those of the present day, which pointed, I conjectured, to the employment of children in early fictile art. However that may be, my knowledge of the subject had a natural and independent genesis.

The subject of identification by this means has been brought under the notice of the authorities on criminal matters of different countries by me from time to time, and some years before Mr. Galton's work was published, Scotland Yard placed one of its most enlightened officers in communication with me on the subject. Inspector Tunbridge studied the subject with me during a forenoon. Even in 1880, I prepared copper-plate outlines of the two hands, accompanied with instructions as to obtaining finger-prints, and some two chief points on the palm, where the rugæ are characteristic. Sir W. Herschel's letter mentions prints of one finger only as being obtained from prisoners on commitment. On page 79 of the Blue Book mentioned above, "Instructions for taking Finger-Prints" are given for the benefit of prison warders, and the ten fingers are to be printed from, as I have advocated. I may add that I have not the slightest wish to diminish the credit that may be due to Sir W. Herschel. What I wish to point out is that his claim ought to be brought out a little more clearly than has yet been done, either by himself or by Mr. Galton. What precisely did he do, and when? HENRY FAULDS.

The Tetrahedral Carbon Atom.

YOUR reviewer, in his notice of my "Elementary Lessons in Organic Chemistry," takes exception to the statement that the carbon atom has been hypothetically regarded as tetrahedral in shape; he is presumably unacquainted with the criticisms of Lossen (*Berichte* 20, p. 3306) on Wislicenus's memoir, with Wislicenus's reply[1] (*Berichte* 21, p. 581), as well as with the pamphlet of Wunderlich ("Configuration organischer Molekule," Würzburg, 1886); he need not, however, search "the whole range of stereo-chemical literature" for references of this kind, as there is in the "Handbuch" of V. Meyer and Jacobson, pp. 433–436, a tolerably full discussion as to the ultimate cause of stereo-isomerism in carbon compounds, where it is stated (p. 434) that "the carbon atom may be regarded as a mass of finite extension in space, of any shape, with four points on its surface corresponding to the corners of a regular tetrahedron as the units of affinity."

Most writers on stereo-chemical subjects prefer to speak of the tetrahedral arrangement in space of the four valencies of the carbon atom, rather than of the tetrahedral shape of the carbon atom itself; but if the "valencies" are sufficiently material to have a definite position in space, they may fairly be regarded as parts of the carbon atom, which then becomes of finite size, and *for the purposes of stereo-chemistry* essentially tetrahedral in shape. This form of statement has the merit of simplicity, and is in itself less objectionable than the idea of "valencies" directed towards the corners of a tetrahedron; at the same time, I freely admit that the statement errs on the side of excessive simplicity, and is not what would be adopted before a class of honours students.

It is possible to connect the facts of stereo-isomerism to some extent by a series of separate propositions, and at the same time to avoid any reference to the distribution of the "valencies" in space, or to the finite size of the carbon atom; one of these propositions would be that "two carbon atoms connected by an ethylene linkage are no longer free to rotate round the axis which joins them"; but so soon as an attempt is made to unite these separate statements into one hypothesis, or to assign any reason for the proposition just quoted, it is impossible (as it appears to me) to escape from the dilemma; of the two alternatives, I think most chemists, who have not become blinded by long usage to the gross misuse which the word "valency" has suffered, will prefer to regard the carbon atom as finite in size with four points in it, occupying the corners of a tetrahedron, distinguished in some way beyond the rest as regards the action of chemical affinity.

This idea must be made more definite before the average student can derive much help from it in correlating the facts of

[1] Wislicenus says "the atom of carbon may possibly resemble very closely regular tetrahedron in shape."

stereo-isomerism; the essential part of it is retained in the assumption that the carbon atom is stereo-chemically to be regarded as tetrahedral in shape. If any student carries away the notion that this is believed to be the actual shape of the atom, there is no more mischief done than in that student's case who gathers the impression that the two carbon atoms united by an ethylene linkage are held together by two pairs of forces which do not act along the line joining the two atoms, but meet at an angle in empty space. G. S. TURPIN.

Huddersfield, September 24.

Careless Writing.

PROF. TILDEN, in his review, published in NATURE, September 20, takes exception to the loose phraseology adopted by writers on chemical subjects. This is, alas! only too common.

For example, in one of the best works on inorganic chemistry, written by a Professor of Chemistry whose writings are characterised by their logical clearness and philosophic reasoning, one may read:—

"When a molecule of hydrogen acts upon a molecule of chlorine to form two molecules of hydrochloric acid gas, 44,000 c. of heat are evolved." Of course, nobody can fail to understand what is meant. But as the words stand, it is certainly one of the most remarkable feats of science, and makes us feel that some happy mortal has succeeded in refining his faculties down to the degree of fineness, popularly ascribed only to a certain species of "demon." F. G. DONNAN.

Holywood, Belfast.

ON THE DOCTRINE OF DISCONTINUITY OF FLUID MOTION, IN CONNECTION WITH THE RESISTANCE AGAINST A SOLID MOVING THROUGH A FLUID.[1]

II.

§ 6. IN every case in which vacuum is formed at an edge of a solid moving in an inviscid incompressible fluid, under pressure constant at all infinitely great distances from the solid, a succession of finite individual vortices is sent from the edge into the liquid, *and the motion is essentially unsteady*. Each individual vortex has a finite endless vacuum for its core instead of the rotationally moving ring of fluid of the Helmholtz vortex ring. But it should be noticed that it would not be rings of vacuum, but bubbles, that would in many cases be first detached from the solid; that by the tumultuous collapse of bubbles they become rings; and that the case in which the collapse of a bubble, in our ideal fluid, could be completed to an annulment of volume, is of necessity infinitely rare; and that the case in which, when a bubble becomes a ring by the meeting of two points of collapsing boundary, there is exactly no circulation through the aperture, is infinitely rare.[2]

§ 7. In the case of our circular disc, it would be circular vortex rings that, if the water were inviscid, would be shed off from its edge when the depth is less than 63 feet. If the depth is very little less than 63 feet these rings would be exceedingly fine, and would follow one another at exceedingly short intervals of time. Thus quite close to the edge there would be something somewhat like Stokes' "rift," but with a rapid succession of vacuum rollers, as it were; and *no slipping* between the portions of the fluid on its two sides.

§ 8. At greater depths than 63 feet, if the water had absolutely no viscosity,[1] the motion would be continuous and irrotational, as described in § 4, text and foot-note: but any degree of viscosity, however slight, would, if the edge were infinitely sharp (instead of having a radius of curvature of 1/2000 of an inch, as has our supposed disc), give rise to a state of motion in its neighbourhood somewhat like to Stokes' rift,[2] "a surface of discontinuity extending some way into the fluid," but with the difference that there is no slip of fluid on fluid. A trail of rotationally moving liquid, a Helmholtz' "vortex sheet" of exceedingly small thickness, is thus left in the wake of the circular edge; which, while becoming thicker as it gets farther from the edge, becomes rolled up in a wildly tumultuous manner, giving the appearance of an irregular crowd of detached circular ring-vortices. This crowd follows the disc at an ever diminishing speed and widens outward farther and farther, and inwards encroaches more on the comparatively undisturbed middle of the wake, as it is left farther and farther behind the disc.

§ 9. Whether as in § 7 for an ideal inviscid incompressible fluid, or as in § 8 for a natural liquid such as water, the "wake," that is to say, the fluid on the rear side of the plane of the disc, as far as it is sensibly affected by the motion of the disc, must be as described in the last sentence of § 8. The rear of the wake is always moving forwards, that is to say, following the disc; but at a continually diminishing speed. Hence, if the disc has been set in motion from rest some finite time, t, ago, the whole wake must be included between the plane from which the disc started, and the plane in which the disc is now, at the time when we are thinking of it. These two planes are at the finite distance, Vt, asunder. In other words the wake extends to some distance less than Vt, rearwards from the disc.

§ 10. The shedding off of vortex rings from the edge of the disc, to follow in its wake at less speed than its own, essentially gives a contribution to negative pressure on the rear side of the disc equal to $\frac{d}{dt}\Sigma\kappa$; where $\Sigma\kappa$ denotes the sum of the circulations of all the coreless ring vortices, or of all the rotationally moving liquid, which have or has left the edge since the beginning of the motion. This, with the commonly assumed velocities of the fluid on the two sides of the rigid plane, seems insufficient to account for the excess of observed pressure above that calculated for a long blade by Lord Rayleigh's formula[3] referred to in my letter to NATURE, "Towards the Efficiency of Sails, &c.," and leaves some correction to be made on those assumed velocities. But the working out of this interesting piece of mathematical hydrokinetics must be deferred for a continuation of the present article in which supposed discontinuity of fluid motion, extending far and wide, as taught by many writers in many scientific papers and text-books since Stokes' infinitesimal rift started it in 1847, will be considered. KELVIN.

(To be continued.)

[1] Continued from p. 525.

[2] The whole subject of the motion of an incompressible inviscid fluid with vacuum on the other side of the whole or any part of its boundary is of surpassing interest. Consider for example an open fixed basin, with water poured into it and left not quite at rest under the influence of gravity; swinging slightly from side to side, let us suppose for example; the water perfectly inviscid, and vapour-less, but may be either cohesional or cohesionless; and there being perfect vacuum over all its free surface. Very soon it will certainly throw up a drop somewhere: and before very long it will become covered with spin-drift and will thus illustrate Maxwell's important allegation (which I believe to be true though it has been much doubted), that any conservative system must "sooner or later" pass through every possible configuration.

[1] Viscosity is resistance to change of shape in proportion to the speed o the change.

[2] Stokes, "Mathematical and Physical Papers," vol. 1. p. 310.

[3] In lines 9 and 10 of the printed letter (NATURE, Aug. 20, 1894, p. 425), for "something like five or ten," substitute 4·8. I unfortunately had not Lord Rayleigh's formula by me at the time the letter was written.

MR. SCOTT ELLIOT'S RUWENZORI EXPEDITION.

ABOUT three years ago, in NATURE (November 5, 1891), I gave an account, rescued from an American periodical, of the botanical results, slender enough it is true, but not without interest, of the Emin Relief Expedition, as described by Major Jephson. The most important feature was undoubtedly the small collection brought away "for Emin Pasha to classify" by Lieut. Stairs from "a high altitude on the slopes of Ruwenzori, or the Mountains of the Moon."

Last year Mr. Scott Elliot, an accomplished botanist and experienced African traveller, submitted to the Government Grant Committee of the Royal Society a scheme for an extended plan of botanical exploration in Central Africa. On the advice of the Board for Botany, Mr. Scott Elliot undertook the investigation of Ruwenzori, and through the kind aid of Sir John Kirk, such official facilities as were possible were obtained on his behalf.

Mr. Scott Elliot, not without many difficulties, has now reached his destination. The following letter, which is communicated to Nature at his request, raises a high expectation that he will succeed in thoroughly investigating the flora of this interesting region. It is a matter of sincere hope that his health will be spared for the task. Unfortunately the time is far distant when, as prophesied by Mr. Stanley, the "tender-hearted botanist" may be "conveyed from point to point without danger to his valuable life." The honour is all the greater to a man of by no means robust physique, who in the pure interests of science is willing to take his life in his hand in the prosecution of such a task.

W. T. Thiselton-Dyer.

Royal Gardens, Kew, September 25.

Ruwenzori, May 2, 1894.

I arrived here on April 1, but have unfortunately been able to do very little, as I have had severe fever. I may not have another opportunity of writing for a long time, so send this now. My route has been through Kavirondo, Usoga, and Uganda to Buddu, through Buddu to Karagwe, and thence diagonally across Ankobe to Toru. I find Uganda, Buddu, and Toru to consist of a plateau apparently gneiss and granite, about 4000–4500 feet high in most parts, but about this part of Toru 5000 or even 5300 feet. The whole of this plateau is cut up into innumerable swampy rivers, due to the comparative slow gradient of these rivers (the Victorian Nyanza being only 3850 feet). In Karagwe and Ankobe this plateau is covered by a series of folded schists and shale which extend with one break from Kitangule to within eight miles of the Albert Edward Nyanza, where the granite plateau is reached again. These schists are at 80°-90° dip, and strike usually 20°–30° east of north. A curious little chain of small volcanic craters, running east and west nearly, appears in the midst of the granite at Vijongo (on Lugard's map), that is, at the base of Ruwenzori, but I have not been able as yet to see much of the geology of Ruwenzori itself. The flora over the whole of this country up to 6000 feet is identical, and even at 6000 feet there are but few new species. It seems probable to me that this flora extends right down to the Zambesi. I have been able to get a fair number of species representing it, but in what condition they will reach England remains to be seen. Of trees there are very few. A tree *Euphorbia* and an *Erythrina* are the commonest. The most objectionable is a bamboo-like grass, often twenty feet high, which makes travelling most annoying. Another conspicuous plant is an Acanth with handsome red spikes of flowers and very large prickly leaves. There are two or three Helichrysums, numerous Commelinas and twining *Leguminosæ*, and, strangely enough, a *Rubus*, a buttercup, and three *Umbelliferæ*. I find also the same beetles, butterflies, and dragonflies everywhere.

The country as a whole seems very fertile, and the population is probably one-hundredth part of what it might be. The swamp rivers alluded to are probably the most extensive natural rice-fields in the world; but rice has only been grown in a very half-hearted manner. The banana supplies all the wants of the people. Tobacco could also be grown anywhere, and, as far as one can judge from the native plant, a very good kind could be produced. Coffee could also be grown, and cotton, and, in fact, most of the common tropical plants. Kasamaga, the king here, tells me he wants Europeans to settle here and teach his people; and a young fellow who is disposed to rough it, and fond of sport, might do very well here at Ruwenzori. He could support himself the first few years by ivory (shooting and trading), and by the time his plantation came into bearing there ought surely to be communication with the coast. A curious fact in natural history has come about here. Kabbarega has eaten up all the cattle in the country. There is scarcely a fowl left, and in consequence lions and leopards have taken wholesale to man-hunting. They have completely changed their manner of hunting in accordance with this. Usually speaking they are continually roaring on the trail, but here neither ever utters a sound, and though I have had two men injured, and been within a hundred yards of another man who was carried off, I heard nothing.

Mapping is very difficult here; the compass shows the most extraordinary variations, and the rivers are almost impossible to trace, even from a great height, as where I am now.

I have not been able yet to get at the higher flora. One curious fact is that the woods on Ruwenzori very closely follow the ordinary morning clouds and mists: these are usually at the same line every morning, and mount to the top towards evening. This line of wood or cloud is not, however, horizontal, but is highest at the main mass, and slopes gradually as the mountain chain sinks in height.

(Signed) G. F. Scott Elliot.

THE PHYSIOLOGICAL ACTION OF THE PARAFFIN NITRITES.[1]

THE valuable investigations described in this communication to the Royal Society have been made to determine more exactly the mode of action of paraffinic nitrites, and the part which the nitroxyl group NO_2 plays in their physiological action, and also to throw light on the effect of variations in their molecular constitution. For these objects a series of careful observations have been made as to the action of ten of the fatty nitrites on (1) blood pressure, (2) pulse frequency, (3) respiration, (4) striated muscle tissue.

The compounds selected for examination included the nitrites of methyl and ethyl, the primary and secondary propyl nitrites, the primary, secondary, and tertiary butyl nitrites, and three amyl nitrites (α and β isoprimary, and tertiary amyl nitrite). By this selection it has been possible to compare the action of a series of substances containing an atom of NO_2 united respectively to CH_3, C_2H_5, C_3H_7, C_4H_9, and C_5H_{11}, and thus to determine the modifying influence which these radicals exert on the action of the NO_2 group. It has also been possible to ascertain the effect produced by a modification of arrangement of the molecules in nitrites having the same composition as, *e.g.* in primary and secondary propyl nitrite,

$$CH_3CH_2CH_2NO_2, \text{ and } (CH_3)_2CHNO_2$$

It has long been known that the fatty nitrites lower blood pressure, but opinions have differed as to their mode of action, Filehne considering that this lowering is caused by a paretic influence on the vasa motor centres, whilst Brunton looks upon it as due to a direct effect on the vessels themselves. Cash and Dunstan are led by their experiments to range themselves on the side of

[1] *Phil. Trans.* vol. clxxxiv. (1893), B, pp. 505-639. A paper by Dr. J. Theodore Cash F.R.S., and Prof. Wyndham R. Dunstan.

Brunton, for they find that if the presence of amyl nitrite is confined to the vessels of the brain alone, a fall of pressure does not take place, but it does occur if blood containing the nitrite circulates in the peripheral vessels of the body, even though the access of any nitrite to the brain is prevented. They likewise find that nitrites are capable of influencing vessels in the area supplied by the splanchnic nerves after section of these nerves—another proof that the action of the nitrites is peripheral.

The part which the group NO_2 plays in its fatty compounds they have sought to determine by ascertaining quantitatively the comparative amount of influence which each nitrite exerts on blood pressure, pulse frequency, and respiration, when introduced into the circulation of anæsthesised cats, by inhalation or by injection into the arterial or venous system, and also by ascertaining the comparative effect of paraffinic nitrites on the pulse frequency in man.

The quantitative method is doubtless open to some fallacies, but from the extreme care which has manifestly been taken in conducting the experiments, and the laborious manner in which they have been repeated, it seems certain that the results are in the main reliable. With regard to the influence of the nitrites in accelerating the beat of the heart, it is shown that physiological activity increases with molecular weight; amyl nitrite is more powerful than butyl nitrite, butyl than propyl, and so on, methyl being the weakest of all.

The order in which the paraffinic nitrites reduce blood pressure in amount is somewhat, though not quite the same, as that in which they accelerate the pulse, but important exceptions occur, especially in the case of methyl nitrite, which occupies a higher position as a pressure reducing agent than it does as a pulse accelerator. On the other hand, as regards duration of subnormal pressure, the order is quite altered, the nitrites which depress blood pressure to the greatest extent acting for the most part for the shortest time.

The authors have also endeavoured to determine the comparative influence of the various nitrites on striated muscle by exposing the excised gastrocnemius and triceps muscles of frogs to equal quantities of their vapours, and recording the extent and duration of contraction produced with or without electric stimulation. This method is open to the objection that hydrolysis of nitrite vapours occurs very rapidly in the presence of aqueous vapour, nitrous acid being produced. Now, muscle tissue is very susceptible to the influence of acids, and it seems by no means certain that the contractions recorded may not have been in part, at least, due to the acid evolved from the nitrite decomposition. With one exception (propyl nitrite) it was noted that the nitrites with low molecular weight were the least powerful in causing muscle contraction, but they acted for the longest time.

Concerning the effects which constitution of the molecule apart from composition has, it was noted throughout that when the effects of primary, secondary, and tertiary nitrites having the same composition were compared, the secondary nitrite was found to have a more powerful influence on pulse acceleration, blood pressure, and muscular contraction than the primary, and the tertiary than the secondary.

The fact that the acceleration of the heart caused by the various fatty nitrites increases with their molecular weight indicates, as the authors justly assume, that the quickening action on the pulse cannot be simply conditioned by the amount of nitroxyl in their molecules, even though it may be true that the nitroxyl group itself quickens the heart's action, for the molecule of methyl nitrite, which is the least effective, contains the largest amount of NO_2, whilst that of amyl nitrite, which most powerfully accelerates the heart's action, contains less NO_2 than any of the other nitrites examined. A similar conclusion is drawn with regard to the influence of the nitroxyl element in causing lowered blood pressure. It is further pointed out, that the preponderance of the hydrocarbon molecules in the higher nitrites is not necessarily the cause of their increased influence in quickening the pulse and lowering pressure. There are other possible causes. After considering some of these the authors express their opinion that the more marked effect of the nitrites having the largest molecules but containing the smallest amount of NO_2 is due to their decreased chemical stability. They incline apparently to the view that the actual molecules of the paraffinic nitrites do not accelerate the heart's action and lower tension, and give reasons for believing that they may actually retard the rapidity of the heart's beat. When, however, the molecule is broken up, the nitrite element becomes active, entering, perhaps, into loose combination with hæmoglobin and certain tissues before it is finally oxidised and eliminated.

The lower combinations, such as ethyl and methyl, being, as they suppose, least easily broken up, exercise least power; on the other hand, for the same reason they act for a longer time, both in lowering tension and contracting striated muscle.

To the greater instability of secondary as compared with primary, and of tertiary as compared with secondary nitrites, they attribute their respectively greater power, rather than to the fact that in the secondary and tertiary compounds one and two methyl groups are respectively attached to the carbon combination of the nitroxyl group. Much remains to be done before the inferences drawn from the elaborate investigations, the results of which have been presented to the Royal Society, can be regarded as definitely proved; but this paper adds, in an important manner, not only to our knowledge of the action of the nitrites, but to our comprehension of the manner in which chemical agents influence the tissues, and become of therapeutic value.

THE LATE PROFESSOR J. P. COOKE.

THE death of Prof. J. P. Cooke was briefly announced in these columns on September 13. The following particulars, for which we are indebted to an obituary notice in the *Tribune* of Cambridge, U.S.A., will be read with melancholy interest by the scientific world:—

Josiah Parsons Cooke was born in Boston, October 12, 1827. He was prepared in the Boston schools, and entered Harvard College in 1845, graduating three years later. In the following year he was appointed an instructor, and, in 1851, Erving professor of mineralogy and chemistry, and director of the chemical laboratory of Harvard University, a post he held until his death.

At the time Prof. Cooke entered upon his duties as head of the chemical department at Harvard, the methods of instruction were of the most rudimentary sort. Students in chemistry were required only to hear so many lectures; work in the laboratory was thought unnecessary, its place being taken by the few experiments which the lecturer saw fit to perform before his classes. Now the chemistry courses at Harvard, as at all other American colleges, consist almost entirely of laboratory work. The credit for this change is due very largely to Prof. Cooke.

Prof. Cooke was made an LL.D. by the University of Cambridge in 1882, and received the same degree from Harvard in 1889. He was a Fellow of the American Academy and a Member of the National Academy of Science. He was a popular lecturer, and delivered several courses at the Lowell Institute, one of the best-remembered being that given in 1887 on the "Necessary Limitations of Scientific Thought."

He was the author of a number of books, pamphlets, and scientific papers. Perhaps the best known of his books was his "Religion and Chemistry," published in 1864, which maintained that the designs of a higher intelligence were to be discovered in the province of chemistry. Among other books were: "The New Chemistry," and its companion volume, "Laboratory Practice," reviewed in NATURE, vol. xlvi. p. 99, "The Elements of Chemical Physics," "The Principles of Chemical Philosophy," and "Scientific Culture."

Prof. Cooke was a highly cultivated man, whose attention was directed to many things outside of his own profession. One of his last published papers was written to recommend that scientific men should be educated more broadly. He did not believe in an exclusively scientific education.

His funeral on September 6 was attended by a group of men and women, whose mere presence was the highest compliment that could be paid to the memory of any man. The successors of Longfellow, Lowell, and the brilliant coterie with which Prof. Cooke was so long a part, were glad of the opportunity to show their love and respect for the man who was all but the last of his generation, there being only a very few of his early contemporaries left.

Among the well-known people present were President C. W. Eliot, Profs. H. B. Hill, W. W. Goodwin, Francis J. Child, Josiah Royce, C. L. Jackson, G. A. Bartlett, Edward Cummings, Ira N. Hollis, Dr. Samuel A. Green, Prof. William Watson (one of the secretaries of the American Academy of Arts and Sciences, of which Prof. Cooke was president), Dr. Henry P. Wolcott, and Dr. Benjamin E. Cotting.

NOTES.

Mr. Frank McClean, writing to Dr. Gill, under date of August 10, has expressed his desire to present a large equatorially mounted telescope, equipped for photographic and spectroscopic work, to the Royal Observatory at the Cape of Good Hope. With this object he has arranged with Sir Howard Grubb for the construction of a photographic refracting telescope of 24 inches aperture, and for an object-glass prism to work with it, having a refracting angle of 7½ degrees and the same aperture as the object-glass. The glass for the object-glass and prism have already been secured, and the definitive order for the instrument was given to Sir Howard Grubb on May 4 last. Coupled with the photographic telescope there is to be a visual refracting telescope of 18 inches aperture. The mounting is to be sufficiently elevated to allow a slit spectroscope, for the determination of stellar motions in the line of sight, to be attached to the photographic telescope, and the gift will include such a spectroscope, as well as an observatory of light construction. Subject to the concurrence of the Lords Commissioners of the Admiralty, Dr. Gill has cordially and gratefully accepted this noble gift to the Cape Observatory.

Capt. W. J. Wharton, the hydrographer of the Admiralty, has sent us a copy of a report, drawn up by Mr. P. W. Bassett-Smith, on the results of dredgings obtained on the great bank known as the Macclesfield Bank, in the China Sea. It may safely be asserted that never before has the biological condition of a sunken coral reef in mid-sea been so completely explored. One of the general results of the whole examination, hydrographical and zoological, is that on the whole of the two hundred miles forming the periphery of the bank, there exists a rim of coral in luxurious growth, and at a remarkably even depth below the surface of from ten to fourteen fathoms. Capt. Wharton points out that this evenness of depth is the most striking feature of the chart, and when the great distances are considered, this appears to be a strong argument against any movement of the bottom since the atoll form was assumed. It is at any rate quite evident that from the present time onwards no movement is necessary in order to form in the future a perfect atoll, the simple growth of the coral on the rim sufficing; and that we may have here an instance of a suitable original foundation for an atoll so formed, as pointed out by Mr. Darwin. Mr. Bassett-Smith's examination of the specimens was necessarily very cursory, and it is to be hoped that the mass of material collected may be thoroughly investigated by skilled zoologists at the British Museum, that full value may be obtained for the labour bestowed upon these examinations. The work is so admirable, and the results so important, that we shall return to the subject in a future issue.

At several London and provincial medical schools, on Monday last, the opening of the winter session was made the occasion for introductory addresses to the students. Dr. Isambard Owen, at St. George's Hospital, discoursed chiefly on the importance of mental training in medical study. He remarked that the method of the physician was the method ordinarily employed in all forms of physical investigation. Science consisted of soundly-drawn conclusions based upon accurately-made observations. Accurate observation was the foundation of all medical work; and Dr. Owen dwelt at some length on the fallacies of ordinary observation, and the scrupulous care needed to ensure exactitude. At St. Thomas's Hospital, the Rev. W. W. Merry delivered an address mainly concerned with Plato's criticisms upon the practice of medicine and surgery in Homeric times. Mr. G. Hartridge offered practical counsel to the students at Westminster Hospital, and, as an inducement to work, remarked that "the Royal Society numbers among its members a large proportion of medical men, a much larger number than all the other professions put together." At Middlesex Hospital, Dr. R. Boxall discoursed upon the relations existing between the public, the medical profession as a whole, and medical charities. Words of exhortation and advice were also offered at St. Mary's Hospital, by Dr. S. Spicer, and at University College Hospital, by Prof. H. R. Spencer. Miss M. Sturge advised the students at the London School of Medicine for Women to cultivate from the first a scientific habit of mind, as its possession was invaluable to the medical profession. Lord Bacon's words, "We must be content to stand before nature and ask questions; nature can only be subdued by submission," were quoted as a clue to the method of work of all great physicians.

The Council of the Institution of Civil Engineers has issued a long list of subjects upon which original communications are invited. Papers upon any question of professional interest will have their merits considered, even if they do not deal with subjects specified in the list. For approved papers the council has the power to award premiums, arising out of special funds bequeathed for the purpose, the particulars of which are as under:—(1) The Telford Fund, left "in trust, the interest to be expended in annual premiums, under the direction of the council." This bequest (with accumulations of dividends) produces £235 annually. (2) The Manby Donation, of the value of about £10 a year, given "to form a fund for an annual premium or premiums for papers read at the meetings." (3) The Miller Fund, bequeathed by the testator "for the purpose of forming a fund for providing premiums or prizes for the students of the said institution, upon the principle of the 'Telford Fund.'" This fund (with accumulations of dividends) realises nearly £140 per annum. Out of this fund the council has established a scholarship, called "The Miller Scholarship of the Institution of Civil Engineers," and is prepared to award one such scholarship, not exceeding £40 in value, each year, and tenable for three years. (4) The Howard

Bequest, directed by the testator to be applied "for the purpose of presenting periodically a prize or medal to the author of a treatise on any of the uses or properties of iron, or to the inventor of some new and valuable process relating thereto, such author or inventor being a member, graduate, or associate of the said institution." The annual income amounts to nearly £15. The next award will be in 1897. The council will not make any award unless a communication of adequate merit is received, but will give more than one premium if there are several deserving memoirs on the same subject. In the adjudication of the premiums, no distinction will be made between essays received from members of the institution or strangers, whether natives or foreigners, except in the cases of the Miller and the Howard bequests, which are limited by the donors. There is no specified date for the delivery of MSS., as when a paper is not in time for one session it may be dealt with in the succeeding one.

THE Queen has been pleased, on the recommendation of the Secretary for Scotland, to approve of the appointment of Mr. Angus Sutherland, M.P., as chairman of the Scottish Fishery Board.

THE death is announced of Prof. K. M. Albrecht, of Hamburg, at the age of forty-three. He was the author of several important researches in the domains of zoology and comparative anatomy.

DR. CHARLES L. EDWARDS has been appointed to the Chair of Biology in the University of Cincinnati, Ohio, U.S.A.

AT St. Helens, on Tuesday, Colonel Gamble laid the foundation-stone of an institute which is to form a central library and reading-room and a school for technical education and manual instruction. He has given the site, and will spend £20,000 on the building.

MR. WILLIAM LUNT, of the Royal Gardens, Kew, who acted as botanical collector to Mr. Theodore Bent's expedition to the Hadraumaut Valley, Southern Arabia, has been appointed, by the Secretary of State for the Colonies, Assistant Superintendent of the Royal Botanic Gardens, Trinidad.

SEVERAL earthquake shocks, accompanied by subterranean rumblings, were felt at Dortmund, Germany, on Tuesday morning, and caused some alarm.

AT the meeting of the Royal Photographic Society, to be held on Tuesday next, the medals will be presented to successful exhibitors at the annual exhibition, and the President will deliver an address.

THE new buildings of the Durham College of Science, Newcastle-upon-Tyne, will be opened by the Mayor of Newcastle on Tuesday, October 9.

SUNSHINE is such an untrustworthy quantity in the climate of the British Isles, that it is no wonder that professional photographers have for some time been developing methods for making themselves independent of it. Judging from the extent in which artificial illumination is used in photographic studios at the present time, it seems probable that a few years hence the sun will be largely (if not entirely) disregarded in negative-making. An exhibition of apparatus for illuminating studios, and some of the pictures obtained by means of artificial light, is now being held at the *Photogram* Commercial Museum, and will remain open until the end of this month. A number of interesting exhibits are on view. There are various magnesium lamps, electric lamps designed for portraiture work, and gas-light systems for studios. Two of the most interesting instances of the use of magnesium flash-lamps are to be found in the pictures obtained by Mr. J. C. Burrows in the tin mines of Cornwall, and Mr. H. W. Hughes in the coal mines of the Black Country. The exhibition well deserves a visit.

THE *Weather Review*, edited by Mr. John Eliot, and published every month by authority of the Government of India, always contains an admirable summary of the chief features of the weather in India during the month to which it refers. The annual summary, which has just reached us, contains a discussion of the meteorology of India for the year 1893. The report reminds us that meteorological data in India are chiefly utilised for the following purposes: (1) In the discussion of the prevalence and spread of diseases, more especially of cholera and other diseases of an epidemic character; (2) in connection with agricultural questions, more especially the progress and character of the crops as determined by the weather conditions of the period. In the monthly reviews, all the meteorological facts and data are therefore presented from these two points of view. For medical statistics India is divided into eleven provinces, which are believed to be fairly homogeneous so far as the conditions of the prevalence of the more common diseases are concerned. According to the second method of arrangement, there are fifty-two meteorological divisions, or areas divided from an agricultural standpoint. By following this plan, the meteorological data available are made to yield the greatest amount of good to the people of India.

QUESTIONS of natural history assume a particular value when they deal with the supply of a popular article of food, and we present, therefore, some conclusions recently arrived at by Mr. F. H. Herrick, of the U.S. Fish Commission, upon the reproductive habits of the American lobster (*Zoologischer Anzeiger*, xvii. No. 454). It is not improbable, as Mr. Herrick suggests, that the habits of the European lobster are essentially the same as those of its American relative. (1) The majority of adult females extrude their eggs during June, July, and August, but a considerable number—probably 10 per cent. of the entire number which breed in the year—lay eggs in the autumn, winter, and spring. (2) The lobster cannot possibly breed oftener than once in two years. (3) The eggs are carried by the mother for ten or eleven months: on the coast of Massachusetts, from the middle of July to the middle of the following June. (4) Sexual maturity is reached occasionally at a length of 8 inches, but sometimes not under 12 inches. The majority, however, are mature when $10\frac{1}{2}$ inches long. (5) The numbers of eggs produced by female lobsters at each reproductive period increase in a geometrical series, while the lengths of the lobsters producing these eggs vary in an arithmetical series. A lobster 14 inches long will produce four times as many eggs at one laying as a lobster of only 10 inches. (6) Out of the 10,000 eggs produced at one time, not more than two arrive at maturity, and even this estimate is probably too high, as the fisheries are now declining.

THE exact measurement of the density of very dilute aqueous solutions to within a millionth of its value, is the subject of a paper by F. Kohlrausch and W. Hallwachs in *Wiedemann's Annalen*. The method adopted was that of suspending a glass globe in the solution by a fine thread, and determining its weight. The thread found most suitable was a single smooth cocoon fibre. Small disturbing fibres or dust particles could be detected by the behaviour of the swinging balance. The stirring was done by means of a glass rod bent into a horizontal ring at the bottom, and carrying a ring of platinum foil. During stirring, the glass body was lifted by another glass ring provided with pieces of platinum wire to prevent the body sticking to it. The thermometer indicated hundredths of Centigrade degrees, and could be read to thousandths by the telescope. The sensitiveness of the balance employed was not excessive, since it gave a deflection of two-thirds of a millimetre for a milligram. The weight of the suspended body was 133·310 gr., and the loss of weight in the solutions was always over 129 gr., so that the thread was not required to support more than 4 gr. The loss of weight in pure water was 129·194 gr. at 17·5° C., and did not vary by more than 0·002 gr. in five months. The difference in the individual numbers for the loss of weight in any given liquid was 0·11 mg. on the average, which corresponds to about a millionth of the density to be determined. These very accurate determinations brought out some interesting details with regard to the "molecular volumes" of the substances in solution. Phosphoric and sulphuric acids showed a decided diminution of this volume at extreme dilutions, while sugar, hydrochloric and acetic acid, and sodium chloride and carbonate did not show this diminution.

THE *Annales de Chimie et de Physique* for September contains a paper, by M. Henri Bagard, on the thermoelectric force between two electrolytes, and on the Thomson effect in the case of electrolytes. The paper contains a very complete history of the work which has been done on this subject. The author uses a number of thermoelectric junctions joined in series, and measures the electromotive force developed by a given difference in temperature between the hot and cold surfaces of separation between the electrolytes by means of a capillary electrometer. This electrometer was capable of indicating an electromotive force of one-hundred-thousandth of a volt. In order to check the diffusion which takes place at the common surface of the electrolytes, the author uses a porous membrane. By using membranes composed of such different substances as goldbeater's skin and vegetable parchment, it was proved that the membrane had no effect on the electromotive force, except to cause it to diminish slightly with time. Thus the results obtained with a membrane are probably identical with what would be obtained could observations be made without a membrane, and without diffusion and convection currents being set up through the surface of separation. Observations were taken both while the temperature of one junction was rising and again when cooling. The points obtained during the second of these operations often fell below the curve given by the previous set. This effect, which never amounted to a difference of $\frac{1}{10000}$ volt, the author considers to have been entirely due to diffusion. Thermoelectric couples, consisting of solutions of two different salts, and of solutions of the same salt but of different concentration, were examined, and the results obtained are shown by means of curves. In order to examine the Peltier and Thomson effects in the case of electrolytes, small bolometers were employed to measure the change in temperature. The important fact that the Peltier effect is of opposite sign on opposite sides of the neutral point was amply verified, and it appears that the change of sign takes place at the neutral point. In all cases the thermoelectric phenomena, the Peltier effect and the Thomson effect gave results in the case of electrolytes similar to those obtained with metals.

"CREAMERIES and Infectious Diseases" is the title of a short paper which Dr. Welply has had reprinted from the *Lancet*. It is a most useful little pamphlet, inasmuch as it calls attention to a danger which, so far, has escaped public notice. Creameries receive, as is well known, their milk from a number of farms; but after the cream has been removed, some of the skim or separated milk is sent back to the farms, where it is consumed in various ways. The milk received from the various farms is all mixed together, and thus it is not difficult to see how one case of typhoid fever, or some other illness on one of these farms, may not only infect the creamery, but may, by means of the separated milk, infect the whole group of dairies supplying this creamery, thus starting an indefinite number of fresh disease centres. Dr. Welply describes an outbreak of typhoid fever which he traced to a creamery, and to the use of food or milk from dairies which became infected secondarily. In several of the dairies which he visited, he states that he found the dairy-maids acting in the dual capacity of milkers and nurses, and he is distinctly of opinion that the contagium got into the milk from the hands of the dairy-maids. It is clear that unless we can obtain stringent regulations passed, such as are in use in Denmark, Sweden, and Germany, and which our Board of Agriculture have published in their reports on dairy farming in these countries, unless we can procure similar legislative measures, co-operative dairy farming in England will always remain a continual source of danger to the public health. Dr. Welply says "it would be wise at all times to boil separated milk when used as an article of human diet"; we would go still farther, and say that it is undesirable to drink any milk which has not been previously thoroughly boiled, not warmed or brought to the boil, but boiled for several minutes. The National Health Society took this question up some years ago, and issued a short leaflet on the advisability of boiling all milk before use.

LUERSSEN AND HAENLEIN'S *Bibliotheca Botanica* will in future be edited by Prof. C. Luerssen and Prof. B. Frank.

MESSRS. BLACKIE AND SON have just issued part 6 of Prof. Oliver's translation of Prof. Kerner's "Natural History of Plants."

WE have received the Calendars for the Session 1894–5, of the University College, Bristol, the Durham College of Science, Newcastle-upon-Tyne, and the Merchant Venturers' Technical College, Bristol.

THE General Report on the Operations of the Survey of India Department for 1892–93 has just been issued from the office of the Superintendent of Government Printing, Calcutta.

THE June number of *Timehri*, the journal of the Royal Agricultural and Commercial Society of British Guiana, has just come to hand, and contains, as usual, a number of very varied and interesting papers, notably, "The Guiana Orchids," by the editor—James Rodway; "Late Rainfalls, some of their Effects," by James Gillespie; and "Some Enemies of our Canefields," by S. R. Cochran. The society celebrated the fiftieth year of its existence in March of this year, when a successful historical exhibition was held in honour of the event.

THE sixteenth annual meeting of the Greenock Natural History Society was held on September 28, Mr. T. L. Patterson, president, occupying the chair. During the session 1893–94 seven papers were read, viz.: "The Sorghum Sugar Experiments in the United States," by Mr. T. L. Patterson; "A Study of Fungi," by Dr. M. Calder; "Scenes from Australia," by Mr. Thomas Steel; "Gems and Precious Stones," by Mr. James M'Neil; "The Evolution of Navigation and Nautical Astronomy," by Mr. G. W. Niven; "Plants with Angular Stems," by Mr. John Ballantyne, Rothesay; "Notes on the Cladocera," by Mr. M. F. Dunlop.

"SCIENCE is measurement." Mr. J. Lawrence, of 56 Fulham Road, London, evidently believes that the converse of this is true, for he has sent us a "Tell-tale" milk-jug, which London milkmen will probably regard with sorrowful feelings. The object of the jug is to furnish householders with a standard wherewith to judge the probity of their dairymen. The jug is a glass measure graduated at every quarter-pint. Below each pint and half-pint mark three lines are etched showing the thickness of cream which should appear in milk of average quality, in milk of good quality, and in milk of very good quality after the liquid has been allowed to stand for a time. Both the quantity and the quality of the milk can thus be easily tested.

The Society for Promoting Christian Knowledge have just brought out a second edition of "Our Secret Friends and Foes," by Prof. Percy Frankland, F.R.S. It will be remembered that the volume was the source of a good deal of discussion between some members of the Society, who, with the late Lord Coleridge at their back, announced their intention of retiring from their membership unless the book was withdrawn from circulation, it being, according to their interpretation, written in support of vivisection. That the Society did not yield to the very considerable pressure brought to bear upon them, is evidenced by the appearance of the second edition, which, whilst containing an entirely new chapter on the action of light on micro-organisms, remains otherwise, with the exception of a few (mostly verbal) alterations, unchanged.

Messrs. Chapman and Hall will publish, almost immediately, a complete "Text-book of Mechanical Engineering," by Mr. W. J. Lineham, the Head of the Engineering Section of the Goldsmiths' Institute, New Cross. The work consists of nearly eight hundred pages and more than seven hundred figures. The first half is devoted to practical work, viz. casting and moulding, pattern-making, and casting design; metallurgy and properties of materials; smithing and forging; machine tools; marking off; fitting, machining, and erecting; boiler-making and plate-work. The second part of the book deals with theory and examples, the order of treatment being strength of materials; energy and the transmission of power to machines and heat engines; hydraulics and hydraulic machines. The book is not supposed to be an exhaustive treatise on mechanical engineering; nevertheless, it will be a valuable aid to engineering students and apprentices, and engineering draughtsmen generally.

Since the publication of "Forthcoming Scientific Books" in our issue of September 20, the following list of announcements has been sent to us by the Cambridge University Press:—"The Scientific Papers of John Couch Adams"; "A Treatise on Spherical Astronomy," by Prof. Sir Robert S. Ball, F.R.S.; "Hydrodynamics: a Treatise on the Mathematical Theory of the Motion of Fluids," by Prof. H. Lamb, F.R.S., new edition; "Catalogue of Scientific Papers compiled by the Royal Society of London," new series for the years 1874–83, vol. xi. in the press; "A Treatise on Geometrical Optics," by R. A. Herman; "An Introduction to Abel's Theorem and the allied Theory," by H. F. Baker; "A Treatise on Geometrical Conics," by F. S. Macaulay; "An Elementary Introduction to Mineralogy," by R. H. Solly; "Euclid's Elements of Geometry," Books XI. and XII., by H. M. Taylor; "Arithmetic for Schools," by C. Smith, with or without answers, second edition; "Key to C. Smith's Arithmetic"; "Practical Physiology of Plants," by F. Darwin, F.R.S., and E. H. Acton; "Practical Morbid Anatomy," by Dr. H. D. Rolleston and Dr. A. A. Kanthack; "The Distribution of Animals," by F. E. Beddard, F.R.S.; "Petrology," by A. Harker; "Text-book of Physical Anthropology," by Prof. Alexander Macalister, F.R.S.; "The Vertebrate Skeleton," by S. H. Reynolds; "Fossil Plants: a Manual for Students of Botany and Geology," by A. C. Seward; "Elements of Botany," by F. Darwin, F.R.S.; "Mechanics and Hydrostatics," by R. T. Glazebrook, F.R.S.; "Electricity and Magnetism," by the same author.

Messrs. Charles Griffin and Co. have also sent a list of the scientific books they hope to issue during the ensuing season; it is as follows:—"Petroleum," a treatise on the geographical distribution, geological occurrence, chemistry, production, and refining of petroleum; its testing, transport, and storage, and the legislative enactments relating thereto, together with a description of the Shale Oil industry, by Boverton Redwood, assisted by Geo. T. Holloway, with maps and illustrations; "Calcareous Cements: their Nature, Preparation, and Uses," with some observations on cement testing, by Gilbert R. Redgrave; "Griffin's Chemist's Pocket-book": tables and data for analysts, chemical manufacturers, and scientific chemists, by J. Castell-Evans; "Measurement Conversions" (English and French), 28 graphic tables or diagrams, showing at a glance the mutual conversion of measurements in different units of length, areas, volumes, weights, stresses, densities, quantities of work, horse powers, temperatures, &c., for the use of engineers, surveyors, architects, and contractors, by Prof. Robert Henry Smith; "The Metallurgy of Iron," by Thomas Turner; "An Elementary Text-book of Metallurgy," for the use of younger students and those commencing the study of metallurgy, by Prof. A. Humboldt Sexton, with numerous illustrations; "Kitchen Boiler Explosions: why they occur, and how to prevent their occurrence," a practical hand-book, based on actual experiments, by R. D. Munro; "Fibroid Diseases of the Lung, including Fibroid Phthisis," by the late Sir Andrew Clark, Bart., F.R.S., and Drs. W. J. Hadley and Arnold Chaplin, with tables, and eight plates in colours; "Practical Hygiene," including air and ventilation, water, supply and purity; food and the detection of adulterations, sewage removal, disposal, and treatment, epidemics, &c., by Surgeon-Major A. M. Davies, with illustrations; "A Manual of Ambulance," by J. Scott Riddell, with numerous illustrations and full-page plates; "The Hand-Rearing of Infants: a Guide to the Care of Children in Early Life," by Dr. John Benj. Hellier; "Year-book of the Scientific and Learned Societies of Great Britain and Ireland," compiled from official sources, including lists of the papers read during 1894 before Societies engaged in fourteen departments of research. Twelfth annual issue (early in 1895).

One of the most striking features of chemical progress at the present time is the rapid advance which is being effected in our knowledge of the compounds of nitrogen. Another compound of primary importance, symmetrical hydrazo-ethane, $C_2H_5NH.NHC_2H_5$, the symmetrical di-ethyl derivative of hydrazine, has been isolated in the laboratory of the Berlin University by Dr. Harries. Prof. Emil Fischer has already obtained the unsymmetrical di-ethyl hydrazine, and Prof. Curtius, to whom we owe the discovery of hydrazine itself, some time ago succeeded in obtaining the symmetrical di-benzyl hydrazine, but hitherto the simple symmetrical fatty hydrazines have eluded isolation. Indeed it is only by a somewhat circuitous, although practically quite easy, series of reactions that symmetrical di-ethyl hydrazine has at length been prepared. A remarkable derivative of hydrazine was first obtained, in which one hydrogen of each amidogen radicle was replaced by the radicle formyl, CHO, and the other by the metal lead, the compound being represented by the formula

$$\begin{array}{c} CHO{-}N{-}N{-}CHO. \\ \diagdown\;\diagup \\ Pb \end{array}$$

This substance, a white powder, is readily obtained by reacting with sodium upon di-formyl hydrazine, a compound with which Prof. Curtius has made us familiar, and subsequently decomposing the latter with sugar of lead. The lead compound, when slightly heated in a sealed tube with ethyl iodide, together with sand to maintain porosity, and magnesia to fix the liberated hydriodic acid, is converted into a compound in which the lead atom is replaced by two ethyl groups. This latter compound, a somewhat volatile liquid, is treated with fuming hydrochloric acid, which removes the formyl groups and converts the compound into symmetrical di-ethyl hydrazine hydrochloride, which is precipitated. Upon distillation with caustic potash the free di-ethyl hydrazine passes over at 85°. The new compound is a liquid of pleasant odour, reminding one at the same time of ether and of weak ammonia. It reduces Fehling's solution with great energy upon gently warming, and silver nitrate in the cold. It vigorously attacks caoutchouc. Its hydrochloride contains two molecules of hydrogen chloride, and crystallises well in plates melting at 160°. The symmetrical di-ethyl hydrazine behaves in a most interesting manner with certain oxidising agents, particularly mercuric oxide. The yellow oxide reacts in a most violent manner, but the red oxide affords a more manageable reaction; the products are a large quantity of mercury di-ethyl, $Hg(C_2H_5)_2$, and a smaller quantity of azoethane, $C_2H_5N = NC_2H_5$, the ethyl analogue of the well-known azobenzene. The symmetrical and unsymmetrical di-ethyl hydrazines are clearly distinguished by their reactions with nitrous acid, for while the latter yields di-ethylamine and nitrous oxide, the former affords ethyl nitrite together with a smaller quantity of a nitroso compound.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus sinicus*, ♂ ♂) from India, presented respectively by Mr. Philip E. Morel and Miss Ling; a Common Marmoset (*Hapale jacchus*) from Brazil, presented by Mr. A. E. W. Burns; a Brush-tailed Kangaroo (*Petrogale penicillata*, ♀) from New South Wales, presented by Lady Isabel Clayton; three Australian Cranes (*Grus australasiana*) from Australia, a Brown Crane (*Grus canadensis*) from North America, an Indian White Crane (*Grus leucogeranos*) from India, presented by Mr. E. W. Marshall; two Californian Quails (*Callipepla californica*) from California, presented by Mr. H. H. Howard Vyse; a Ground Hornbill (*Bucorvus abyssinicus*), from Nyassaland, presented by Mr. H. H. Johnston, C.B.; three Pratincoles (*Glareola pratincola*), four Night Herons (*Nycticorax griseus*), a Great Bustard (*Otis tarda*), South European, presented by Lord Lilford, three Dwarf Chameleons (*Chamaeleon pumilus*) from South Africa, presented by Mr. C. Stonham; two Cerastes Vipers (*Vipera cerastes*), two Egyptian Eryx (*Eryx jaculus*), a Cliffords Snake (*Zamenis cliffordi*) from Egypt, deposited; A Simonys Lizard (*Lacerta simonyi*) from the Island of Hiero, Canaries, presented by Mr. Sydney Crompton; a Deadly Snake (*Trigonocephalus atrox*) from Trinidad, presented by Messrs. Mole and Urich; an Axis Deer (*Cervus axis*), a Rufous Rat Kangaroo, *Hypsiprymnus rufescens* born in the Gardens.

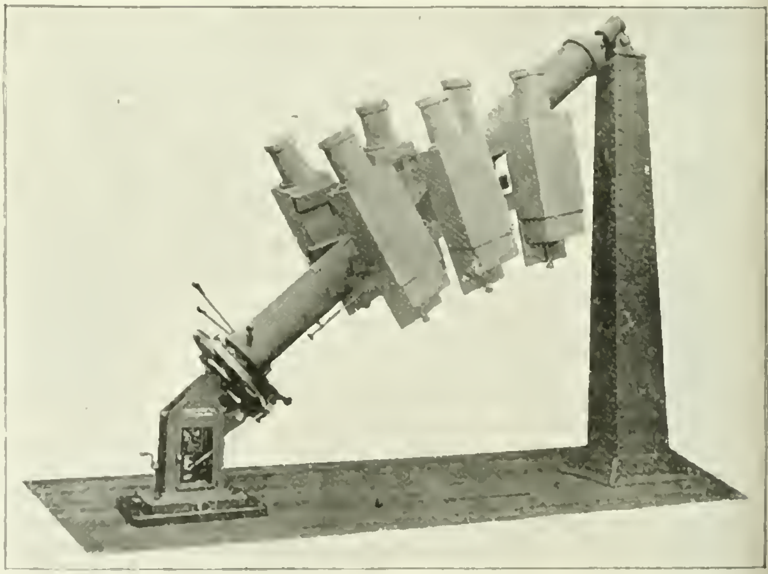
OUR ASTRONOMICAL COLUMN.

AN INSTRUMENT FOR PHOTOGRAPHING METEORS.—Up to the present time meteoric astronomy has had little, if any, instrumental equipment to further its development, the nature of the phenomena rendering simple naked eye observations the only available means of research. It is true that even now we know of a very considerable number of radiant points, and what is more, we have been able to note the daily movements of some of these in the heavens; but this knowledge has only been gained by the great patience and perseverance of astronomers, the most notable being Mr. W. F. Denning. With a thorough knowledge of the constellations, a good globe or star-map, and an accurate eye, he has been able to plot down track after track of these travellers through space, deducing from their paths the points in the heavens from which they are coming.

What will most probably lead to a great advance in the determination of the positions of these radiant points, is the introduction of photography for recording permanently the visible tracks in the sky. There may have been many attempts already for photographing these trails, and the writer himself a few years back, with an ordinary camera, was fortunate enough to catch nine trails on the sensitive plate. The camera being fixed and not equatorially mounted, the star images were consequently curved arcs, and not points. Even on this plate fairly accurate positions of the trails could have been obtained.

A somewhat unique instrument for locating the tracts of meteors and their radiant points, has recently been constructed by Messrs. Warner and Swazey for the Yale University Observatory. The accompanying illustration of the instrument is from *Popular Astronomy* for September.

The illustration shows the polar axis of the "English" form carrying a number of cameras. The axis is of a tubular form, about twelve feet long, the ends working on pivots which are capable of adjustment. The southern support is connected with clockwork, while that at the northern end is supported on a pillar in which are the driving weights in connection with the clock by cords passing under the floor. On the declination axis are fitted two arms which serve as supports to the cameras, three cameras being on the eastern and three on the western side. These cameras are so oriented that they take, in their



respective fields, adjoining portions of the sky, so that altogether they cover a very large area. The instrument is supplied with slow motions, both in right ascension and declination, and the clockwork has an electric control. Whether satisfactory results have yet been obtained, one cannot say, but the apparatus was intended to be used for the Perseid swarm of October last.

SUN-SPOT OBSERVATIONS AT THE POTSDAM OBSERVATORY.

IN the publications of the "Potsdam Astrophysical Observations," Dr. Sporer has previously (No. 17) presented us with the observations of the sun-spots for the years 1880 to 1884. The most recent addition to these records will be found in No. 32, in which are collected the sun-spot observations for the years 1885 to 1893. The observations themselves are given in all details, being grouped together with regard to the period of rotation. These are followed by a brief discussion, from which these notes and extracts have been made.

The following table, bringing together the results relative to frequency and positions (as regards latitude) of the spots may be first given, as many references will be made to the numbers therein :—

Year.	Frequency. Northern hemisphere.	Frequency. Southern hemisphere.	Frequency. Both hemispheres.	Mean heliographic latitude. Northern hemisphere.	Mean heliographic latitude. Southern hemisphere.	Mean heliographic latitude. Both hemispheres.
				°	°	°
1870	738	765	1503	+17·0	−18·9	17·9
1871	545	605	1150	17·8	14·8	16·2
1872	523	618	1141	16·0	13·2	14·5
1873	323	415	745	13·3	11·2	12·1
1874	249	246	495	11·0	11·2	11·1
1875	108	85	193	11·0	10·4	10·9
1876	44	81	125	10·3	10·0	10·1
{ 1877	48	66	114	8·3	9·7	9·1
{ 1878	30	10	40	7·8	7·0	7·6
{ 1879	11	3	14	8·3	6·1	7·8
{ 1877	3		3	29·3		29·3
{ 1878	1	1	2	34·4	20·2	27·3
{ 1879	23	37	60	24·5	21·9	22·5
1880	218	156	374	20·0	20·3	20·1
1881	318	252	570	18·0	19·9	18·8
1882	366	311	677	15·4	16·9	16·1
1883	286	546	832	11·5	13·4	12·7
1884	373	460	833	10·5	11·9	11·3
1885	198	444	642	10·2	12·2	11·6
1886	103	226	329	9·9	10·5	10·3
1887	53	120	173	8·5	9·2	8·5
1888	22	80	102	5·9	6·9	6·7
{ 1889	12	44	56	6·3	6·2	6·2
{ 1890	2	9	11	3·5	7·9	7·1
{ 1889	6	27	33	25·8	23·3	23·7
{ 1890	64	71	135	22·2	25·0	23·7
1891	383	142	525	19·8	19·9	19·9
1892	453	416	869	15·3	20·2	17·6
1893	437	627	1064	14·4	15·3	14·9

From the table above, it will be seen that the minimum of 1878 was followed after 5·2 years by a maximum in 1884·0. The mean heliographic latitude of the spots at this period of maximum decreased to 12°, which is lower than was the case at the preceding maximum. Following this a minimum in 1889·5 occurred, the precession of spots disappearing at the mean latitude of 7°, and a new series beginning in 1889 at 40° on the southern hemisphere, and somewhat later at 23° and 35° on the northern hemisphere. Higher latitudes were at times recorded, the highest occurring in September 1893 and amounting to 42°. The mean yearly heliographic latitude for 1893 diminished to 15°. For the earlier part of the present year five periods of rotation have given for the mean latitude also 15°, indicating, when compared with the two foregoing periods, a further decrease in the numbers representing the "frequency." The time of maximum then can apparently be placed at 1893·5, but this would most probably have to be altered if the more recent observations show a further rising.

An examination of the Carrington observations also shows this movement in the heliographic latitude. Wolf, to explain it, suggested the existence of currents, which commenced with a minimum on both hemispheres in high latitudes, and continued to the following minimum towards lower latitudes. As indications of these currents, it might be stated that at the times of maximum suitable stripes appear on the meridian, which are for a long time free from spots and faculæ. This suggests that "special channels exist from time to time for the hypothetical currents."

Dr. Spörer next examines the old sun-spot observations for finding out the period from the "rate" of the heliographic latitudes. The cases he takes into consideration show, as he says, "eine genügende Uebereinstimmung mit den neueren Beobachtungen in Betreff des Ganges der mittleren heliographischen Breite während der Haufigkeits perioden. Dagegen scheinen nach dem Jahre 1614 in einen Zeitraume von 70 Jahren wesentlich andere Verhaltnisse geherrscht zu haben."

Different records, he goes on to say, agree that from 1645–70 the spots observed were few. After this the number increased, reaching an important maximum in 1716. It was even then remarked (in 1715) that it was curious to note that spots were visible on different parts of the solar disc at the same time. In 1704 and the following year, one case occurred in which spots at the same time, but on two different positions of the disc, were seen; it was here expressly stated that such had not been observed for sixty years. Other instances (two) of this "scarce" case occurred in 1707. In 1716, spots were seen for several days, in eight different places on the disc.

Bringing together the positions of the observed spots, as regards latitude, Dr. Sporer adds that from 1671–1713 none were found in high latitudes. The highest (in 1703) was 19°. Previous to this, from November 1700, the latitude lay between 2° and 12°. At this time higher latitudes had been normal, because from May 1695–Nov. 1700 not a single spot had been observed. For this reason Prof. Wolf is stated to have assumed a minimum (1698·0), and determined the following minimum 1712·0, the authenticated records giving the information that no spot appeared in the years 1711 and 1712.

Some interesting facts may be stated now regarding the spots on the respective northern and southern hemispheres. The deficiency of spots for the former is "noch besonders hervorzuheben." In 1671, during two periods of rotation, a spot (12° N. Lat.) was observed. In 1705 and 1707 a spot is also cited to have been seen, but the northern hemisphere was free from them until 1713, and it was not till 1714 that they were then found to be numerous; thus one can hardly assume that, besides those recorded on the northern hemisphere, more spots in greater number appeared, for Cassini mentioned expressly, from the observation of a spot from the year 1707, "the spot deficiency of the northern hemisphere," and at the same time remarked "that the constitution of the northern hemisphere was different in a certain manner from that of the southern hemisphere." A glance at the records for the period 1644–1670 also shows that in the "period of seventy years on the northern hemisphere certainly no periodicity of spots had occurred."

The behaviour of the two hemispheres, as regarded in the light of more recent observations, is also very striking, and since 1883 the southern hemisphere has received the greater preponderance of spots. This continued to be the case during the minimum, and only discontinued when a rise of the number of spots had begun on the two hemispheres. The year 1891 was a critical year, on account of the astonishing change that was brought about.

While on the southern hemisphere the number of spots only slowly increased, that on the northern hemisphere attained considerably greater proportions. The resulting ratio for the spots during the year 1891 was as 8 : 3 for the northern and southern hemisphere respectively. The nature of this preponderance for the northern hemisphere was not more than temporary, for in 1892 it had greatly diminished, and the southern hemisphere had again attained its old position. Last year the proportion for the northern and southern was as 7 : 10.

The division of the spots with regard to their heliographic latitude displays also differences for the two hemispheres. A table bringing together the results for five periods of rotation indicates a great difference in the mean values of the heliographic latitudes; this difference, on the other hand, is to a certain extent eliminated if one deals with the yearly mean.

Reference is made also to the great change that occurs in the "Rotationswinkel" of some spots. "The most simple case for such a difference of the angle of rotation teaches us, if only in the first instance a spot with a penumbra is present, that a division takes place, which results in the appearance of two separate spots. Such spots regularly move away from one another, each having a separate penumbra. The observations furnish examples which show that the distance of the spots for many days continually increases, and that the angle of rotation of the preceding spot is very considerably greater than that of the following one." The observations included in this volume contain examples of these in great number.

W. J. L.

PHYSICS AND ENGINEERING AT THE McGILL UNIVERSITY, MONTREAL.

SO long ago as 1855, Sir William Dawson pointed out the importance to the McGill University of a department of practical science. But though some attempt was made to carry out the suggestion, little success was obtained until 1878, when the department was constituted a Faculty of Applied Science, with Prof. H. T. Bovey as Dean. The Faculty passed through many vicissitudes, but it was placed on a firm basis at the beginning of last year, by the opening of well-furnished workshops and laboratories equipped with the best and most modern apparatus for scientific investigations in all kinds of engineering and physics. A description of the opening ceremonies has lately been published in a souvenir volume, together with descriptions of the main features of the laboratories. We are indebted to this volume for the following information, and to Dean Bovey for the accompanying illustrations.

The McDonald Engineering Building, erected and equipped through the munificence of Mr. W. C. McDonald, one of the Governors of the University, is a fine structure containing laboratories for all branches of engineering work. The Physics Building owes its existence to the generosity of the same donor. It has been designed for the teaching and study of physics (including mechanics) with special regard to (1) its intrinsic importance as an integral part of a liberal education in the Faculty of Arts; (2) its essential necessity as a study preliminary to the courses of engineering, mining, and practical chemistry in the Faculty of Applied Science, and (3) the prosecution of scientific research. The completeness and liberality with which all the necessary plant has been put into these buildings may be judged from the accompanying illustrations and brief descriptions. It will astonish the various authorities who have similar technical institutes under their control in this country, to know that the cost of the equipment alone of the two buildings came to very nearly one hundred thousand pounds sterling! Compare this princely generosity with the fact that only twenty-three thousand pounds were asked for to erect and equip the Engineering Laboratory of the University of Cambridge. The exact amount of Mr. McDonald's benefactions has not been told, but they are certainly nearer seven than six figures. Everything, in fact, required in the pursuit of physical and engineering study has been lavishly provided. Few occupiers of chairs of Physics here are in the fortunate position of Prof. Cox. He was instructed to spare no expense in obtaining everything required to carry on work in experimental physics. "From first to last," he says, "whether it was a question of part of the buildings or of the equipment, I have heard no other language from Mr. McDonald than 'Let us have everything of the best, with a definite aim for everything, but always the best.'"

The Thermodynamic Laboratory (Fig. 1), in which heat engines are studied, has a very notable equipment.

The great feature of interest is a four-cylinder steam engine arranged double tandem fashion, and intended for use in a large number of totally different ways. This machine, designed by Messrs. Schonheyder and Druitt Halpin, of London, under the general direction of Prof. Carus-Wilson, of McGill College, was manufactured by Messrs. Yates and Thom, Blackburn.

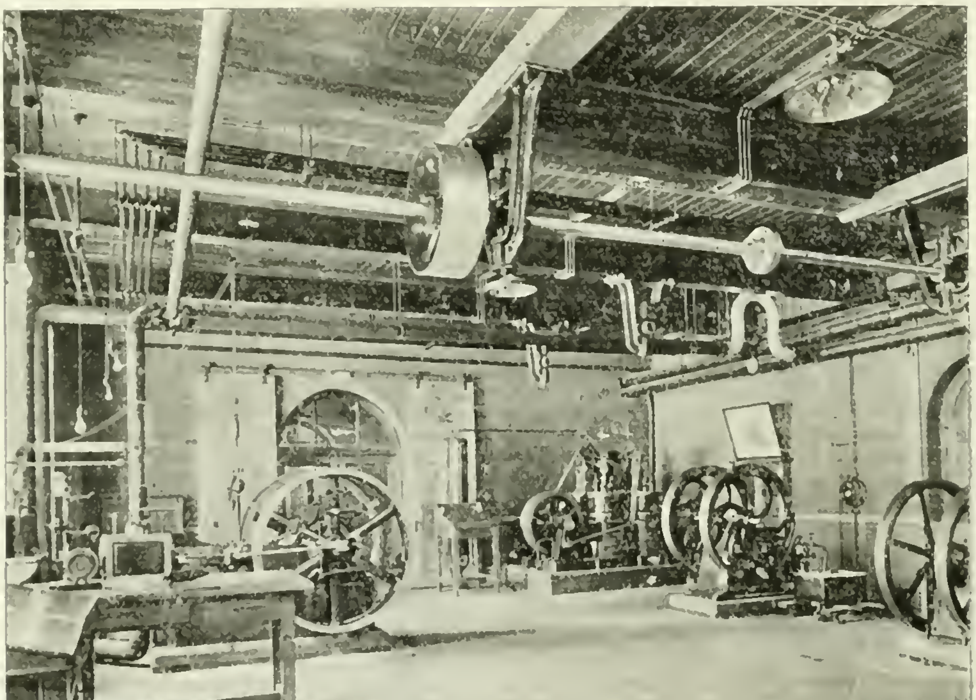


FIG. 1.—Thermodynamic Laboratory.

The engine may be described as a double tandem inverted direct acting quadruple expansion engine, to work at 200 lbs. pressure on the gauge, developing eighty horse-power at about 150 revolutions. The two engines may be uncoupled from each other, and run at different rates of speed on the plan proposed by Mr. John I. Thornycroft, and already carried out on the triple expansion engines at the Owens College, Manchester; and in this way the advantages of variation of relative cylinder volume are to some extent obtained.

The measurement of the power delivered to the brakes is made by means of hydraulic brakes of the types designed by the late R. E. Froude, and improved by Prof. Osborne Reynolds.

The steam pipes about the cylinders are so arranged that the engines may run either quadruple, triple, double, or single expansion. And as the pipes are led both to condenser and atmosphere, all these types may be tried either condensing or non-condensing.

In fact, a complete balance-sheet of the heat supplied, used, and rejected by the engines can be made, and the materials for the study of cylinder condensation by Hirn's analysis are easily obtained.

Several other engines and boilers are available for experimental purposes.

The Third-year Laboratory contains apparatus for the demonstration of the properties of the permanent gases and of steam; and a complete set of the most modern types of pyrometers and thermometers, gauges, mercury columns, planimeters, calorimeters, render possible investigation of many problems of importance to the engineering world.

In the third year, students of thermodynamics are taught the principles of the science by direct experiment; and original research is encouraged during the summer under the direction of the professor.

for many hours. The instrumental equipment consists of comparators, dividing engines; a portable Bessel's reversible pendulum, for the determination of gravity; an astronomical clock, break-circuit chronometer and chronograph; level triers, end-measuring gauges, and minor instruments.

The equipment of geodetic and surveying instruments for the use of students consists of transits and transit theodolites of various forms, levels of the Dumpy Wye and precision types, sextants for marine sounding and land work, plane tables of English and American forms, surveyors and prismatic compasses, current meters, an altazimuth for triangulation work, a zenith telescope, astronomical transits.

There are also hand levels, chains, steel bands, tapes, barometers, pedometers, and other minor instruments required for geodetic work.

The Mathematical Laboratory (Fig. 3) is liberally supplied with apparatus with which the student learns to make measurements of time, mass, distance, acceleration, and other quantities dealt with in the lectures, as well as to verify the fundamental

FIG. 2.—Geodetic Laboratory.

In the fourth year, engine boiler and fuel testing is largely worked at; and the higher parts of the subject are explained by reference to the results obtained from the indicator card, as measured and examined for moisture and heat exchange. The gas and hot-air engines are tested again and again, and the effect of the different factors which modify results pointed out by careful observation.

The Geodetic Laboratory (Fig. 2) is primarily designed for the investigation of apparatus used in geodetic and surveying operations; it also affords the means of producing standards of length and of graduating circles.

The laboratory is double-walled, and the inner wall, which is of brick, contains an air space. In the basement there is an air chamber, from which hot or cold air may be supplied to the work-room by a system of pipes. The air circulation is maintained by a fan which is driven by an electro-motor at any required speed. When the desired temperature is reached all openings are closed, and a practically uniform temperature held

laws of mechanics and to investigate various mathematical and dynamical constants. Special attention is directed to the general principles underlying the ordinary instruments of precision which are used in physics, the simpler forms of these instruments being put into the hands of the student at an early period in his course. The experiments are in almost all cases quantitative, and the learner is encouraged to attain the greatest possible precision which the nature of the experiment and the instruments available admit.

The Electrical Engineering Laboratories are under the care of Prof. C. A. Carus-Wilson. They consist of the magnetic laboratory, the electrical laboratory, the dynamo room and the photometer room.

The equipment in the magnetic laboratory comprises a ballistic galvanometer designed for use in a variable magnetic field (this can be connected with any apparatus in this room or in the dynamo room); a calibrating coil for the galvanometer, two magnetic yokes, a solenoid and spring balance for traction experiments up to one hundred pounds, fitted with search coil for ballistic tests; Ewing's magnetic curve tracer; round and rectangular bobbins for experiments in self-induction; a secohmmeter, telephones, rheostats, &c., and a set of secondary cells.

The electrical laboratory is situated over the dynamo room. Slate slabs are let into the wall on three sides of the room, and stout wooden tables placed down the centre. Current is supplied to all parts from the dynamo room. The apparatus here comprises a Thomson galvanometer, three Kelvin electrostatic voltmeters, two Siemens dynamo-meters, four d'Arsonval galvanometers, seven Weston ammeters and seven Weston voltmeters of different ranges, two Weston alternating wattmeters, two Kelvin balances, one of which is specially arranged for testing transformers; two Cardew voltmeters, several other ammeters and voltmeters of different types, standard cells, resistance boxes, rheostats, &c. All tests of transformers are carried on in this laboratory, the current being brought up from the dynamo room below.

dynamo, a 7 k.w. Fort Wayne dynamo, a 5 k.w. Brush arc light dynamo, a 7 k.w. Victoria Brush motor generator, a 15 k.w. Thomson-Houston incandescent dynamo, a 5 horse-power Crocker-Wheeler motor, and several smaller motors of different types; also a 12 k.w. Mordey alternator specially made for this laboratory (the armature coils can be moved through any angle, and two or three currents of any phase difference thus obtained). There are in the building at present eight motors driving lathes, fans, &c., besides a 10 horse-power electric elevator. The dynamo room also contains several transformers, arc lamps, &c., and a set of five enamel rheostats, each of which can be made to carry from 1 to 50 amperes on 100 volt circuit.

The photometer room is furnished with a Bunsen photometer and a Methven standard, and is specially arranged for testing incandescent lamps.

These four laboratories are supplemented by an *Electrical Workshop* containing a fine lathe, by the American Machine Tool Company, driven by an electric motor.

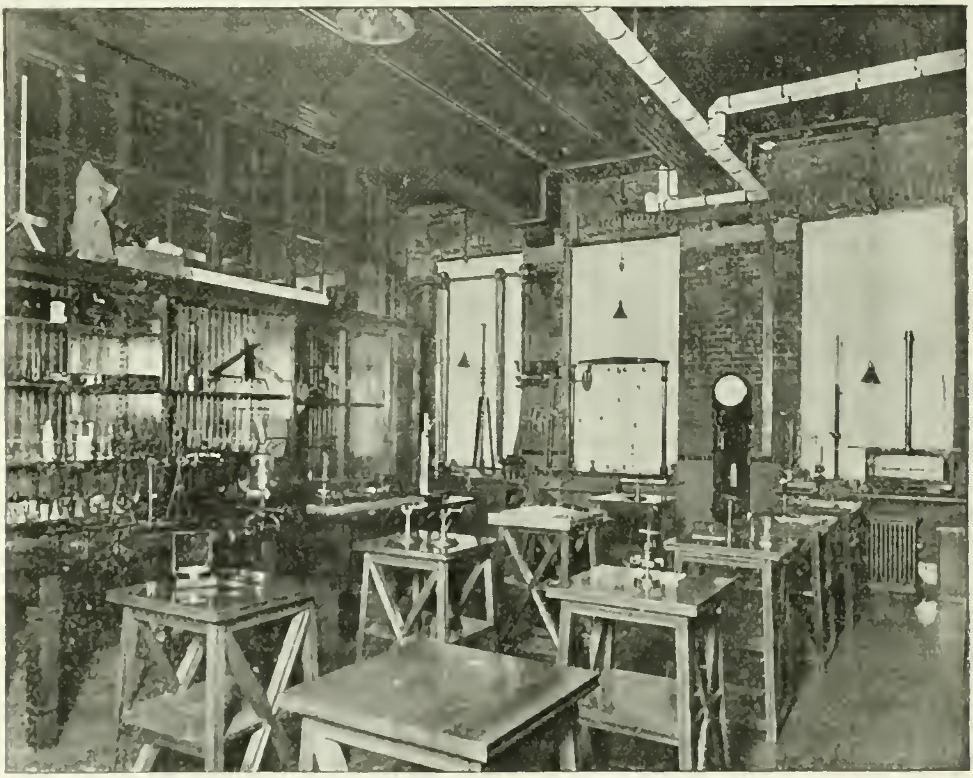


Fig. 3.—Mathematical Laboratory.

The dynamo room is on the ground floor. In one half of the room are placed the lighting, in the other the experimental dynamos. The *Lighting Dynamo* consist of a Siemens dynamo and an Edison-Hopkinson dynamo, each of 30 kilowatts output at 105 volts, and each driven by a 60 horse power Willans engine. The building is wired on the three-wire system, but can be run by either one of the dynamos when the load is light, or by a set of secondary cells of 800 ampere hours' capacity placed in another room. The lighting switch-board was made in the electrical workshop, and is fitted with Weston station ammeters and voltmeters. The *Experimental Dynamos* are driven off a main shaft either by a 90 horse-power MacIntosh and Seymour engine, or by a 25 k.w. Edison motor, as is most convenient. The main shaft is provided with ten magnetic clutch pulleys of 20 horse-power each, designed and fitted at the college, and with one magnetic clutch-coupling for 90 horse-power; the dynamos comprise two 12 k.w. Edison dynamos, a 7 k.w. Victoria Brush dynamo, a 6 k.w. Thomson-Houston arc light

The work in the Electrical Engineering Laboratories is commenced in the second term of the third year. By that time the students have gained a fair general acquaintance with electricity in the physical laboratory. They then begin a series of experiments on electricity and magnetism, using methods and instruments in ordinary practical use, confining their attention, however, to principles and not to their practical application. This term's work is preparatory to that of the fourth year, when students study the practical application of these principles in the dynamo room. Here they make experiments on electrical machinery of all kinds, and carry out tests of dynamos, transformers, motors, &c., under practical working conditions. They can also see a typical lighting station at work, and become familiar with the best practice and design in all branches of electrical engineering.

The practical instruction in the workshops is solely designed to give the student some knowledge of the nature of the materials of construction, to familiarise him with the more important hand and machine tools, and to give him some manual skill in the use of the same. For this purpose, the student, during a specified number of hours per week, works in the shops under the direct superintendence of the Professor of Mechanical Engineering, aided by skilled mechanics. The courses commence with graded exercises, and gradually lead up to the making of joints, members of structures, frames, &c., finally concluding in the iron-working department with the manufacture of tools, parts of machines, and, if possible, with the building of complete machines.

The machine shop and engine room (Fig. 4), an extremely good equipment, including twelve metal lathes for the special use of students, one large centre lathe, planing, shaping, universal milling, drilling and tapping machines, and all necessary centering and grinding machines. The shop, which is also used for fitting, contains seventeen vices and a very complete assortment of tools. All the machinery consists of types selected from the best manufacturers in England and America.

The hydraulic laboratory contains a tank twenty-eight by five by five feet square, perfectly flush on the inside, and specially designed for investigations as to the action of water under low pressures. The tank is provided with specially designed valves and gauges, which do not interfere in the slightest degree with the stream-line flow, and by means of which variations in pressure in different horizontal sections and under different conditions of flow, can be observed with accuracy. The tank has also fixed to it a recording hydraulic gauge, which has been designed to make one, two, four, eight, or twenty-four revolutions in a specified time. The tank discharges into a water-course about forty feet long and five feet wide. This course may be divided up into one, two, or more compartments, each compartment being carefully calibrated so that the amount of the discharge can be easily estimated. At the end of the course, provision is made for inserting weirs of various forms and dimensions. Over these weirs the water flows into large measuring tanks, which have been carefully calibrated, and each of which has a capacity of about 250 cubic feet. The volume by weight of water in each of these, or in all the tanks, may be observed at a glance by means of an indicator on the wall of the laboratory. Experimental work under high pressures up to 150 lbs. per square inch is rendered possible by a connection with the high-level reservoir of the city. By means of a stand-pipe with special fittings for pipes, nozzles, valves, &c., investigations can be made under any pressure from zero up to the maximum. Any desired head may be kept constant by means of a water-pressure regulator, designed for this laboratory. Pipes from six inches in diameter downwards, can also be led from this stand-pipe for a distance of about sixty feet, so that experiments on the frictional resistance to the flow of water in pipes can be carried out under varying pressures. Another special feature of this laboratory is an impact machine, designed by Prof. Bovey, for measuring the power and investigating the efficiency of water-jets in combination with buckets of different forms and sizes. The laboratory is also to have a set of pumps specially designed for experimental work and research. These pumps are to be adapted to work under all pressures up to 120 lbs. per square inch, and at all speeds up to the highes found practicable, with valves of the best kind and proportions. The equipment of the laboratory also includes a Venturi water-meter, water-meters of other kinds, gauges and gauge-testers, and in fact all the apparatus necessary for the scientific investigation of the properties of water and water-meters, and all kinds of hydraulic apparatus.

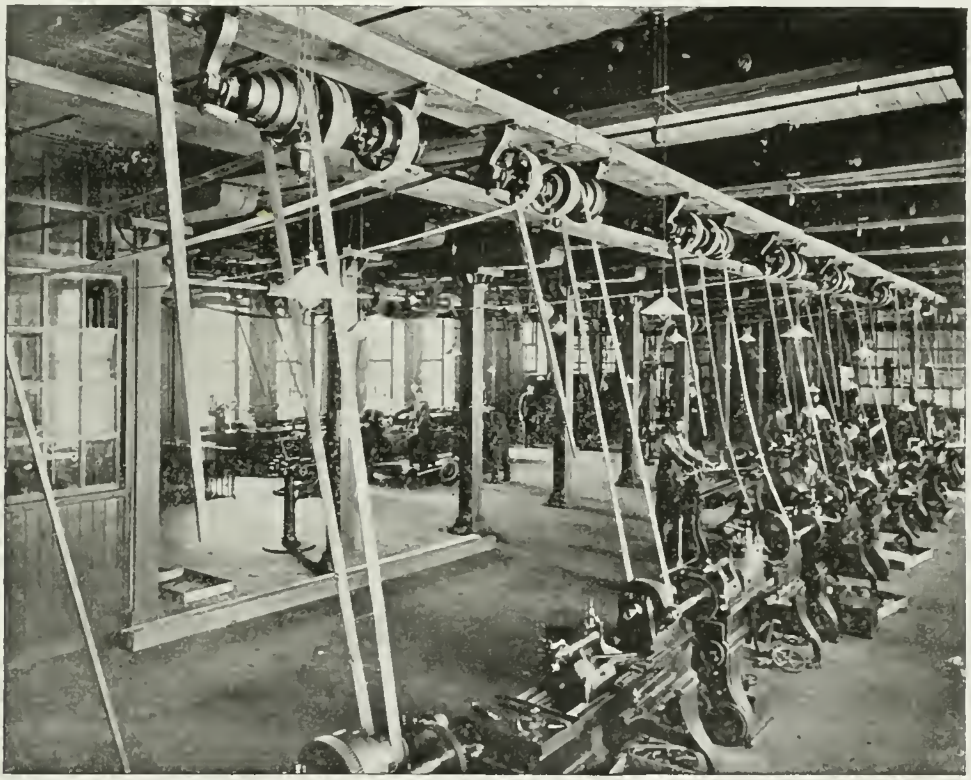


Fig. 4.—Machine Shop.

The main apparatus in the testing laboratories (Fig. 5) consists of a 75-ton Emery testing machine, with a capacity for tension specimens up to 66 in. in length, for compression specimens up to 85 in. in length, and for transverse tests up to 60 in. between bearings; a 100-ton Wicksteed testing machine (Fig. 6), with a capacity for tension specimens up to 72 in., for compression specimens up to 48 in. in length by 10 in. square; an Unwin testing machine for torsional, transverse, and tensile testing; an angle cathetometer (this instrument was specially designed and elaborated for the testing laboratory by Messrs. Nalder Bros., under the direction of Prof. Bovey, to enable

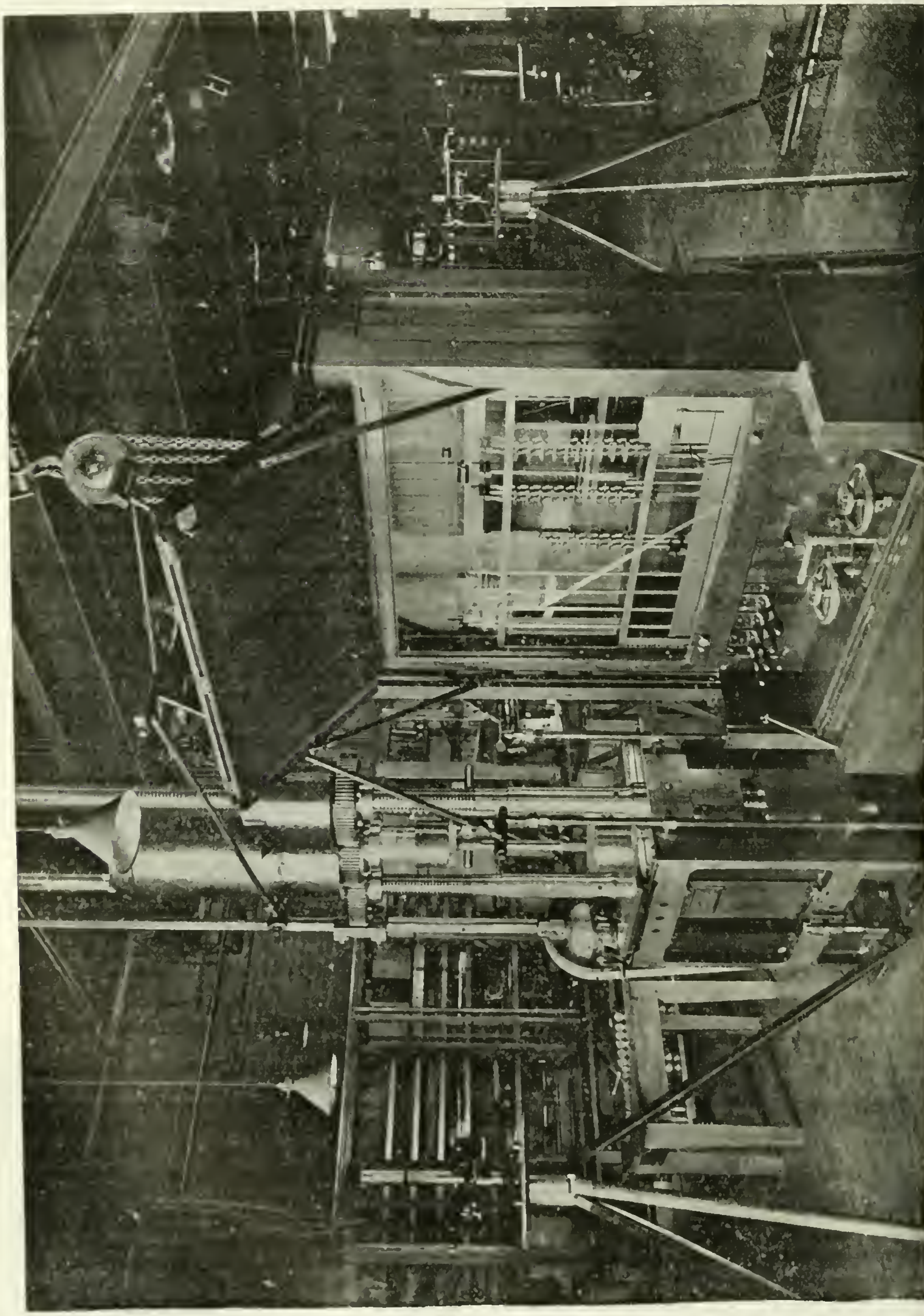


Fig. 5.—Testing Laboratory.

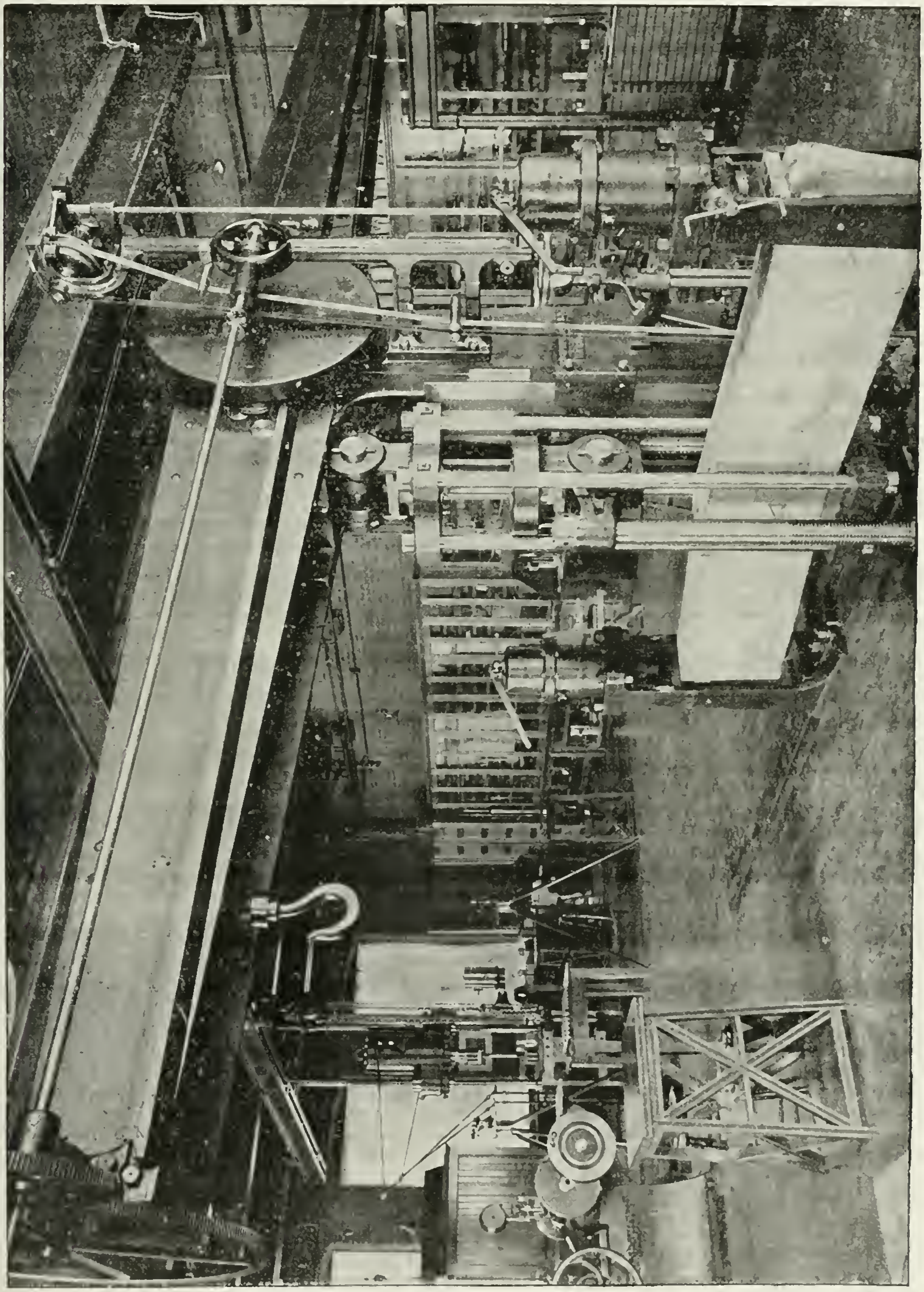


Fig. 6.—Wicksteed Testing Machine.

accurate measurements to be made in connection with the use of horizontal types of torsion testing machines, and also to measure any deflections of a pointer moving about a horizontal axis, through an angle not exceeding 180°; a cathetometer, specially designed for the testing laboratory.

An impact machine is being constructed, fitted with revolving drum, tuning-fork, &c., for recording deflections under rapidly repeated blows. With the aid of this apparatus valuable results may be expected from tests carried out upon materials subjected to repeated stresses.

In the laboratory there are also an Oertling bullion balance with a capacity up to 125 lbs. and down to 1/100 of a grain, and standard weights up to 100 lbs.; a Muir lathe, a shaping machine, and a grinding machine are provided, so that all the apparatus required for preparing the specimens for testing is at hand.

In addition to the above, the laboratories are supplied with numerous other small pieces of apparatus, amongst which may be mentioned Whitworth's measuring machine for measuring a variation of one-hundred-thousandth of an inch, Sweet's measuring machine, and a very complete and elaborate collection of micrometers, vernier calipers, caliper squares, depth gauges, rules, &c.

Our space will not permit us to give an adequate description of the laboratories and lecture-rooms which the McGill University owes to the benefactions of Mr. McDonald and Mr. Thomas Workman, and the mere enumeration of the experimental apparatus contained in them will raise a spirit of envy in the minds of the many workers whose expenditure on scientific instruments is curtailed within very narrow limits. Certain it is that these magnificent donations have provided Montreal with a school of practical science unsurpassed in its facilities for learning.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 24.—M. Lœwy in the chair.—Geodesy and its relations with geology, by M. H. Faye. Gravity has a greater numerical value in islands than in the midst of continents, as the constant is determined by pendulum observations; this is probably due to the more rapid cooling of the crust of the earth beneath extensive seas, as evidenced by the low temperature of water (1° or 2°) at depths at which the temperature is about 133° in land. The greater average density owing to the lower temperature accounts for the higher value of the constant at sea, notwithstanding the replacement of so much solid matter by the specifically lighter water. The author then draws attention to the need of aid from geologists in the further elucidation of the reasons for variations in the constant of gravity.—Truffles (Domalan) from Smyrna, by M. A. Chatin.—M. A. Pomel accompanies a copy of his "Monographie des Bœufs-Taureaux fossiles des terrains quaternaires de l'Algérie" by a brief note on its contents.—Experimental researches on the influence of low temperatures on the phenomena of phosphorescence, by M. Raoul Pictet. Substances showing strong phosphorescence after exposure to sunlight entirely lose this property on strongly cooling (say to −100°), but regain their power on being allowed to approach the ordinary temperature in the dark without further exposure to light. The time during which this *potential luminosity* may be retained, at temperatures such that most of the energy of heat vibrations is abstracted, is now being investigated.—Observations of the sun, made at Lyons Observatory with the Brunner equatorial, during the second quarter of 1894, by M. J. Guillaume. The distribution of spots and faculæ during April, May, and June is given in tabular form.—On the rotation of solar spots, by M. Flammarion. The observed rotations of spots on themselves in several cases are all in the same sense from south through west to north, and amount in one case to 77° in three days, in another to 152° in four days, and in a third case the rotation reaches 34° in two days. This law of rotation is not, however, applicable to cases where segmentation occurs.—On the theory of the Wimshurst machine, by P. V. Schaffers. It is shown that a small modification of the Wimshurst machine enables its efficiency to be doubled, and the reasons leading to this modification are discussed.—On the coexistence, in the same host, of a monosporous coccidian and a polysporous coccidian, by M. Alphonse Labbé.—On the function of the kidney in Helix, by M. L. Cuénot.—On the alimentation of two commensal organisms (*Nereilepas* and *Pinnothere*), by M. Henri Coupin.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Shilling Arithmetic: J. Hamblin Smith (Longmans).—Memorials of Old Whitby: Rev. Canon Atkinson (Macmillan).—Timber and Timber-Trees: late T. Laslett, 2nd edition (Macmillan).—A Text-book of Pathology: Prof. D. J. Hamilton, Vol. 2 (Macmillan).—An Introductory Account of certain Modern Ideas and Methods in Plane Analytical Geometry: Dr. C. A. Scott (Macmillan).—General Report on the Operations of the Survey of India Department during 1892-93 (Calcutta).—Apparitions and Thought-Transference: F. Podmore (Scott).—The Senile Heart: Dr. G. W. Balfour (Black).—A Text-Book of Statics: W. Briggs and G. H. Bryan (Clive).—A Text-Book of Dynamics: W. Briggs and G. H. Bryan (Clive).—Régularisation des Moteurs des Machines Électriques: P. Minel (Paris, Gauthier-Villars).—Fortification: E. Hennebert (Paris, Gauthier-Villars).—Durham College of Science Calendar, Session 1894-95 (Reid).—Rain-making and Sunshine: J. Collinson (Sonnenschein).—Spiritual Law in the Natural World: J. T. Thomas (Longmans).—Merchant Venturers' Technical College, Calendar, Ninth Session, 1894-95 (Bristol).—La Géographie Littorale: J. Girard (Paris, Société d'Éditions Scientifiques).—Badminton Library—Archery: C. J. Longman and Colonel H. Walrond (Longmans).—Lithogenesis der Gegenwart, Dritter Theil; Einleitung in die Geologie als Historische Wissenschaft: Prof. J. Walther (Jena, Fischer).—Lehrbuch der Vergleichenden Anatomie: Vierte Abthg. Vergleichende Anatomie der Echinodermen und Enteropneusten: Dr. A. Lang (Jena, Fischer).—Ways and Works in India: G. W. MacGeorge (Constable).—The Theory of Sound: Lord Rayleigh, Vol. 1, 2nd edition (Macmillan).—Tenth and Eleventh Annual Reports of the Bureau of Ethnology to the Secretary of the Smithsonian Institution (Washington).—The Nests and Eggs of Non-Indigenous British Birds: C. Dixon (Chapman).—Astronomie Sferica: Prof. Porro (Roma, Società Editrice Dante Alighieri). The New Technical Educator, Vol. iv. (Cassell).—Nomenclator Coleopterologicus: S. Schenkling (Frankfurt a/m, Bechhold).—New South Wales, Report of the Minister of Public Instruction for the Year 1893 (Sydney, Potter).

PAMPHLETS.—Thesis for the Degree of Doctor of Science of Edinburgh University, on the Relative Efficiency of certain Filters for Removing Micro-organisms from Water: Surgeon-Major H. H. Johnston (Edinburgh, Banks).—Report on the Relation between Malarial Fever among Her Majesty's White Troops at Port Louis, Mauritius, and the Meteorological Elements of Temperature, Rainfall, and Relative Humidity for the Year 1889: Surgeon-Major H. H. Johnston (Edinburgh, Banks).

SERIALS.—Royal Natural History, Vol. 2, Part 11 (Warne).—Zeitschrift für Physikalische Chemie, xv. Band, 1 Heft (Leipzig, Engelmann).—Timehri, June (Stanford).—Schriften der Naturforschenden Gesellschaft in Danzig, Neue Folge. Achten Bandes Drittes und Viertes Heft (Danzig).—Sunday Magazine, October (Isbister).—Good Words, October (Isbister).—Records of the Geological Survey of India, Vol. xxvii. Part 3 (Calcutta).—Popular Astronomy, September (Wesley).

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THURSDAY, OCTOBER 11, 1894.

ASTRONOMICAL SPECTROSCOPY.

A Treatise on Astronomical Spectroscopy. A translation of Dr. J. Scheiner's "Die Spectralanalyse der Gestirne." Translated, revised, and enlarged by E. B. Frost, M.A. xiii. + 482 pp. 8vo., 81 woodcuts, 2 plates. (Boston and London: Ginn and Co., 1894.)

THE German original of this work appeared in the autumn of 1890, and was doubtless eagerly welcomed by many who had felt the want of a handbook of spectroscopy which gave a tolerably detailed account of the vast amount of work accumulated during the last twenty-five years. From the position of the author in the Astrophysical Observatory at Potsdam, it was to be expected that the subject would be treated in a scientific spirit, and that he would not merely produce a popular book, but one which would be of real use to students of the youngest branch of astronomy. These expectations were to a great extent fulfilled, although it must have been felt by many readers outside Germany that the book suffered from the same defect as Secchi's "Le Soleil," that of frequently giving undue prominence to the researches made at the observatory where the author was working.

The English edition now before us is not a mere translation. Not only has it been brought up to date by the addition of the results of observations published since 1890, and in some cases even by the insertion of results of American work not yet published elsewhere, but Prof. Frost has evidently been anxious to be more fair in dealing with older work of non-German astronomers, and to bear in mind that all spectroscopic researches do not bear the stamp, "Made in Germany." No attempt has been made to distinguish the portions so added from the original text, except in a few cases where Dr. Scheiner requested it, and where the additional matter is put in brackets. At the end of the preface Dr. Scheiner has inserted a number of notes on various points, as to which he differs from the views of the translator.

The first part (110 pp.) deals with "Spectroscopic Apparatus," beginning with the effect of imperfect achromatism of the telescope objective on the spectrum, and the means it furnishes of testing the achromatism of an object-glass. Harkness, Vogel, and Young have applied this method in various ways; but it may be mentioned here that the method is much older, and has been used by d'Arrest and others. The next paragraphs discuss the passage of light through prisms and prism-systems, the loss of light by reflection and absorption, the curvature of the spectral lines, the properties of the cylindrical lens, and the effect of atmospheric disturbances on spectroscopic observations. A lengthy account follows of all the various spectroscopes and spectrometers which have been brought into use from about the year 1817 (not 1823), when Fraunhofer designed the objective-prism spectroscope, and down to the present day, the theories and modes of adjustment of the instruments being fully considered. The translator has here added accounts of Rowland's construction and use of concave gratings, and of Michelson's and Morley's application of interference methods to spectroscopic measurements; he might also in this chapter have inserted a description of the bolometric methods of observation, which have yielded such splendid results (they are partly mentioned in the chapter on the sun, but the instrumental arrangements should have been given in detail). In the paragraph on photographic spectra the Potsdam spectrograph is chiefly considered, but the translator also describes Hale's spectroheliograph.

The second part of the book (pp. 111–150) on "Spectroscopic Theories" is divided into two chapters on Kirchhoff's Law of the ratio between the absorptive and emissive power, and on Doppler's principle. Prof. Frost states in the preface, that in view of the contradictory results of recent investigations upon the emission of light by gases, he has not thought it wise to make any additions to the chapter on Kirchhoff's Law. It seems, however, strange that he should not have drawn attention to these investigations, and pointed out their immense importance for the interpretation of celestial spectroscopic observations, though a careful reader will not fail to see, even from the short account given of E. Wiedemann's researches, how great a *rôle* "luminescence" phenomena are likely to play in future theories of the nature of celestial bodies. The chapter on Doppler's principle deals fully with the theoretical aspect of this important matter and the various objections which have been raised from time to time, while the splendid practical results are deferred to a chapter at the end of the book.

The third and largest part (pp. 151–360) is devoted to the "Results of Spectroscopic Observations." In the German original all wave-lengths were based on the Potsdam system of Müller and Kempf, and were expressed in millionths of a millimetre, but the translator has reduced them all to Rowland's system of 1893, and has adopted the tenth-metre as his unit, in accordance with the practice of most British and American spectroscopists. The chapter on the sun describes first the various methods of investigating the ultra-red spectrum, and includes an account of Langley's unpublished method. By this the invisible spectrum is moved by clockwork across a bolometer strip, the passage of the lines being recorded by a sensitive reflecting galvanometer, the point of light from which falls on a photographic film, also moved synchronously by clockwork in a direction at right angles to the plane of the mirror's movement, thus automatically producing an energy curve. This is subsequently converted into a linear spectrum containing dark lines corresponding to the cold spaces in the invisible spectrum. The ultra-violet spectrum is next shortly described, and lists of elements present in the sun are given. In the paragraph on the atmospheric lines, the translator has substituted Cornu's list of these for those of Angström and Vogel, which Dr. Scheiner had preferred; but we miss references to Dr. L. Becker's investigation of the low-sun spectrum and (curiously enough) to Dr. Müller's spectroscopic observations on the Säntis, although the latter were published more than a year and a half ago in the Potsdam publications. More remarkable than these omissions is, however, the brevity with which the spectra of sun-spots, faculæ, and the chromosphere are treated in only twenty-one pages. In the preface, the author accounts for this by pointing out that the present state of our knowledge of the constitution of the sun is unsatisfactory, and that we have "a large mass of observational data, although for the most part unscientifically discussed; and on the other hand, an indefinite number of hypotheses and solar theories, which are, with few exceptions, radically wrong at the start, and often contradictory to the most simple physical views of to-day." He therefore felt unwilling to undertake the task of discussing and sifting these theories. No doubt an author has a perfect right to decline an uncongenial task, but it certainly detracts from the value of the book that it gives comparatively scant information about our central luminary, on which spectroscopists have spent so much labour; and in the succeeding chapters Dr. Scheiner has by no means been adverse to dealing with "hypotheses and theories." It is, of course, as impossible to discuss the results of spectroscopic observations without attempting to interpret them, as it was for our forefathers three hundred years ago to discuss the motions of the planets "without any hypothesis." And notwithstanding his caution, the author has not been able to keep clear of questionable hypotheses on matters connected with the sun, as when he, for instance, suggests that the unsymmetrical broadening of lines in spot-spectra might arise from the metals entering into combinations with the metalloids. This idea is also afterwards brought in to account for the same phenomenon in star-spectra of Type III*a*, but Dr. Scheiner seems lately to have abandoned it, as he in a note to p. 308 concludes from recent observations that the unsymmetrical broadening is due to accidental "clustering" of fine lines. With regard to the spectra of sun-spots, we notice that all the work done at South Kensington is completely ignored.

While the chapter on the spectra of the planets, as to which not much work has been done of late years, is naturally somewhat meagre, that on comets is very full and interesting, and includes an account of the important laboratory work of Hasselberg. The evident dependence of the spectrum on the distance of a comet from the sun is duly emphasised, but the account of the two most remarkable comets of 1882 might have been more lengthy, as we, for instance, do not find any reference to the dark absorption lines seen with more or less certainty by several observers, and which (if really existing) are of very great importance for the interpretation of the changes in the heads of comets about the time of perihelion passage.

In the chapter on Nebulæ, a complete list of gaseous nebulæ is given, as well as one of the minute planetary nebulæ found with the spectroscope by Pickering and Copeland, and it is interesting to see how this latter class of objects, like the older gaseous nebulæ, cling to the Milky Way. A list is also given of all the lines observed in the spectra of nebulæ. It might have been mentioned that the line at 4472 (which also occurs in some stars of Type I*a* and in Nova Aurigæ) is probably identical with a well-known chromospheric line, associated with D$_3$ and the hydrogen lines, as suggested by Mr. Lockyer. The author does not express any opinion as to whether the temperature of nebulæ is high or low, but he remarks that the comparative simplicity of the spectrum points to the conclusion that the density of these bodies is extremely low.

In the lengthy chapter on the spectra of the stars, the classification of Vogel is followed, apparently somewhat reluctantly on the part of the translator. So long as the system is not supposed to represent the gradual evolution of a star, there can, of course, be no objection to it; but in the light of the results obtained from temporary stars, and the detection of dark lines in spectra of Type I*c*, it certainly looks doubtful if the bright line stars can properly be divided among the two first classes (I*c* and II*b*).

The account of spectra of Type I*a* includes a list of ninety-one lines measured by the author in the photographic spectrum of Sirius, and an account of the harmonic relations between the hydrogen lines. That the stars of this class are the hottest of all, is generally conceded, and the confirmation of this view, which Dr. Scheiner (in a note on p. vii.) finds in the appearance of the magnesium line at 4481, was indeed found many years ago by Mr. Lockyer (*Proc. R.S.* xxx. p. 29), who first called attention to the fact that this line can only be produced by a high tension spark, and is indicative of very high temperature. In the spectrum of *a* Cygni (Type I*b*) it is the strongest of all lines. Notwithstanding this the author concludes from the fact that only the fainter iron lines occur, that a very different temperature must prevail in stars of Type I*b* from that in stars of I*a*. Yet the possibility does not seem to be excluded that this may arise from different conditions as to density. Under the heading "Spectra of Type I*c*," the translator gives a detailed account of Belopolsky's investigation of β Lyræ, with regard to which Dr. Scheiner remarks in a note that, in view of recent observations made at Potsdam, he cannot believe the phenomenon to be nearly as simple as Belopolsky's observations would indicate. "There is great probability that more than two bodies are concerned in the case of β Lyræ."

Passing to the Type II*a*, we find a catalogue of 290 lines measured by the author on Potsdam photographs of the spectrum of *a* Aurigæ. While the author justly considers this a complete proof of the absolute agreement between the spectrum of this star and that of the sun, he takes a very pessimistic view of the measures of the visual spectrum of *a* Tauri by Huggins and Vogel, whose identifications of lines with metallic lines he seems, with few exceptions, to consider worthless. Many readers will probably dissent from this view, as the agreement between the two observers is really good (as also conceded by the author), and this somewhat sweeping condemnation would apparently, if consistently applied, wipe out many conclusions drawn from spectroscopic observations.

In the section "Spectra of Type II*b*" the translator has put together a large amount of information not to be found in the original, by giving a list of fifty-five stars of this class (which are with few exceptions in or close to the Milky Way), and a list of bright lines in the visual spectra of thirty-one of them, recently observed by Campbell at the Lick Observatory. The existence of a large envelope of incandescent hydrogen about one of these stars (D.M. + 30°, 3639) seems to be proved by Campbell's latest observations, according to which the F line, observed with a narrow slit, is a long line extending to a very appreciable distance on each side of the continuous spectrum, and with an open slit is a large circular disc about 6″ in diameter. The same appearance is noticeable in the faint $H\gamma$ and very faint $H\alpha$ lines, but not in other lines.

The section on Temporary Stars has also been very considerably extended by the translator, by the addition of a detailed account of the observations of Nova Aurigæ and of the various theories which have been proposed to account for the manifold phenomena exhibited by this object. The difficulties in the way of accepting any one of these hypotheses as fully satisfactory are pointed out, and it seems impossible to deny that there must have been more than two bodies in action. The complete transformation of the spectrum at the revival of the star, so strikingly similar to that discovered by Copeland in the case of Nova Cygni, is also an awkward fact to deal with, and one that cannot be avoided by merely denying that we have here "a star turned into a planetary nebula." The interpretation of the nebulous appearance of the star as caused simply by the chromatic aberration of the blue hydrogen rays, when the telescope is focussed for the most intensive rays of the chief nebular line 5002, seems untenable, as so experienced and sharp-sighted an observer as Prof. Barnard has recently declared himself to be absolutely sure, that the nebulous appearance is not a mere telescopic effect (*Astr. Nach.* 3238). And why should we think it impossible for the object to *look* like a nebula, when it has the unmistakable spectrum of one, and when we remember the above-mentioned observation by Campbell of D.M. 30°, 3639? The objects which caused the outburst in December 1891 probably left the scene of the catastrophe a few months after, leaving behind them masses of gas both visually and spectroscopically seen as a nebula. But, as pointed out by Prof. Frost, the most difficult facts to explain are the enormous relative velocities of the objects.

The study of the spectra of Type III*a* has, during the last few years, produced results which have very much lessened the supposed similarity between these spectra and those of sun-spots, and the development of bright lines in many spectra of long-period variables at their epochs of maximum obliges us to give up the ideas which formerly prevailed with regard to these variables. Here, as in the case of Nova Aurigæ and β Lyræ, we have evidently to do with very complex phenomena. The translator refers in a few words to the theory advanced by Mr. Lockyer, that the long-period variables may be systems of two swarms of meteorites revolving in elliptical orbits, and he dismisses it with the objection (which is not new) that the conditions in a system of this kind could not be permanent, as with successive collisions the smaller swarm would become spread out into a ring, thus causing the variability to cease. This objection is, however, not a serious one, as our own Leonids, though spread out into a ring, have for many centuries exhibited a very strongly marked maximum.

After describing the spectra of Type III*b*, the translator gives a summary of Pickering's statistical examination of the Draper Catalogue. He has omitted the short notice of the Meteoritic Hypothesis which Dr. Scheiner had inserted at the end of this chapter, and which hardly gave a fair idea of the hypothesis. The two remaining chapters are devoted to the spectra of the Aurora and Zodiacal Light, and the displacements of spectral lines as caused by the rotation of the sun, the motion of stars in the line of sight, or by spectroscopic binaries. A useful addition is given in the shape of a reprint of Campbell's formulæ and tables for the reduction of observations of displacement.

The fourth part of the book (pp. 361–426) contains a very valuable set of spectroscopic tables, viz. Rowland's new table of standard wave-lengths (*Astronomy and Astrophysics*, April 1893), Abney's wave-lengths of lines in the ultra-red spectrum, Kayser's and Runge's arc spectrum of iron, a catalogue of stars of classes III*a* and III*b*, and, lastly, an unpublished partial revision of the chromospheric lines by Young. Finally, on pp. 427–472, a bibliographical list is given of books and papers relating to astronomical spectroscopy. This list is unfortunately very incomplete, and glaringly so with regard to solar phenomena. We have, also, in several cases missed references to papers quoted in the body of the book, and in others only found references to short notices in NATURE, instead of to original memoirs.

On the whole, this English revised edition is a great improvement on the original, valuable as the latter undoubtedly was, and it forms both an excellent text-book for the student and a useful book of reference to workers in spectroscopy. J. L. E. DREYER.

AGRICULTURAL ZOOLOGY.

Agricultural Zoology. By Dr. J. Ritzema Bos, Lecturer in the Royal Agricultural College, Wageninen, Holland. Translated by J. R. Ainsworth Davis, B.A. With an introduction by Eleanor A. Ormerod. (London: Chapman and Hall, 1894.)

AGRICULTURISTS will be misled by the title of this book, if they expect to find any reference in it to farm animals which especially interest and concern them, such as horses, cattle, sheep, and pigs. There are no descriptions of these animals in this work upon agricultural zoology, although after having enumerated the thirteen orders of mammals, Dr. Ritzema Bos says he shall "deal only with those of agricultural importance," and forthwith leaves out all references to cattle, horses, sheep and pigs. But, on the other hand, such animals as wild boars, deer, otters, golden eagles, nightingales, herring-gulls, and grebes, having no connection with agriculture, are treated of at some length, and figures of them are given. Cuttle-fishes and star-fishes also seem out of place in a work entitled "Agricultural Zoology," which should rather have been styled "Zoology, or the Elements of Zoology."

Among the insects the migratory grasshopper (*Acridium migratorius*) and the Colorado beetle (*Doryphora decemlineata*) figure, though these are not British insects, nor are they likely ever to gain a foothold in this country. A work upon British Agricultural Zoology is much wanted that would give the cultivators accurate information upon all the animals that are in any way, directly or indirectly, serviceable to them, and all those that are harmful to them, directly or indirectly. Dr. Ritzema Bos just touches the fringe of this subject with regard to the larger animals, though, it must be admitted, he goes into rather more detail concerning insects. Knowledge of the inner life of animals is most desirable, and should be spread through the whole of the country districts by the Technical Education Committees of County Councils, by means of competent lecturers, in the absence of any standard text-book on the subject. There is a capital book on Agricultural Zoology in France, compiled by Dr. Brocchi, entitled "Traité de Zoologie Agricole," in which detailed descriptions are given of all the animals that are useful and injurious to cultivators. Their habits (*mœurs*) are first detailed, then their use (*utilité*), or the harm (*dégâts*) occasioned by them, so that one may see at a glance those that may be counted upon as friends or foes. It might be supposed naturally that in a treatise upon Agricultural Zoology, Dr. Ritzema Bos would have dealt at some length with, for instance, such a useful bird as the kestrel (*Falco tinnunculus*), which must be held to be one of the best friends of the farmer, for it feeds upon mice, rats, and cockchafers. Swallows, martins, and swifts are dismissed with exceedingly short notices, and their indescribably good services to cultivators are unfairly depreciated in the following inconsistent passage :—

"Swallows fly quickly and catch insects while on the wing. The insects on which they prey are generally unimportant to agriculture and forestry; but they may also do good by catching crane-flies (Tipula) and ribbon-footed corn-flies (Chlorops), which often fly about our fields in enormous swarms in order to lay their eggs."

It must be strenuously denied that the insects on which they prey are unimportant to agriculture, as they are known to be especially fond of aphides, and many hop-planters believe that the far greater frequency of the attacks of the *Phorodon* (*aphis*) *humuli* upon hop-plants in the last five years is due in a degree to the scarcity of swallows and martins. There is no doubt, also, that these birds clear off the Hessian fly, *Cecidomyia tritici*, and others of the *Cecidomyidæ*, and as they live entirely on insects, and especially on the smaller and most dangerous insects, they are of inestimable benefit, and should therefore be preserved with religious care. It is much to be lamented that swallows, martins, and swifts are so ruthlessly massacred in the sunny climes in which they pass the winter seasons. Plovers, too, whose value to farmers is inestimable, are not alluded to. This is an unfortunate omission, as it is desirable to clearly point out that these birds should be encouraged, and that the general raids upon their eggs, to satisfy the appetites of gourmets, should be stopped.

In his large, valuable work, "Tierische Schadlinge und Nutzlinge fur Ackerbau, Viehzucht, Wald- und Gartenbau,' published at Berlin in 1891, Dr. Ritzema Bos, like Dr. Brocchi, gives full accounts of all animals in any way connected with the field, forest, and garden, and this might have been liberally epitomised and translated for the benefit of British agriculturists with far more advantage to them than the unsatisfactory *réchauffée* now before us. Insects are Dr. Ritzema Bos's strong point, as all are aware who know his labours in this direction, so that it is not surprising to find considerably more than a third of the contents of "Agricultural Zoology" devoted to them. But it is rather strange that some very important insects are not mentioned, and that others are dismissed with a short account of their habits. In some cases methods of prevention and remedies against insect attacks are suggested, but they are generally given in the briefest possible manner. Thus for the pea-weevil (*Sitones lineatus*) the remedy prescribed is "rational rotation," which will convey little or no meaning to the perplexed pea-grower.

For the ravages of the Diamond-back Moth (*Plutella cruciferarum*), no remedy whatever is mentioned, although the caterpillars of this insect occasionally do serious harm to many species of the Brassica, as in 1891, when many thousands of acres of turnips, rape, and cabbages were ruined by their action.

Another instance of a curious remedy may be given in the paragraph upon Cockchafers (*Melolontha vulgaris*) in which it is recommended that the grubs that are turned up during ploughing should be collected, and that the cockchafers should be caught. "This is very expensive, since it has to be done very energetically if most of them have left the pupa case. A part of the expense may, however, be recouped by using the cockchafers as manure." This "part of the expense," it is thought, would be absurdly infinitesimal.

Again, for the Red Spider (*Tetranychus telarius*), most destructive to many crops of the farm, garden, and glass-house, no modes of prevention or remedial measures are hinted at, although economic entomologists have pointed out that as moisture is most obnoxious to these mites, washing or spraying infested plants frequently is an efficacious remedy against them. One of the best parts of this volume is that devoted to the *Anguillulidæ*, or eelworms, which are most injurious to a number of crops, and in many cases are quite unsuspected enemies.

With regard to the insects omitted, it will be seen that none that are injurious to fruit crops have been included, though fruit-growing forms an important feature of British land culture. As in Holland and Germany, the Winter Moth (*Cheimatobia brumata*) is terribly destructive to the apple crops in this country, and the Codlin Moth (*Carpocapsa pomonella*) is almost equally injurious in some seasons to apple-trees in Great Britain, the Continent, and the United States and Canada. Both these are unnoticed, as well as several other moths, and many weevils and sawflies, that attack apple, pear, and plum trees, gooseberry and currant bushes, and raspberry-canes, against whose onslaughts fruit-growers would only be too thankful to have some practical advice from an expert of the reputation of Dr. Ritzema Bos.

In a few instances valuable remedies are recommended against insects, as, for example, the remedy adopted for the Silver Y Moth (*Plusia gamma*), by fastening together by laths several long troughs with steep inner walls, at distances equal to those between the adjacent furrows, and the caterpillars are swept by besoms fixed to the laths into the troughs, from which they are collected in sacks at the end of the furrows. With this cheap machine about twelve acres per day can be cleared. This is a practical remedy, and is derived from Taschenberg, the most practical and able of all economic entomologists, who has done more for cultivators in the way of describing insects, and prescribing methods of prevention and remedial measures against them, than any other entomologist; and whose store of information many writers upon economic entomology have calmly used without acknowledgment. His "Praktische Insekten-Kunde" is a model of what a work upon baneful insects should be.

The 149 illustrations in "Agricultural Zoology" are good, especially those from Taschenberg, which are very clear, and some of these form very pretty pictures. It would be a great assistance to readers if an index had been supplied, for it is difficult to find references that are required.

Upon the whole we cannot congratulate Prof. Ritzema Bos upon his last production. If he had reproduced parts of his larger work, "Tierische Schadlinge und Nützlinge," without alteration, it would have been far better than boiling it down and entitling the result "Agricultural Zoology."

OUR BOOK SHELF.

Progress in Flying Machines. By O. Chanute, C.E. (London: Messrs. Sampson Low, Marston, and Co., 1894.)

This book is a reissue of a series of twenty-seven articles which appeared in *The Railroad and Engineering Journal* (now re-designated as *The American Engineer*) of New York City. It gives a very complete account of the many experiments that have been performed by various experimenters with details of the machines used, and clear reasons why so many of them have failed. After a short statement of general principles the author describes the machines in which wings and parachutes were used; then those in which screws were used to lift and to propel. The author believes that the true function of aerial screws is to propel and not to lift (page 72); but Lord Kelvin, in the discussion on aerial navigation at the British Association in Oxford, last August, stated his belief in screws working round a vertical axis for the latter purpose. The greater part of the book is devoted to a description and discussion of aeroplanes. The whole subject of aerial navigation resolves itself into ten problems or conditions:

(1) The resistance and supporting power of the air.

(2) The motor, its character and its activity.

(3) Selection of the instrument to obtain propulsion.

(4) The form and kind of the apparatus for sustaining the weight—whether flapping wings, screws, or aeroplanes.

(5) The amount of the sustaining surface required.

(6) The best materials to be employed for the framing and for the moving parts.

(7) The maintenance of the équilibrium, which is the most important, and perhaps the most difficult of solution, of all the problems.

(8) The guidance in any desired direction.

(9) The starting up into the air under all conditions.

(10) The alighting safely anywhere. Safety in starting up, in sailing, and in coming down is essential.

All these problems are fully and fairly discussed in this volume. There are eighty-two diagrams, and an excellent index, which add greatly to the value of the book.

Fertilisers and Feeding Stuffs; their Properties and Uses. By Bernard Dyer, D.Sc. (Lond.) (London: C. Lockwood and Co., 1894.)

This little book, which is a handbook for practical farmers, and is not addressed to the agricultural student, is issued opportunely. It contains the full text of the Fertilisers and Feeding Stuffs Act 1893, and the Regulations and Forms of the Board of Agriculture relating to the same, and also some useful notes on the Act, by Mr. A. J. David, Barrister-at-Law. Dr. Dyer's notes were first published in the form of newspaper articles, and have been reprinted by request; they will prove very useful to the class to whom they are addressed, containing as they do short descriptions of the origin, composition, and uses of farmyard manure, artificial manures, and of purchased feeding stuffs, all of a practical nature. The notes on the new "Fertilisers and Feeding Stuffs Act" will also be useful to those who wish to put this Act into use; but these, we anticipate, will be few.

Heat treated Experimentally. By Linnaeus Cumming, M.A. (London: Longmans, Green, and Co., 1894.)

The companion volume to this—"Electricity treated Experimentally"—is known to most teachers of physics. The present work aims at giving (1) an elementary account, with easy experiments, of the general laws of heat; (2) a brief account of the classic researches of Regnault, Joule, and other eminent investigators; (3) a description of the theory of heat comprehensible to students whose mathematical range does not extend beyond elementary trigonometry. This laudable design is satisfactorily realised. Mr. Cumming writes clearly; in other words, he knows what to say and how to say it. The experiments described are all workable and well arranged, hence the book is one which may be used in science classes with confidence and pleasure.

Ways and Works in India. By G. W. Macgeorge, M.I.C.E. (Westminster: Constable and Co., 1894.)

An account of the public works in India from the earliest times up to the present day should be useful, if only as an outline for a precise and detailed history of Indian Public Works. The materials for the compilation before us have been collected by the author from various official publications, and the facts are arranged in a satisfactory manner. The subjects treated are the trigonometrical survey of India; roads; irrigation works; railways; water-supply of towns; internal telegraphic system; and sea and harbour works. The data referring to these matters will be valuable to all interested in the progress of India. The work does not appeal to a large public in England; nevertheless, it presents, in a readable form, much useful information on the engineering works which will stand for many years as monuments to British rule in India.

Manual Pratique de L'Aéronaute. By W. de Fonvielle. (Paris: Bernard Tignol.)

In this book of 246 pages, M. de Fonvielle, a well-known writer on aeronautical matters, contrives to compress a mass of information of use to the aeronaut. We recommend the book to practical aeronauts, meteorologists, and the numerous amateurs who are interested in ballooning and its possibilities. Seventy figures illustrate the text. It has been said that the development of the art of flying has been retarded by the balloon; but even if this is conceded, M. de Fonvielle's book shows that science has gained a little from ballooning.

Fruit Culture for Profit. By C. B. Whitehead, B.A. Pp. 68. (London: Society for Promoting Christian Knowledge, 1894.)

In view of the recent correspondence in the *Times*, on fruit culture, this book appears very opportunely. Fruit-growing is now recognised as a valuable branch of agriculture, and English producers are becoming alive to its importance. The Royal Agricultural Society and the Board of Agriculture have encouraged fruit-growing by publishing articles and pamphlets upon the subject. These publications, and Mr. Whitehead's little volume, should be obtained by all who are interested in the profitable production of fruit.

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.*]

Wilde's Theory of the Secular Variation of Terrestrial Magnetism.

SOME prominence is given in NATURE of August 9 to a letter of L. A. Bauer, a magnetic computer of the United States Coast and Geodetic Survey, on the above subject. Absence from home and other circumstances have prevented me from replying to this letter before now. It is not my intention to engage in controversy with a critic who roundly condemns my theory and experiments without reason, and at the same time naïvely announces that, by means of formulæ established by himself, he has succeeded in representing the observations many times better than the magnetarium results.

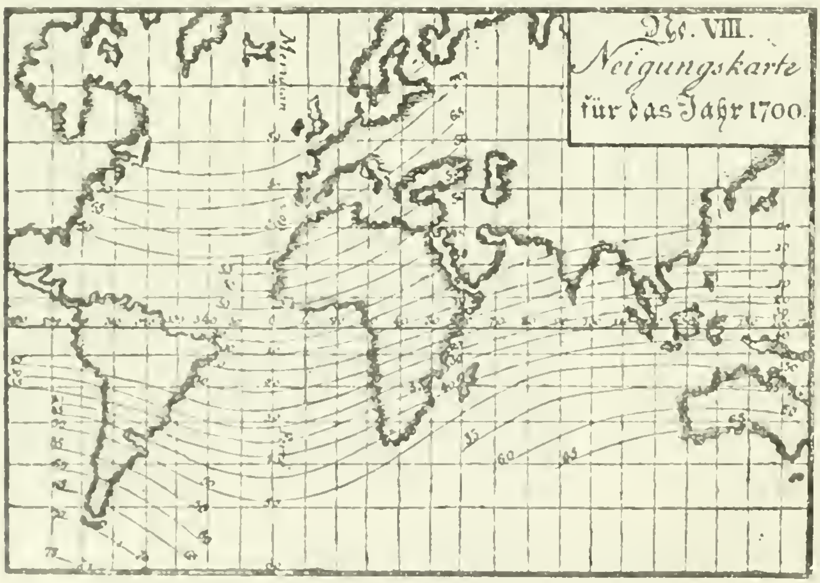
My principal object in writing is to correct an error I have made in stating that no observations had been made on the dip at St. Helena previous to the year 1825. The error is all the more inexcusable as I have in my possession Hansteen's "Magnetismus der Erde," with its valuable atlas-folio of charts of the magnetic variation, from which L. A. Bauer has derived his information of the dip at St. Helena for the epoch 1700–1780. Had I said that no *reliable* observations had been made before 1825, the statement would hardly have called for any notice. It is well recognised by magneticians that observations of the dip, up to the early part of the present century, were much more difficult to make than those of the declination, on account of instrumental imperfections and the unrecognised influence of vertical masses of ship's iron and local geological formations. Sabine, in his "St. Helena Observations," vol. 2, p. lxv., shows a difference of between 2° and 3° at Longwood and Sister's Walk, from the latter cause, and this illustrious magnetician did not venture to give observations of the dip further back than the epoch 1825.

I regret to observe that L. A. Bauer, in his intolerance of the magnetarium results, has inserted in his table guesses of his own for observations, which are very wide of the truth.

In order that my remarks on the dip at St. Helena may be better understood, I will, by your permission, reproduce the table of L. A. Bauer, although that of Sabine and the Admiralty chart are more in agreement with my results.

Date.	Observer.	Observed inclination.	Wilde inclination.	Observation Theory.
1700	Hansteen chart	11·5 S.	3·9 N.	−15·4
1754·3	La Caille	9·00	0·5 S.	−8·5
1771·4	Ekeberg	13·00	3·5	−9·5
1775·4	Cook	11·42	4·0	−7·4
1780	Hansteen chart	10·5	5·1	−5·4
1825·0	Duperry	14·93	14·7	−0·2
1840·1	Ross	18·27	18·5	+0·2
1842·3	Belcher	17·00	19·0	+2·0
1846·8	Smyth	19·39	20·5	+1·1
1890·1	U.S.C. & G.S.	29·65	33·8	+4·1
,,	,,	31·18	33·8	+2·6

It will be observed that for the epoch 1825–1890, the dip increased no less than 16°·25, or fifteen minutes annually. Hansteen's great work was published in 1819, and his curve of the inclination for the epoch 1780, showing 10°·5 S., at St. Helena, was laid down from the observations of Ekeberg, La Perouse, and Cook, which indicate a diminishing dip for the epoch 1771–1775. Hansteen's chart of the inclination for 1700 is exquisitely drawn, but on a scale so small that St. Helena is not shown thereon. The position of the island is, however, easily found from the latitude 15° 55′ S., and long. 5° 43′ W., or 12° E. of the meridian of Ferro.



As Hansteen's historical work on the magnetic variation is very rare, I have had his chart of the inclination for the epoch 1700 reproduced by a photographic process, with the position of St. Helena dotted thereon, for the benefit of your readers.

It will be seen from the chart that the magnetic equator, or line of no dip, is about 1° north of St. Helena, so that the amount of south dip would not be more than 2° for the epoch 1700. Hansteen would appear to have laid down his curve of the dip for 1700 from the previous observations of Ekeberg and La Caille, which indicate a decrease, reckoning backwards, from 1771 to 1754; but he nowhere states in the text of his work, that his curve was drawn from an observation made at St. Helena in 1700.

The amount of dip, 11°·5, shown by L. A. Bauer for 1770, is the same as that observed by Cook in 1775, and is an obvious blunder in his reading off the position of St. Helena 1° below the isoclinal of 10° south, instead of from the magnetic equator.

I shall leave others to judge how far any statements of L. A. Bauer on the subject of terrestrial magnetism in general, and on the magnetarium in particular, are entitled to credit when he places his erroneous computation under the heading of observed inclinations standing against the distinguished names set forth in his table.

It may be of interest to magneticians to know that the secular changes shown in my tables of the declination and inclination at London, Cape of Good Hope, St. Helena, and Ascension Island are obtained conjointly on the magnetarium without change of resistance in the secondary circuit; together with the great eastern and western lines of no declination, the Asiatic oval of small westerly declination, the oval of small easterly declination in the Pacific, the magnetic equator, and many other agreements with the observations, all for the epoch 1880.

I regret that I have not been able to accomplish more; but in reply to the remark of L. A. Bauer that although I possess the records of secular variation stations in the United States, I have made no published attempt to reproduce them, I may say that two years ago I presented a magnetarium to the United States Coast and Geodetic Survey, at considerable cost and trouble to myself, with full instructions for working it, and have no doubt that the department will make good use of the instrument.

Alderley Edge, September 28. HENRY WILDE.

The Newtonian Constant of Gravitation.

I SHOULD be obliged if you would allow me to make a correction in my lecture at the Royal Institution, published in NATURE, Aug. 2, 9, and 23, on page 331. I have stated that in pieces of apparatus geometrically similar but of different dimensions, the disturbances due to uncertain convection currents are likely to be in the proportion of the seventh power of the linear dimensions. Having discussed this at some length lately with Prof. Poynting, I find that I was in error, and that in reality the disturbances would be proportional to the fifth power of the linear dimensions if the circulation of the air were so extremely slow as to be steady. If, however, its velocity were sufficient to give rise to unsteadiness, the rate at which momentum would be given to the suspended portion of the apparatus would depend on the square of the velocity, at least in part, and as the part depending on the square increased in importance the disturbance would gradually rise to the eighth power. So long, therefore, as the apparatus is small enough to prevent terms involving the square of the velocity from being appreciable, the ratio of the disturbance to the couple to be measured or the stability is the same whatever the size; but as soon as the apparatus exceeds this, then the disadvantage of size very rapidly becomes evident.

Of course the objection due to the great increase of time which must elapse between the handling of apparatus and its being fit for observations to be made, which accompanies increase of size, remains.

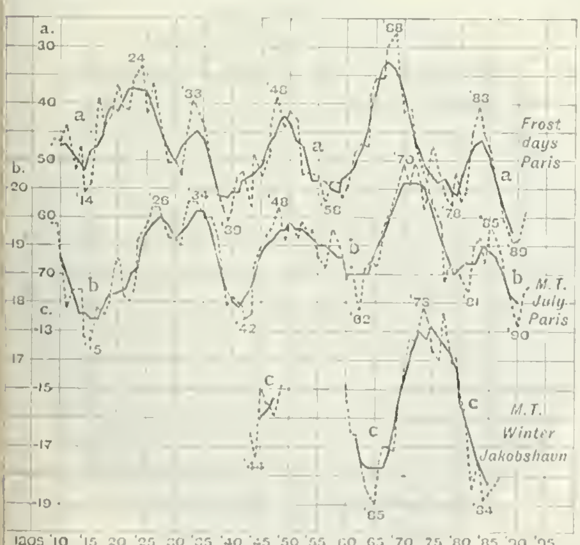
As the consideration of the relation between disturbance and couple to be measured, and its variation with linear dimensions, is a matter of great importance in the design of most instruments in which the movements of a suspended system supply the means of measurement, there is an additional reason for correcting in these columns the error that I made.

C. V. BOYS.

On Some Temperature-Variations in France and Greenland.

THE relations indicated in the diagram sent herewith are, I think, instructive; and they might perhaps be found to contain some useful clues to coming weather.

This diagram has two kinds of curves, dotted line, and continuous. Both are *smoothed* curves. In the former, the actual



values have been smoothed with averages of five; and in the latter, those averages have, in their turn, been treated in the same way. High points in all the curves denote heat; low points cold.

The first pair of curves (a) show, by averages, the variation in the number of frost days in Paris in October to April of each cold season since 1806. (I designate each cold season by the year in which it *ends*; 1806 meaning 1805 6, &c.). These are *inverted* curves, the numbers increasing downwards. They present a succession of (say) five obvious waves, which, with regard to the crest intervals, are neither wholly regular nor wholly irregular, the intervals of the smoother curve being, in series, 12, 15, 18, and 17 years.

The second pair of curves (b) show the variation in mean temperature of July at Paris during the same period; and we may perceive in these a general correspondence to the first curves, with, however, a distinct tendency to lag somewhat.

There is a good deal of general similarity, of course, between the weather of Paris and our own, and between the longer waves of variation of July and those of the whole summer. Hence we find, *e.g.*, that a once-smoothed curve of mean temperature of summer at Greenwich presents obvious minima in the years 1814, 1839, 1862, and 1881. Compare this with the Paris July curve.

It is known that in our climate a severe winter tends to be followed by a cool summer; but the facts here presented are, it will be perceived, of a somewhat different order, and wider scope.

The third pair of curves (c) relate to Jakobshavn, on the west coast of Greenland, and show the smoothed variations in mean temperature of winter (December–February) for a series of years. These curves are short compared with the others, and are interrupted at one part; but so far as they go, they seem to present a similar variation, with further lag; so that, as compared with the Paris frost curve, we find the phases have come to be nearly opposite. Our European winters, indeed, seem to be generally opposite to those of Greenland. This is pointed out, as regards Vienna, by Dr. Hann in the paper from which those Jakobshavn figures are obtained. (*Met. Zeits.* 1890, p. 113.)

By way of comparing these curves, it may be useful to note the lowest points of the three once-smoothed curves; and the intervals between those of the same curve and of different curves. (The intervals, in years, are given in brackets.)

Paris, frost,	1814 (25),	1839 (17),	1856 (22),	1878 (11),	1889
	(1)	(3)	(6)	(3)	
Paris, July,	1815 (27),	1842 (20),	1862 (19)	1881 (9),	1890
		(2)	(3)	(3)	
Jakobshavn, winter,		1844 (21),	1865 (19),	1884.	

The fact of this lagging correspondence would appear to suggest that the general variations of our winter seasons are, in some measure, a key to those of approaching summers, and also, if the Jakobshavn correspondence were confirmed by a longer series of data, to those of approaching winters in Greenland.

An explanation of these curious facts may perhaps be supplied by those who have a comprehensive knowledge of polar meteorology and its relations.

A. B. M.

New Element in the Sulphur Group.

DR. B. BRAUNER, of Prag, in 1888 made a careful investigation of the atomic weight of tellurium, an account of which will be found in *C. S. J.* 320, p. 382. In accordance with Messrs. Newland's and Mendeléef's Periodic Law, tellurium should have, if pure, an atomic weight of 125, or even lower.

Prof. D. Mendeléef takes Sb = 122, Te = 125, I = 127. Taking the latest numbers for antimony and iodine (Sb = 120, I = 126·8), Dr. Brauner proceeds to investigate the atomic weight of Te, for which he finds by a great number of experiments the number 127·65. As is only to be expected from such a staunch advocate of the Periodic Law, he at once came to the conclusion that neither himself nor former experimenters (Berzelius, in 1812, 1818 and 1832; von Hauer, in 1857, &c.) had been dealing with the pure element. As he puts it, tellurium is not an element.

Tellurium prepared from the dibromide gave the high atomic weight of 130. Prepared from the tetrabromide, which latter was distilled in vacuo, the resulting element being distilled in a current of hydrogen, Te = 127·65. Under these circumstances, he says, no doubt one constituent of "tellurium" partly escapes, thus reducing the atomic weight. He terms tellurium the gadolinium of the sulphur group.

In the following year, 1889, Prof. Mendeléef predicted (Faraday Lecture, *C. S. J.* 323, p. 649) an element with atomic weight 212, which he calls Dvi-(= Bi-) tellurium, for which he suggests the symbol Dt, and predicts the following characters: it will be capable of forming an oxide RO_3; its hydride, if it exists, will be even more unstable than tellurium hydride; its compounds will be easily reduced; it will form definite alloys with metals; and have the specific gravity of about 9·3. Since then Prof. W. Preyer, in his "Genetisches System der chemischen Elemente," Berlin, 1893, p. 100, among unknown elements, gives one in the sulphur group, thus predicted by Mendeléef. He goes into further details, representing the atomic weight as 213; specific gravity, 8·6; atomic volume, 24·7; specific heat, 0·03; electro-negative, divalent, diamagnetic.

A. Grunwald (Bl. 1891, 5, p. 21) appears to have seen the spectrum of this element, whilst observing spectra of tellurium, copper and antimony.

Norwegium is considered by some chemists to be this missing element; Dr. Preyer is not of that opinion, regarding the claims of norwegium to be considered an element to be insufficiently supported.

In consideration of Dr. Brauner's work on the atomic weight of tellurium, and the priority of his suggestion of the existence of an accompanying element of higher atomic weight, coupled with his excellent work generally in furthering the claims of the Periodic Law (notably in the cases of beryllium and of the cerium, lanthanum and didymium series), I would suggest that this new element, when isolated from its close union with tellurium, be called Bohemium, in his bonour.

C. T. Blanshard.

Bright Meteors.

A pretty bright meteor crossed the eastern sky here on Saturday evening last, at about 7.54 p.m. I saw only the flash of light which it cast on the ground and in the sky towards the east, like a momentary weak red flash of lightning. "A shooting-star," said a bystander close to me, who saw it fairly well, and who gave me, roughly, this description, by the stars, of its apparent course: From about R.A. 340°, Decl. + 25°, to about 336°, + 12°. It described this course of 12° in about a second, and was red in colour, and broke up at last with a red flash, leaving no train of light or of sparks along the track which it had traversed, so long as for a second or two in which I had time to look towards the direction where he pointed. Tree-tops intercepted his view beyond the point of this disruption, but the light's sudden extinction there made a much further extension of the track unlikely.

About an hour afterwards, at about 8.49 p.m., I chanced to see another rather fine shooting-star, of about the brightness and colour of the planet Mars at present, descending some 16° or 18° across the northern sky in one and a-half or two seconds, from R.A. 47°, Decl. + 70°, to 100° + 69°, beginning and disappearing rather suddenly, and of nearly uniformly bright appearance all along its course. It projected no sparks, and, like the earlier meteor, left no train of light or enduring sparks along its track to mark its course.

Prolonged backwards the apparent paths of these two meteors diverge from near α Cassiopeiæ, and it may perhaps be that a shower of bright, ruddy meteors from the direction of Cassiopeia was in progress on that date, of which the two meteors here described may have been bright enough members to have been generally noted. The above observations, although those of the brighter meteor are only of rather slender accuracy, will perhaps be useful, in that case, to serve for comparison with other records which, at least of the larger meteor of the two, may not impossibly have been noted and preserved elsewhere.

A. S. Herschel.

Observatory House, Slough, October 1.

Tan-Spots over Dogs' Eyes.

Can any of your readers explain the meaning of the tan-spots seen so commonly over the eyes in black-and-tan dogs of most breeds?

When in Melbourne last year, I went carefully over all the dogs in a show, with one of the stewards, and we found the spots in all the black-and-tan terriers, foxhounds, deerhounds, collies, lurchers, &c; but I could get no information regarding them from the experts.

In some of the highly-bred toy dogs, as the small black-and-tan terriers, I found on inquiry that these spots, formerly so very conspicuous, were being bred out, and had *nearly* disappeared. Their persistence through so many strongly-marked varieties, except those of late date, is singular, for there is fairly good proof that when first domesticated the dog was red or bright brown, like the pariah, dingo, &c.

As far as I can see, we do not find the spots white on a black or dark ground; nor yet black or dark on a white or light ground. My explanation is that they have arisen as a permanent marking after the dogs "sported" to black under domestication, and have been preserved and developed through natural selection. Possibly they are protective, and simulate *eyes*.

One morning, just at dawn, I had occasion to go out into the garden, and while stooping to examine some flowers, near a fence partly covered with creepers, I suddenly saw an animal's head looking through, and what seemed to be two black, and seemingly large, eyes glared at me. Suspecting that a black leopard was about to spring over, I started back, clapped my hands, and shouted. To my relief, however, I saw a tail wag, and found that the spectator was a coolie's dog I knew very well, and which recognised me. The use of the tan-spots—in this case at least—then occurred to me.

May it not be that the spots thus serve a protective purpose, and have often saved the lives of dogs (black dogs) from their enemies, the smaller felines, such as the clouded leopard, &c.? Perhaps the matter is not new; but if it is, it seems worth looking into.

I have several dogs about here now with black bodies and heads; the tan-spots, rather pale, are of the size of a shilling. I have shot one, keeping the skin of the head as a curiosity.

Sibsagar, Asam, September 7. S. E. Peal.

Flight of the Albatross.

At the request of several friends, I enclose, for your inspection, a snap-shot of a northern albatross, which I took *en route* from Victoria, British Columbia, to San Francisco.

The photograph gives the bird in a position in which the human eye is incapable of seeing it. Strangely enough, the flight of the bird which I photographed had been during the whole course of the morning the subject of much discussion: none of us could imagine how the force which enabled it to fly at such

great speed was generated. I remembered having seen some discussion in the papers on the subject, and stated that the matter had been settled to the satisfaction of scientific people, and did my best to explain the theory.

I chose the moment for my photograph when the bird was about fifteen feet from the camera, and sailing alongside of the steamer. The stretch of the wings was estimated by the captain of the ship at between eleven and twelve feet, and the indicator on the camera showed these wings apparently at full stretch at the instant that I pressed the button. The result is certainly somewhat astonishing, and I shall be glad to know whether it is worth comment in your paper; to me it certainly seems to entirely upset the accepted theories as to the flight of this bird. A. KINGSMILL.

Stanmore, October 10.

ON THE DOCTRINE OF DISCONTINUITY OF FLUID MOTION, IN CONNECTION WITH THE RESISTANCE AGAINST A SOLID MOVING THROUGH A FLUID.[1]

III.

§ 11. THE accompanying diagram (Fig. 1) illustrates the application of the doctrine in question, to a disk kept moving through water or air with a constant velocity, V, perpendicular to its own plane. The assumption to which I object as being inconsistent with hydrodynamics, and very far from any

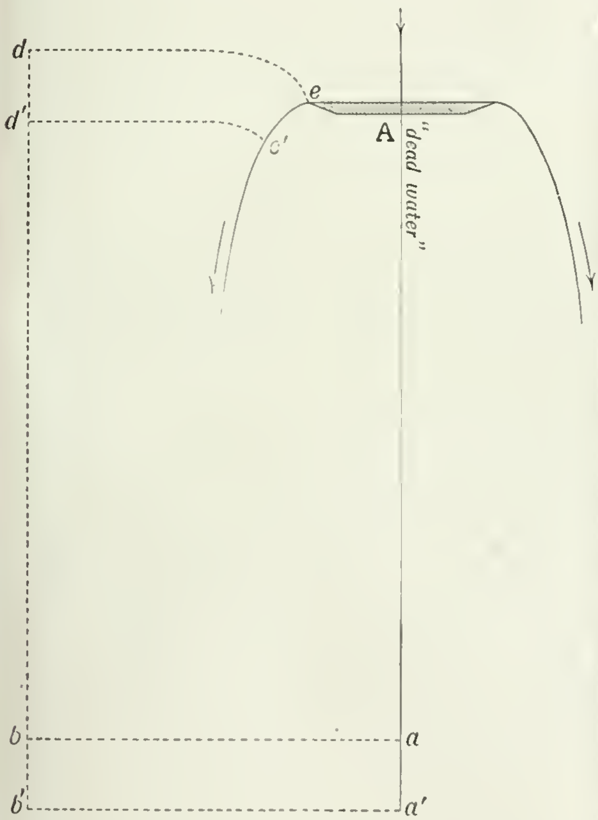


FIG. 1.

approximation to the truth for an inviscid incompressible fluid in any circumstances, and utterly at variance with observation of disks or blades (as oar blades) caused to move through water; is, that starting from the edge as represented by the two continuous curves in the diagram, and extending indefinitely rearwards, there is a "surface of discontinuity" on the outside of which the water flows, relatively to the disk, with velocity V, and on the inside there is a rear-less mass of "dead water"[2] following close after the disk.

[1] Continued from p. 549.

[2] This is a technical expression of practical hydraulics, adopted by the English teachers of the doctrine of finite slip between two parts of a homogeneous fluid, to designate water at rest relatively to the disk.

§ 12. The supposed constancy of the velocity on the outside of the supposed surface of discontinuity entails for the inside a constant pressure, and therefore quiescence relatively to the disk, and rearlessness of the "dead water." How such a state of motion could be produced? and what it is in respect to rear? are questions which I may suggest to the teachers of the doctrine, but happily, not going in for an examination in hydrokinetics, I need not try to answer.

§ 13. But now, supposing the motion of the disk to have been started some finite time, t, ago, and considering the consequent necessity (§ 9) for finiteness of its wake, let ab, bd be lines sufficiently far behind the rear, and beyond one side, of the disturbed water, to pass only through water not sensibly disturbed. We thus have a real finite case of motion to deal with, instead of the inexplicably infinite one of § 11. Let us try if it is possible that for some finite distance from the edge, and from the disk on each side, the motion could be even approximately, if not rigorously, that described in § 11, and indicated by the diagram.

§ 14. Let v be the velocity at any point in the axis, Aa, at distance y from the disk, rearwards. Draw ed perpendicular to the stream lines of the fluid, relatively to the disk supposed at rest.

The "flow"[1] in the line ed is 0;
" " " db " $V \times db$;
" " " ba " 0;
" " " aA " $-\int_0^{Aa} v dy$;
" " " Ae " 0, by hypothesis.

Hence for the "circulation"[2] in the closed polygon $edba$Ae, we have

$$V \times db - \int_0^{Aa} v dy.$$

Similarly, for the circulation in the same circuit[3] at a time later by any interval, τ, when the line ba has moved to the position $b'a'$, and ed to $e'd'$, we have

$$V \times db - \int_0^{Aa} v' dy.$$

where v' denotes, for the later time, $t+\tau$, the velocity in Aa, at distance y from A. Hence the circulation in edaAe gains in time τ an amount equal to

$$-\int_0^{Aa} (v' - v) dy;$$

which is the same as

$$-\int_0^{\infty} (v' - v) dy,$$

This, by the general theorem of "circulation,"[4] must be equal to the gain of circulation in time τ, of all the vortex-sheet in its growth from the edge according to the statement of § 11. Hence, with the notation of § 10,

$$(\Sigma\kappa)' - \Sigma\kappa = -\int_0^{\infty} (v' - v) dy.$$

§ 15. Remarking now that the fluid has only continuous irrotational motion through a finite space all round each of the lines ed, db, ba, aA; and all round Ae except the space occupied by the disk and the fluid beyond its front side, we have, for the velocity-potential of this motion, relatively to the disk,

$$Vy + \phi(x, y, z, t)$$

where ϕ denotes the velocity-potential of the motion

[1] "Vortex Motion" (Thomson), *Trans. R.S.E.*, 1869.

[2] *Ibid.*

[3] Remark that the circulation in $abb'a'$ is zero, and therefore the circulation in $edb'a'$Ae is equal to that in $edba$Ae.

[4] "Vortex Motion," *Trans. R.S.E.*, 1869.

relative to the infinitely distant fluid all round: and we have

$$v = \mathrm{V} + \frac{d}{dy}\phi(o, y, o, t).$$

With this the equation of § 14 becomes

$$(\Sigma\kappa)' - \Sigma\kappa = \{\phi(o, o, o, t+\tau)\} - \{\phi(o, o, o, t)\}.$$

Hence, by taking τ infinitely small,

$$\frac{d}{dt}\Sigma\kappa = \frac{d}{dt}\phi(o, o, o, t).$$

§ 16. Now in the time from t to $t + \tau$, there has been, according to the supposition stated in § 11, a growth of vortex sheet from e, at the rate $\frac{1}{2}$V, being the mean between the velocities of the fluid on its two sides,[1] and the circulation, per unit length, l, of the sheet thus growing is lV. Hence the vortex-circulation of the growing sheet augments, in time τ, by $\frac{1}{2}\mathrm{V}\tau \times \mathrm{V}$: and therefore, by § 15,

$$\frac{d}{dt}\,\phi\,(o, o, o, t) = \tfrac{1}{2}\,\mathrm{V}^2.$$

§ 17. Now, if Π denotes the pressure of the fluid at great distances, where its velocity, relative to the disk is V, and p the pressure at any point of the rear side of the disk, being the same as the pressure at A, we have, by elementary hydrokinetics,

$$p = \Pi + \tfrac{1}{2}\,\mathrm{V}^2 - \frac{d}{dt}\,\phi\,(o, o, o, t)$$

because the velocity of the fluid at every point of the rear side of the disk is zero according to the assumption of "dead water." Hence, by § 16,

$$p = \Pi,$$

which, being the same as the pressure on the rear side given by the unmitigated assumption of an endless ever broadening wake of "dead water," proves that our substitution (§ 13) of a finite configuration of motion conceivably possible as the consequence of setting the disk in motion at some finite time, t, ago, instead of the inconceivable configuration described in § 11, does not alter the pressure on the rear side of the disk.

§ 18. Hence were the motion of the fluid for some finite distance from the disk, on both its sides, the same, or very approximately the same, as that described in § 11, the force that must be applied to keep it moving uniformly would be the same, or very approximately the same, as that calculated by Lord Rayleigh from the motion of the fluid supposed to be wholly as described in § 11.

§ 19. But what reason have we for supposing the velocity of the fluid at the edge, on the front side of the disk, to be exactly or even approximately equal to the undisturbed velocity, V, of the fluid at great distances from the disk? None that I can see. It seems to me indeed probable that it is in reality much greater than V, when we consider that, with inviscid incompressible fluid in an unyielding outer boundary, the velocity, in the case considered in § 14, is equal to V at even so far from the edge as 1/5 of an inch, and increases from V to 63·7 × V between that distance from the edge, and the edge with its 1/2000 of an inch radius of curvature.

§ 20. And what of the "dead water" in contact with the whole rear side of the disk which the doctrine of discontinuity assumes? Look at the reality and you will see the water in the rear exceedingly lively everywhere except at the very centre of the disk. You will see it eddying round from the edge and returning outwards very close along the rear surface, often I believe with much greater velocity than V, but with no steadiness: on the contrary, with a turbulent unsteadiness utterly unlike the steady regular motion generally assumed in the doctrine of discontinuity.

[1] Helmholtz, Wissenschaftliche Abhandlungen; vol. i., foot of p. 151

§ 21. We may I think safely conclude that on the front side the opposing pressure is less than that calculated by Rayleigh. That this diminution of resistance is partially compensated or is over-compensated by diminution of pressure on the rear, is more than we are able to say from theory alone, in a problem of motion so complex and so far beyond our powers of calculation: but we are entitled to say so, I believe, by experiment. Rayleigh's investigation of the resistance experienced by an infinitely thin rigid plane blade bounded by two parallel straight edges, when caused to move through an inviscid incompressible fluid, with constant velocity, V, in a direction perpendicular to the edges and inclined at an angle i to the plane, gives a force cutting the plane perpendicularly at a distance from its middle equal to

$$\frac{3\cos i}{4(4 + \pi \sin i)}$$

of its breadth, and gives for the amount of this force in gravitation measure,

$$\frac{2\pi \sin i}{4 + \pi \sin i}\,\mathrm{PA},$$

where A denotes the area of one side of the blade, and P the weight of a column of the fluid of unit cross-sectional area, and of height equal to the height from which a body must fall to acquire a velocity equal to V.

§ 22. The assumption (§ 11) on which this investigation is founded admits no velocity of fluid motion relatively to the disk greater anywhere than V. It gives velocity reaching this value only at the edges of the blade; and at the supposed surface of discontinuity; and in the fluid at infinite distances all round except in the infinitely broad wake of "dead water" where the velocity is zero. It makes the pressure equal to Π all through the "dead water," and makes it increase through the moving fluid, from Π at an infinite distance and at the "surface of discontinuity," to a maximum value Π+P attained at the water-shed line of the disk. If the fluid is air, and if V be even so great as 120 feet per second (1/10 of the velocity of sound)[1] P would be only 7/1000 of Π. The corresponding augmentation of density could cause no very serious change of the motion from that assumed: and therefore in Rayleigh's investigation air may be regarded as an incompressible fluid if the velocity of the disk is anything less than 120 feet per second.

We may therefore test his formula for the resistance, by comparison with results of careful experiments made by Dines[2] on the resistance of air to disks and blades moved through it at velocities of from 40 to 70 statute miles per hour (59 to 103 feet per second).

§ 23. Dines finds for normal incidence the resistance against a foot-square plate, moving through air at m British statute miles per hour to be equal to ·0029 m^2 of a pound weight.

This, if we take the specific gravity of the air as 1/800, gives according to our notation of §21,

$$1{\cdot}16 \times \mathrm{PA}$$

as the resistance to a square plate of area A. At the foot of p. 255 (*Proc. R.S.*, June 1890) Dines says that he finds the resistance to a long narrow blade to be more than 20 per cent. greater than to a square plate. For a blade we may there take

$$1{\cdot}34 \times \mathrm{PA}$$

as the resistance according to Dines' experiments. This is 1·52 times the resistance calculated from Rayleigh's formula (§ 21 above), which is

$$\cdot 88\ \ \mathrm{PA},$$

for normal incidence.

§ 24. For incidences more and more oblique, the dis-

[1] Or $\frac{1}{2}\mathrm{V}^2 \div g\mathrm{H}$, where H is "the height of the homogeneous atmosphere."

[2] *Proc. R.S.A.*, June 1890.

crepancy is greater and greater. Thus, from curves given by Dines (p. 256) showing his own and Rayleigh's results, I find the normal resistance to a blade moved through air in a direction inclined 30° to its plane, to be 1·82 times that given by Rayleigh's formula. And by drawing a tangent to Dines' curve at the point in which it cuts the line of zero pressure, I find that, for very small values of *i*, it gives

$$3{\cdot}25 \times \sin i \times \text{PA}.$$

This is rather more than double the value of the force given by Rayleigh's formula for very small values of *i*, which is

$$\tfrac{1}{2}\,\pi \sin i.\text{PA}.$$

It is about three and a half per cent. greater than that given by my conjectural formula (NATURE, August 20, p. 426, and September 27, p. 525; and *Phil. Mag.*, October 1894) for very small values of *i*, which is

$$\pi \sin i \cos i.\ \text{PA}.$$

My formula is, however, merely conjectural; and I was inclined to think that it may considerably under-estimate the force. That it does so to some degree is perhaps made probable by its somewhat close agreement with Dines; because the blade in his experiments was 3*i* broad and ⅜ of an inch thick in the middle with edges "feathered off." An infinitely thin blade would probably have shown greater resistances, at all angles, and especially at those of small inclination to the wind.

(*To be continued.*)

OBSERVATIONS ON YOUNG PHEASANTS.

THE pheasants which formed the subjects of the following observations were hatched out in an incubator from eggs kindly given me by Sir Cecil Miles. The eggs were taken from the hen and transferred to the incubator a few days before the young birds were due to emerge.

The accuracy of pecking and seizing was found to be about the same as that of newly-hatched chicks. For example: two pheasants were hatched out at about 3 p.m.; that evening, at about 6.30, finely chopped egg was placed before them, but they showed no signs of pecking at it; nor did they peck at grain or sand next morning at 11 a.m. At 4 p.m. they began to peck, but seized very little. One struck repeatedly at a crumb of egg on the other's back, but failed to seize it, though the other bird was quite still. On the following morning they pecked at sand and grain (chiefly canary seed) with fair aim. One seized, at the first stroke, a grain of boiled rice at the end of a long steel pin. Another pheasant was hatched out in the night. At about 12 noon, I offered him some egg-bread on the end of a tooth-pick. He struck at it and missed, struck a second time and seized, swallowing some. He could not be induced to strike again. Later he picked up some ants' "eggs," striking with fair accuracy, but did not swallow any. At 4 p.m. he pecked some egg-bread off the end of the tooth-pick, and swallowed. He also pecked at an ant's "egg," but failed to swallow it; then at a second, and swallowed it. Further details would be merely wearisome. One may say that the co-ordination for pecking and swallowing is inherited in a condition such as to ensure fair but not complete accuracy; and that some individual experience is necessary to bring it to perfection.

The young pheasants took no notice whatever of water placed before them in a shallow vessel. When I gave them water on the tip of my finger, they seemed to enjoy it, and one in particular drank eagerly from the end of a tooth-pick, so that an association was established between the sight of the tooth-pick and the satisfaction of drinking. But when I lifted this bird and others, and placed them in the shallow vessel, they made no attempt to drink from it. They learnt to drink from the vessel through pecking at grains of food lying on the bottom. They drank, however, less freely than chicks.

The little birds showed no sign of fear of me. They liked to nestle in my warm hand. My fox-terrier was keen to get at them, much keener than with chicks, probably through scent-suggestion. I placed two of the young pheasants, about a day old, on the floor, and let him smell them (under strict orders not to touch them). He was trembling in every limb from excitement. But they showed no signs of fear, though his nose was within an inch of them. When the pheasants were a week old, I procured a large blind-worm and placed it in front of the incubator drawer in which the birds slept at night. On opening the drawer they jumped out as usual, and ran over the blind-worm without taking any notice of it. Presently first one, then another, pecked vigorously at the forked tongue as it played in and out of the blind-worm's mouth. Subsequently they pecked at its eye and the end of its tail. This observation naturally leads one to surmise that the constant tongue-play in snakes may act as a lure for young and inexperienced birds; and that some cases of so-called fascination may be simply the fluttering of birds round this tempting object. I distinctly remember when a boy seeing a grass-snake with head slightly elevated and quite motionless, and round it three or four young birds fluttering nearer and nearer. It looked like fascination; it may have been that each hoped to be the first to catch that tempting but elusive worm! Presently they would no doubt be invited to step inside.

Another incidental observation is worth recording here. I gave the young birds some wood-lice. These were frequently caught when they were moving, and eaten. But if one had time to roll up, and was thus seized, it was shot out to a distance by the pressure of the bill, just as a fresh cherry-stone is shot from between the finger and thumb of a school-boy. The protective value of the round and slippery form was thus a matter of observation.

I have not observed in the young pheasants the crouching down, which is seen in young chicks when an unusual sound startles them. They appear under such circumstances to stand motionless. For example, when two of them were walking about, picking up all the indigestible odds and ends they could find on my carpet, a high chord was sharply struck on the violin. Both stopped dead. The gentle piping noise they were making ceased. One of them was just lifting his leg, and remained in this position quite still, with neck stretched out, exactly as if he had been suddenly fixed in the attitude in which he chanced to be when the sharp sound fell on his ears. Thus he remained for half a minute. Then he took a few steps and again stopped, remaining quite still for about the same period. (Age 13 days.)

The method of tackling a worm appears to be a matter of inherited co-ordination. So soon as the worm is seized, it is shaken and battered about. There seems to be, also, an inherited tendency to run away with it to some distance before eating it. At all events, of two little pheasants, one of which was weakly, the stronger always bolted off with his worm, though his weakly brother or sister seldom or never chased him. He sometimes tried to bolt with one of his companion's toes by mistake, when one or both of the birds would topple over.

Two notes or sounds, one loud and distressful, the other soft and contentful, appear from the first to be clearly differentiated. A third sound, more gentle than the soft note and double, was occasionally heard when one caressed the birds in one's warm hand. It closely resembles a similar note uttered under similar circumstances by the chick. The note expressive of danger, alarm, or anger, was occasionally heard after about the sixth day. For example, as the little pheasant was bolting with his worm, I seized it with a pair of forceps. This alarm or anger note was at once uttered, and the little fellow bridled up and seemed ready to show fight.

The birds when fresh run about with little short spurts or dashes, as do also chicks. They have a dislike to being confined. When they were surrounded with wire netting, although the space inside was ample for all their needs, they squeezed through the meshes, and did so very cleverly when four or five days old. At about this age or earlier they preen their down, and the incipient feathers of the wing, often tumbling over from imperfect co-ordination. They also peck persistently at their toes. They scratch the ground much less than chicks.

More difficulty was found in rearing the pheasants by hand than in the case of chicks. Several died apparently from constipation. None were reared beyond the fifteenth day. The coldness of the season was against them, and unfortunately, through an accident, the incubator drawer in which they slept was allowed to get cold, and this caused the death of the last two, one of which was quite healthy. I hope to repeat the observations, next year, on these and other young birds under more favourable conditions. Such as they are, however, they serve to confirm the conclusions based upon the study of newly-hatched chicks and ducklings, which I briefly set forth in *Natural Science* for March 1894, and which are considered at greater length in my "Introduction to Comparative Psychology," to be published this autumn in the Contemporary Science Series.

C. Lloyd Morgan.

SCHOOLS OF METEOROLOGY.

In your issue of September 13, p. 481, you correctly state that one reason for the small number of meteorologists is the want of a training school. This is a defect in our University curricula that I have frequently pointed out and sought to remedy. You will agree with me that meteorology is worthy of a generous and profound treatment. It should be recognised as a possible major course in all large Universities. Laboratories should be provided where all questions bearing on the atmosphere and its motions can be experimentally elucidated.

I append a sketch of the four years' course of study and work that I hope to carry out with my own students. The necessary laboratory conveniences have not yet been provided, but we are looking forward hopefully.

I shall be glad if your publication of this course contribute in any way to the proper study of meteorology by the young physicists of the British Empire.

Cleveland Abbe.

Washington, September 24.

Columbian University.

Department of Meteorology.

The series of courses in the Department of Meteorology is designed to give a complete review of the present condition of that science, and is therefore necessarily extended through four years; but the series of lectures is so arranged that each of the four divisions is complete within itself; each course presents a view of a branch of the subject such as may be desired by a large number of students who need this information in connection with other branches of knowledge to which they are specially devoting themselves.

Students who intend to take the degree of Ph.D. in meteorology, and who therefore make this the major subject in connection with several other minor courses, must pursue the whole four years' course. Those who desire merely to enter the service of the United States Weather Bureau will probably find the first year's course sufficient to enable them to pass the necessary Civil Service examinations. Those who desire to do work in climatological study should also take the second year. The third year's course is designed for those who wish to perfect themselves in methods of making local weather forecasts. Finally, the fourth year's course will serve as an abundant introduction to the present state of our knowledge of the mechanics and physics of the atmosphere. In addition to the lectures, the instructor will give one hour a week to a quiz-class, in which, by question and answer, he will seek to remove any difficulties that remain.

(1) *Observational Meteorology.*—The methods of observation; the simpler instruments, their errors, corrections, and reductions; the use of self-registers; the forms of record and computation; personal diary of the weather.

Time.—About eighty lectures, or two hours a week, as also eighty other hours of personal investigation of instruments, especially self-registers.

Algebra and trigonometry are necessary preliminaries to this course. Elementary laboratory physics, as illustrated by Hall and Bergen's text-book, is desirable as a preliminary, but may be pursued as a concomitant study. The German language is earnestly recommended as a concomitant. The differential and integral calculus will be needed as preliminary to the Graduate Course in Meteorology.

(2) Climatology, both local and general; empirical meteorology, generalisations, averages, periodicities, irregularities. The relation of climate to geology, to vegetation, to animal life, and to anthropology.

Time.—About forty lectures and four hours weekly given to the investigation of special problems proposed in each lecture.

Students should be familiar with the use of logarithms; the method of least squares; the laws of chance; the details of physical geography, orography, geology, and ocean currents; the physiology of plants and animals; the distribution of species; physical astronomy, especially that of the sun, earth, and moon; terrestrial magnetism; the chemistry of the atmosphere; the biology of atmospheric dust. Physical laboratory work on radiation, conduction, and absorption of heat, and on condensation and evaporation of vapour, and on elementary electricity, is recommended, while German, the calculus and analytic mechanics should be continued as preliminary to the Graduate Course.

Graduate School of Meteorology.

The following scheme of studies in meteorology, subject to arrangement between the teacher and his pupils, is offered for the degree of Doctor of Philosophy:—

(1) Practical meteorology; the daily weather chart; the empirical laws of weather changes as depending on meteorological data, and the arrangement of continents, plateaus, mountains, oceans, &c.; weather types and typical weather charts; prediction of daily weather and seasonal climates; verification of predictions.

Time.—About forty lectures and at least five hours a week additional, in verifying old laws and studying new ones, in making and verifying predictions.

Concomitant Studies.—Methods of chart projection; experimental laboratory work in both steady and discontinuous motions of fluid and gases; mathematical and experimental electricity; the laws of refraction and interference of light; elementary hydrodynamics and thermodynamics; differential equations and definite integrals; the German language.

(2) Theoretical meteorology. Insolation. The absorption, conduction, and radiation of heat by the air and the earth. The thermodynamics of the atmosphere; the graphic methods of Hertz and Bezold. Convective equilibrium, as applied to the atmosphere of the sun by Lane, and to that of the earth by Sir William Thomson

(Lord Kelvin) and his successors. Motion on a rotating globe; Ferrel's and other simple approximate relations between baric gradients and the wind and temperature; Ferrel's general circulation of the atmosphere and his cyclones and pericyclones and tornados. Galton's cyclone and anticyclone. Fourier's most general equations of gaseous motions. Oberbeck's general circulation. Helmholtz's horizontal rolls. The investigations of Diro Kitao, Guldberg and Mohn, Marchi, Boussinesq, A. Poincaré, Sprung, Siemens, Moeller, Ritter, and others into the motions of the atmosphere. Viscosity and discontinuous movements. The possible special solutions of the general equations of fluid motions that apply to the true atmospheric circulation, both on the earth and on the other planets. Atmospheric tides; theories of Laplace, Ferrel, Rayleigh, Margules, A. Poincaré. Theories of atmospheric electricity.

Time.—Eighty lectures and an additional four hours a week given to special reading and investigation, and to the preparation of the final thesis, as closing the four years' course.

Concomitant Studies. — Riemann's "Differential Gleichungen"; Auerbach's "Hydrodynamics"; Lamb's "Fluid Motions" (new edition); physical laboratory work in gaseous motions, optical and electrical phenomena.

THE ROYAL PHOTOGRAPHIC SOCIETY.

SIR H. TRUEMAN WOOD, the new President of the Royal Photographic Society, delivered an address at the opening meeting of the present session on Tuesday. After briefly tracing the development of the Society, he said:

"Turning aside from the consideration of the affairs of our own Society, to the general condition of photography, we find cause for nothing but congratulation. It is not so very long since photography occupied a very subordinate position in the world alike of science and of art. Scientific men looked on photography as a mere art, artists regarded it as a mere science. About twenty years ago, when I suggested that some improvement in a photographic process—I forget now which—ought to be brought before the Physical Section of the British Association, I was told that there was nothing scientific about photography, that it was a mere empirical pursuit, unworthy the attention of serious students of science.

"And to a large extent the reproach was well deserved. Though the list of the earliest workers in photography contains many illustrious names, yet it is true that a large proportion of the most important contributions to photographic knowledge were not made by scientific workers, or by men who worked in scientific methods. They were obtained by practical men, seeking for results; often, indeed, seeking for them successfully by methods which would not have commended themselves to men better equipped with scientific knowledge. Of course this was the consequence of the fact that photographic science was early associated with photographic practice; and the same remark holds good of other sciences, electricity for instance, in which theory and application to practical use advance with equal steps; but I think it applies more to photography than to any other.

"At the present time we have indeed reached a very different condition of things. All the most striking of the recent advances in the science are the result of elaborate scientific research. The most recent improvements in lenses were the fruit of long and laborious investigation into the optical properties and the chemical nature of certain sorts of glass. The increased speed of modern plates, and their improved power of rendering colour values more truly, have only been obtained by minute knowledge of the condition of the problem to be solved, and by careful application of the most recent results of chemical and physical research. If the old photographic crux, the reproduction of colour, has been solved, or, at all events, if a possible method has been indicated for its solution, it was not by haphazard experiment, but by careful adjustment of means to secure an anticipated result. Nowadays, we can only hope for improvement by utilising the advance of scientific knowledge.

"But if the present position of photography is due to progress in the kindred sciences, how amply has she repaid the debt! There is not a single branch of science in which photography is not largely used. There are many whose progress is now absolutely dependent on the power of the camera to observe more accurately, more independently, more minutely, more rapidly, more permanently, than the human eye. If, as appears to be the case, we have reached the limits of human vision, aided by the most delicate instruments that can be constructed, it is difficult to imagine what limits need be set to photographic vision, can we but construct instruments of accuracy sufficient to allow its full powers to be utilised.

"I imagine that the first application of photography to a scientific purpose must have been when Dr. Draper in New York photographed the moon. Whether the pictures he obtained were of any astronomical value, I do not know; certainly those taken a little later, in 1852, by Dr. Warren De la Rue, were, and they were the precursors of the long series of astronomical photographs culminating in Dr. Common's nebula of Orion, and in the great work of charting the heavens by photography which is now in progress.

"The advantages of the 'retina which never forgets,' and it might be added which never tires, which accumulates weak impressions and stores them up till they become one strong one, were long since recognised by De la Rue, and I suppose it will not be very long before, for astronomical purposes, eye observations are entirely superseded by photographic. The photographic camera is now an indispensable adjunct to every large telescope, if indeed it would not be equally correct to say that the telescope is an adjunct to the camera, since the astronomical telescope tends more and more to assimilate to the form adopted long since by Mr. Rutherford, in which the visual rays are treated of but slight importance, and the chief attention is given to the accurate utilisation of the more chemically active rays at the violet end of the spectrum.[1]

"In his recent address to the Photographic Convention at Dublin, Sir Howard Grubb, than whom nobody is better qualified to speak on the subject, dwelt on the services which photography has rendered to astronomy, and gave several striking illustrations of those services. Indeed, if one not qualified to speak on such matters with any authority might hazard an opinion, it would almost seem as if the power of recording observations had already outstripped the capacity for examining the observations, and drawing conclusions from them. When we are told that a photographic plate has recorded 10,000 stars in an area not containing a single visible star, one may be excused an expression of wonder as to how the human mind is ever to grapple with problems of such infinite complexity, to turn to useful account observations dealing with such enormous multitudes.

"But if the telescope has lately become one of the most important of photographic appliances, the spectroscope may be said to have held that position almost since its introduction. Mr. Norman Lockyer, in his well-known text-book, "Studies in Spectrum Analysis," attributes to

[1] A good illustration of the telescope of the future would appear to be the 24-inch photographic refractor with an 18-inch visual telescope, now being constructed at the expense of Mr. McLean for the Cape Observatory.

Sir John Herschel the first suggestion of spectrum photography, and we find that in 1839 the latter pointed out that the way to investigate sensitiveness was to photograph the spectrum. In the following year he read a paper describing his results of spectrum photography. A little later, in 1842, Becquerel and Draper were both at work photographing the solar spectrum. Twenty years later (in 1864) Miller was turning to practical account the power of photography to record the parts of the spectrum beyond the limits of human vision, and from that date nearly all spectroscopic work has been photographic work. Whether applied to astronomical observation or chemical research, the spectroscope has always been combined with the camera, and it is by the combination of the two instruments that such wonderful results have been attained. And as photographic methods have improved, so have fresh facilities been afforded to the spectroscopic worker. Mr. Lockyer's earlier work was of necessity done with wet plates, but with the plates now available he is producing star spectra on a scale comparable with the solar spectra of twenty-five years ago.[1] Rutherford's recent maps of the solar spectrum could not have been produced without the use of colour-sensitive plates, while in one of the most recent attempts to employ spectroscopic analysis for purposes of practical metallurgy[2] Prof. Hartley tells us that he also used orthochromatic plates, specially prepared, and that after trying various developers he found hydroquinone the best.

"As an automatic recorder of scientific observations, photography seems to have been utilised in the Royal Observatory about 1847, under the superintendence of the venerable ex-president of this Society, Mr. Glaisher, who has been kind enough to furnish me with particulars of the methods originally devised by Mr. Charles Brooke, and successfully worked for many years by Mr. Glaisher and his staff.

"The method was first applied to record magnetic variations and the movements of the barometer and thermometer. In the case of the former, a ray of light reflected from a mirror carried by the magnet was focussed on the surface of a cylinder covered with sensitised paper.[3] The cylinder was rotated by clockwork, the result being, of course—in the way now commonly employed for such automatic records—to give, when the image was developed, a record of the movements of the magnet. A base line was given by an invariable spot of light, and by intermissions of this light a time record was provided. Similar results were obtained in the case of the barometer by using a float with a small perforation through which the light passed, and with the thermometer by simply allowing the mercury itself to screen the light from the sensitive surface.[4]

"Later on, in 1865, similar means were used by Mr. Glaisher for the automatic record of earth-currents, and they have consequently been continuously observed since that date at Greenwich.

"To the best of my knowledge but little alteration has been made in the original system, the only improvement being in the sensitive surface employed. When gelatino-bromide paper was introduced, it was tried and adopted at Greenwich, and by its means superior results were obtained.

"I have ventured to dwell at some little length on this part of the subject, not because what I have said can be novel to any of you, but because I think this first application of photography to automatic observation has considerable historical interest, and also because this application was carried out by one so long and so honourably connected with this Society.

"The principle thus first applied at Greenwich has received numerous other applications, and indeed it is now a matter of course that photographic methods should be used to register the movements of any instrument of whose indications it is desired to preserve a record. Instances are of course numerous in which no other method is possible. Hardly any but a photographic method could register the movements of the light spot of a reflecting galvanometer, and thus enable the physicist who, like Langley, is measuring the heat radiated from celestial bodies, to record the minutest differences of temperature; the chemist, like Dewar, who is producing hardly imaginable cold, to record temperatures approaching absolute zero; the metallurgist, like Roberts-Austen, who is dealing with the melting points of metals, to register by a photographically traced curve variations in high temperatures which but a short time ago could not be accurately measured at all. It is interesting to read the testimony of the last named, given at the recent conference of the Camera Club, to the effect that he could not conceive of any method which would give such results in the same space and time. Equally interesting is it to note the Professor's suggestion for a practical method of recording continuously the temperature of the air-supply of a blast furnace, a matter of great importance to the iron manufacturer, of which he says:—'If we had no photography it would be impossible to get a record which would be anything like so true.'

"Numerous other instances will occur to many of you in which photography has been or might be—indeed I may say will be—applied to similar purposes. I will only refer to one, because it appears to me so excellent an instance of the delicacy of the method. At the last (the Oxford) meeting of the British Association, Mr. Burch showed to the newly-formed Physiological Section photographic records taken with the aid of the capillary electrometer of electrical currents produced by speaking into the telephone. The letter *z* produced a complicated curve in which oscillations of current lasting only 1/3000 sec. were visible with a lens.

"It seems hardly worth while to trouble you with the details of many of the other services which photography has rendered to science, and if I were to attempt to produce an exhaustive list, there are many present to-night who could supplement it out of their own knowledge. The meteorologist has been enabled by its aid to study the form and nature of clouds, the shape and character of the lightning flash. The zoologist has been taught much about animal motion. The microscopist has long learnt to rely on the camera as the only accurate means of reproducing the objects of his studies. The physicist has by photographic methods investigated many phenomena in which the changes are too rapid for the human eye to follow them. By such means Lord Rayleigh and Prof. Boys have obtained long series of pictures of occurrences which all took place within a fraction of a second, thus almost analysing time as the chemist analyses matter.

"The uses of photography in ethnology, geology, geography, natural history, archæology, are too obvious to need mention. They and many other applications may be summed up in the remark that whenever the observer of natural phenomena requires to make an accurate record of his observations, photography supplies the means. It also supplies the means of showing to a room full of spectators what could otherwise be seen by but a single observer at one time, and has thus rendered to the popularisation of science no less a service than it has lent to its advancement. This universal use of photography for purposes of demonstration must certainly not be forgotten in however brief a summary of its applications."

[1] "Photographic Spectra of some of the Brighter Stars." *Phil. Trans.*, [illegible]

[2] "Flame Spectra at High Temperatures." *Phil. Trans.*, vol. 185, A., p. 161 *et seq.*

[3] The method employed was a form of the old calotype process. Paper [illegible] with potassium [illegible] was afterwards sensitised with [illegible] nitrate. The development was by gallic acid.

[4] For a full account of the apparatus reference may be made to an addendum to the introduction to the Greenwich magnetical and meteorological observations for 1847.

The services of photography to art were next touched upon by Sir H. T. Wood, who afterwards went on to say:

"The interesting investigations of Buchner and Marshall Ward into the action of light on bacteria can hardly with justice be admitted as adding to the list of photographic materials, though we must certainly claim the 'photobacteriograph' as an advance in our science and as suggesting new directions for photographic work.

"The question of sensitometry has exercised the minds of many of our most active workers for some time, but I think I may say without as yet any positive result. I believe I may put it as the opinion of those best qualified to express an impartial judgment on the subject, that while we have certainly obtained a means of roughly gauging the comparative sensitiveness of plates, and have got a guide of great practical use to the makers and users of plates, we are as far as ever from an absolute standard, and that the attainment of such a standard must await the attainment of a standard of light, a problem the solution of which is of importance not to photographers alone.

"It would obviously be unreasonable to expect that the increase of photographic knowledge should grow *pari passu* with the number of those who practise the art, but I think it is certainly a matter for regret that of the many thousands who have taken up photography as a pastime, so very few pursue it in a serious way, or in a scientific spirit. The popularisation of photography has indeed to my mind been a drawback to real progress. The process of picture-making has been rendered so easy that it has been deprived of much of its interest, even to the merest amateur in science, and the attention of those who might have pursued photography seriously has been diverted to other branches of science. Still we are fortunate in having, even among the younger workers, a considerable band of capable and active students who are adding slowly but surely to our knowledge of the scientific principles of the art.

"In photographic optics there is, I think I may say, a very distinct advance now going on. The expectations of opticians have long been fixed on the productions of the Jena manufactory, and those expectations are, according to the best information at my disposal, now in a fair way of being realised. The qualities of glass that are to be obtained commercially from Jena have provided the opticians with new possibilities for the improvement of photographic lenses. Both in this country and in Germany opticians are availing themselves of these possibilities. Great credit is certainly due to Messrs. Ross, who have carried out the work of Dr. Schroeder, and have produced from his calculations the lens which they have termed the 'concentric' lens. The double anastigmat of Goerz, described last year to the Society by that gentleman, is another new lens, the outcome of the Jena improvements in glass, which ought at least to receive mention.

"Mr. Dallmeyer has also made considerable advances, both theoretical and practical, in his 'telephotographic' lens, an instrument which produces results appealing at once to all who take any interest in photographic matters, and one which, in the opinion of competent authorities, is likely to have important practical applications for astronomical and other branches of scientific photography."

WILLIAM TOPLEY, F.R.S.

A GREAT gap has been made in the ranks of active geologists by the death of William Topley, which took place on the night of Sunday, September 30, at his house at Croydon. He was taken ill, with gastritis, probably from the use of contaminated water, in Algiers, during a short visit, made in reference to its geology; and he fell, therefore, in the fighting line of those who apply their scientific knowledge for the good of mankind.

He was ill whilst travelling home, and though after a time he began a slow recovery, a relapse came on Saturday, September 29, which soon proved fatal.

Born at Greenwich in 1841, he had reached an age when, though the physical powers may have begun to wane, yet the mental powers are reinforced by stores of knowledge and of experience, and the value of a scientific life is high.

His scientific education was at the Royal School of Mines, Jermyn Street. Soon after his student-life was ended, he joined the Geological Survey (early in 1862), and his future career was identified with that Survey, of which he was one of the oldest and best-known officers at the date of his untimely death.

For many years his work lay in the counties of Kent, Surrey, and Sussex, in the investigation of the great district of the Weald and its surroundings, with which his name will ever be linked.

He made his mark as a good observer of facts and an able reasoner from them in 1865, by the paper, read to the Geological Society, "On the Superficial Deposits of the Valley of the Medway, with Remarks on the Denudation of the Weald," which was written jointly with his then colleague, Dr. C. LeNeve Foster. This is a most important essay, in which the general question of inland erosion is discussed, and the special question of the processes of denudation that had acted over a definite tract, on which much had been written, may be said to have been practically settled, an achievement of no small merit.

In 1866 Mr. Topley supplemented his knowledge of our Wealden deposits by a visit to the Boulonnais, a tract that really contains the severed eastern end of the Weald, a visit in which the writer had the pleasure of accompanying him, and the results of which were given to the Geological Society in 1868.

He soon turned his attention to the bearings of geology on other branches of knowledge, and in 1871 the Royal Agricultural Society published a paper by him, "On the Comparative Agriculture of England and Wales," followed, in the next year, by another, "On the Agricultural Geology of the Weald."

In 1873 a paper was printed by the Anthropological Institute, in which he treated of the relation of parish boundaries to great physical features. This was illustrated chiefly from parts of the Weald and its borders: but references were made to other parts, and amongst them to Northumberland, to which county he had been transferred from the south.

In 1874 he gave the Geological Society a very suggestive paper "On the Correspondence between some Areas of Apparent Upheaval and the Thickening of Subjacent Beds," in which he pointed out that an apparent dip (over a large tract) may be partly owing to the thinning of beds underground.

In 1875 appeared the work by which he will probably be best known, and in the writing and compiling of which he may be said to have raised his own monument. The Geological Survey Memoir on the Weald is noted, not so much for local details (of which, however, there are many) as for the thorough way in which the literature of the subject is treated, for the full discussion of the subjects of physical geology, scenery, and denudation, and for the attention given to many branches of applied geology. The parts mentioned indeed take up more than half of the text, adding greatly to the interest of the book.

Naturally the important work of the Sub-wealden Boring was not done without Mr. Topley's help.

In 1876, he used his northern experience in the field in joining his friend Prof. Lebour in a paper to the Geological Society, on the intrusive nature of the Whin Sill, published the following year.

Since that time he contributed papers to various societies, other than those already mentioned, and to various journals These are chiefly on questions relating to economic geology, such as water-supply, petroleum, and coal in south-eastern England; and are too many to be noticed here. His name also appears, of course, as author, or part author, on many sheets of the maps and sections of the Geological Survey.

It is not only, however, by his published works that Mr. Topley is known—in science his was a public life. He took a marked part in the work of the British Association, and was secretary of its Geological Section for no less than fifteen years—one of the longest of such secretarial lives. He also served on some committees, and was secretary of that on coast erosion, the reports of which owe much to him. He served on the councils of the Geological Society and of the Geologists' Association for many years, and was president of the latter body for two years (1885-7). He took part in most of the international geological congresses, and worked hard for the great one in London, of which he was a secretary, in 1888. He was also for some time a sub-editor, and afterwards editor, of the *Geological Record*.

In his latter years, his presence at the Geological Survey Office, for a period of about fourteen years, brought him into contact with many people, who benefited by his knowledge and by his readiness in imparting it. Amongst engineers and others he was widely known as an expert of the most trustworthy kind on questions of water-supply, and of other subjects in which geologic knowledge comes in.

Happy in his domestic relations, of a kindly, cheerful disposition, good-natured and hospitable, he was always ready to help his brethren of the hammer, as well as all those who went to the Survey Office for information; indeed, a former colleague has said of him, to the writer, that his one prominent fault was excessive amiability.

He will be greatly missed by his colleagues, and his loss will be felt over a much wider circle—in fact, by all who knew him. W. W.

NOTES.

Two letters of Charles Darwin are published for the first time in the *Bulletin* of the Royal Botanic Gardens, Trinidad, No. 22, April 1894. These letters were addressed, before the completion of Darwin's book on the fertilisation of orchids, to the late Dr. Herman Cruger, who was Government Botanist at Trinidad for some years, asking him to observe if possible the fertilisation of certain species of the Melastomads. In the first letter he expresses a suspicion that the flowers which have the singular projections, or horns from their anthers, may be visited by small insects which penetrate one of the horns of the anther with their proboscis, to obtain the fluid contained in them. In the second letter he admits that this suspicion is quite groundless, and asks for information with regard to any instances of "bud variation" in plants from the warmer regions cultivated in the West Indies.

THE Botanical Society of America is about to try the experiment of admitting working naturalists only to its full fellowship. By a unanimous vote the Society has adopted a new constitution providing that none but American botanists engaged in research, who have published work of recognised merit, shall be eligible to active membership. Candidates for active membership must be recommended by three active members of the Society, but any nominee may be objected to by any member, and if ten members object, the name will not be considered by the Council. Nominees may be rejected by two negative votes in the Council, which numbers seven members, or by one-fifth of the votes cast after the name has been approved. The President of the Society for the present year is Prof. W. Trelease; the Vice-president, Prof. N. L. Britton; the Secretary, Mr. C. R. Barnes; the Treasurer, Mr. J. Donnell Smith.

DR. T. LAUDER BRUNTON, F.R.S., will deliver the annual Harveian oration at the Royal College of Physicians, on Thursday, October 18, at 4 p.m.

Two new wings of the Durham College of Science were inaugurated on Tuesday. The wings include apartments to be devoted to the study of engineering and the fine arts.

ON Friday last, the Duke and Duchess of York opened the new medical school, erected at a cost of £40,000, in connection with the Yorkshire College, Leeds, and also a new central hall and library, which have been added to the College at a cost of £20,000.

THE Essex Field Club will hold its annual cryptogamic and botanical meeting on Saturday, October 13. The headquarters for the meeting is the "King's Oak" Hotel, High Beach, Epping Forest.

THE opening meeting of the Royal Microscopical Society will take place on Wednesday, October 17, at 8 p.m., when Mr. F. Chapman will read a paper "On the Foraminifera of the Gault of Folkestone"; and Dr. H. Stolterfoth will give some notes on the genus *Corethron*.

A MEETING of the Institution of Mechanical Engineers will be held on Wednesday evening, October 24, and Thursday evening, October 25. The following papers will be read and discussed, as far as time permits:—"The Manufacture of Standard Screws for Machine-made Watches," by Mr. Charles J. Hewitt (Wednesday); "Drilling Machines for Cylindrical Boiler Shells," by Mr. Samuel Dixon (Thursday).

IT is reported that a violent storm passed over the town of Little Rock, Arkansas, at the beginning of last week. Though the storm or tornado only lasted three minutes, eight persons were killed during that time, and several were seriously injured, while property was damaged to an amount estimated at £200,000. The direction of motion of the disturbance was from south-west to north-east, and the width of the path traversed was only about two hundred yards. The storm was accompanied by heavy rain, and was followed by brilliant lightning.

ONE of the most valuable and extensive botanical libraries in the country, that collected by Prof. Lindley, has been for many years deposited in the rooms of the Royal Horticultural Society, under the care of trustees. It is now proposed to increase the value of the Lindley Library by forming, in connection with it, a library fund, to be administered by the trustees in connection with the Council of the Royal Horticultural Society. The money would be expended in cataloguing the library, and in the purchase of new books, for which the income at present at the command of the trustees does not suffice. Donations of horticultural and botanical works are also desired.

THE Berlin correspondent of the *Times* reports:—"The death is announced of Prof. Pringsheim, the well-known German botanist, at the age of seventy-one. As early as his thirty-third year he was elected member of the Berlin Academy of Sciences in appreciation of his researches and writings, which dealt especially with the processes of fructification and germination in the family of the Algæ. From 1864 to 1868 he filled the post of Professor of Botany at Jena, where he founded the first Institute for Vegetable Physiology, and this example was soon followed in other parts of Germany. Prof. Pringsheim returned to Berlin in 1868 and established a private laboratory, in which he carried out valuable investigations on the sexual life of the lowest vegetable organisms."

MR. H. J. MACKINDER commenced a course of lectures on the History of Geography and Geographical Discovery, at Gresham College, on Monday evening. The course, which will consist of twenty-five lectures, has been arranged for jointly by the Geographical Society and the London Society for the Extension of University Teaching.

PROF. RICHTER, of Graz, has been engaged for some time in making a careful bathymetrical survey of the Lake of Garda. By the use of an unusually light and compact wire-sounding machine he has been able to obtain rapid soundings, even in the greatest depths (364 metres) with a lead weighing only 800 grammes, and he is preparing a contoured map of the lake-basin.

EFFORTS were made this summer by several expeditions to ascertain the fate of the Swedish naturalists, Björling and Kalstennius, but no information has yet been received. The *Falcon* called at the Carey Islands, Clarence Head, and Cape Faraday, but found no trace of the unfortunate young men, while the most careful inquiries amongst the Eskimos of the Greenland coast elicited no news. There is no farther probability of their survival.

THE Arctic exploring parties at work during the season just past have not been by any means so successful as might have been expected. The weather seems to have been exceptionally unfavourable, and to have greatly hampered the movements of even the best equipped and most experienced Arctic travellers. Lieut. Peary has not felt justified in returning to America, although Mrs. Peary and her baby came back in the ship sent for their relief. Mr. Peary started on his main journey, after wintering at Bowdoin Bay, on March 6, with eight men, twelve sledges, and a large number of dogs. The cold encountered was very great, the thermometer falling to $-60°$ F., and very high wind was occasionally experienced. The expedition pushed on for twenty-seven days in the direction of Independence Bay, but only succeeded in travelling 220 miles when the death of most of the dogs from cold, and the disablement of some of the men, made it necessary to return, and Bowdoin Bay was regained on April 18. Thus Peary was unable even to reach the starting-point he had fixed upon as the base whence to push northward, and he had to content himself with making a detailed survey of Bowdoin Bay and the neighbouring coast of Inglefield Gulf during the summer. The *Falcon* arrived to his relief on August 20, and after landing a year's provisions, left him determined to make another resolute attempt to reach the new land beyond Independence Bay next spring.

THE Report of the Australian Museum, Sydney, for the year 1893, shows that the Government retrenchment scheme has caused the museum to suffer severely. There have been no funds to purchase specimens, nor to publish the results of investigation. At the commencement of the year there were thirty three officers and workmen on the staff, but owing to the necessity for retrenchment twelve of these were discharged, and the salaries of most of the others were reduced by amounts varying from £5 to £50. The amount voted for the ordinary service of the museum in 1892 was £7150, while in 1893 it was reduced to £3862. The trustees point out that it will be difficult to carry on the institution efficiently out of the reduced vote. It appears that in the parts of the museum open to the public, there are not hands enough now to keep the outside of the cases free from dust, although the specimens in them are duly cared for, and are in good order; the windows have not been properly cleaned for months, and the grounds are being over-run with weeds. Dr. E. P. Ramsay has recently retired from the directorship, owing to ill-health, and has been succeeded by Mr. R. Etheridge, jun.

PROF. A. KLOSSOVSKY, director of the observatory at Odessa, has published an interesting paper on the annual distribution of thunderstorms over the globe, accompanied by a coloured map showing their intensity in different localities. The question has hitherto been but little studied, as it is necessary to have a long series of observations in order to arrive at satisfactory mean values. He points out that a high temperature, a certain degree of humidity, and a considerable amount of rainfall, are the principal agents which favour the development of thunderstorms. The map shows that a zone of electric activity of great intensity exists on both sides of the equator, and this is also the zone of greatest rainfall. This zone is divided into three sections: (1) That embracing Asia and Oceania, Indo-China and the Sunda Isles to New Guinea, the yearly average amounting to ninety or one hundred storms. (2) The zone starting from the west coast of Africa, between 5° and 10° N. latitude, and 10° to 15° S. latitude. (3) The tropical regions of America, where the mean annual number of storms exceeds one hundred between 20° and 22° N. latitude. To the north of the zone which he terms the electric equator the number of storms decreases, we reach the deserts of Africa, Egypt, Persia, and Central Asia, where rainfall is scanty. To the north of the zone of deserts, especially over the continents of Europe and Asia, the electric activity is somewhat increased. For the high latitudes of the southern hemisphere, the principal data refer to the Falkland Islands, where the average number of storms is four. The sketch is necessarily very imperfect, but the subject is worthy of consideration and further investigation; and the author points out that, in his opinion, the solution of many meteorological phenomena is connected with atmospherical electricity.

A BRIEF account of the great Constantinople earthquake of July 10 has been already written by M. D. Eginitis, director of the Observatory of Athens (*Comptus Rendus*, vol. cxix. pp. 480-483). It occurred at 12h. 24m. p.m. Constantinople mean time. The earthquake consisted of three violent shocks, separated by very short intervals, and lasting altogether seventeen to eighteen seconds. The first and slightest was horizontal; the second, by which most of the damage was done, vertical and rotatory; and the third, undulatory and towards the end horizontal. The epicentral area, that of greatest damage, is in the form of an elongated ellipse; the major axis is 175 km. long, and extends from Tchataltza to Ada-bazar along the Gulf of Ismed; the minor axis is situated between the villages of Katirly and Maltépé, at the mouth of the gulf, and is 39 km. in length. At all parts of the epicentre the three shocks had approximately the same direction, nearly perpendicular to the major axis. The intensity was greatest in the islands of Halki and Antigoni. The fissures are few in number, the most important being at Ambarly, a village built on alluvial soil. This one is 3 km. long, 0·08 m. in maximum breadth, and runs east and west, *i.e.* parallel to the neighbouring sea-coast, which is 300 m. distant. The Kartal-Dardanelles cable was cut in several places, as if by a knife. The sea was greatly agitated along the epicentral coast. In some parts, it was observed to retreat for about 200 m., and after some oscillations to return to its normal condition. The depth of the seismic focus was found by Dutton and Hayden's method to be 34 km., and this agrees closely with the value obtained by M. Lacome from the observed times of the shock at different places. The shock travelled to Paris, Pavlovsk and Bucharest, with velocities of 3, 3·5 and 3·6 km. per second, respectively (see NATURE, vol. l. pp. 450-451).

THE *Zeitschrift für Instrumentenkunde* contains some particulars of the new method, adopted by Signor G. Guglielmo, for the exact measurement of differences of pressure. Instead of enlarging the displacement of the mercury column in the manometer or barometer by means of a capillary filled with oil, or containing an air-bubble, the new method is based upon the principle of readjusting the level to a fixed mark by the addition or subtraction of mercury, the quantity added or subtracted being weighed or measured with a burette. If the sectional area of the burette is one-hundredth of that of the manometer tube, a displacement in the former of 1 mm. will indicate a difference of pressure of 0·01 mm. To make the method sensitive it is best to use water as the manometer liquid, and to add or subtract mercury, which is more easily measured. The chief desideratum is a simple method of adding or subtracting, which is best done by attaching a sucking-tube to the top of the burette. A pointer is fixed inside the manometer tube opposite the centre of the meniscus. By observing the reflection of the pointer in the surface, and the depressions or elevations produced by the pointer, the observer is able to fix upon the mark to within 0·001 mm. If mercury is used, an electric contact is desirable. For barometer readings, pointers can be mounted in both branches of the tube, and measurements taken for both. Signor Guglielmo has also constructed an absolute electrometer based upon this principle, in which the level of mercury in a flat dish communicating with another is disturbed by a charged disc, and readjusted by adding or subtracting mercury.

WE have received from Dr. Luigi Palazzo, of the Meteorological Office at Rome, an account of a small portable unifilar magnetometer which he has designed, and which is being employed in the study of local magnetic disturbances in Italy. Signor Palazzo does not claim any special novelty in the general design, which in many respects resembles the Kew form of portable unifilar. The instrument is designed for observing the declination and horizontal force at strings of stations at one of which the elements have been determined by means of one of the more accurate and cumbersome forms of instrument. For the purpose in view it was of importance to have an instrument which should combine extreme lightness with portability, so that the different sets of observations along a line of stations might be quickly taken, and thus, to a certain extent, the effects of disturbances minimised, since there does not seem to be a self-recording magnetograph in the district under investigation, from the photographic records of which the disturbances could be eliminated. The azimuth circle has a diameter of 8 cm. and carries the graduations on the rim, a method of graduating the circle which, unless the tripod is very high, and therefore unstable, renders the reading of the verniers a matter of difficulty. The magnet employed is a hollow cylinder, as in the Kew instrument, carrying a photographic scale at one end and a lens at the other. The mirror which is used for illuminating the scale, as well as for reflecting the rays of the sun when determining the geographical meridian, is composed of a piece of parallel-sided plane unsilvered glass mounted on trunnions which are carried in V's of the ordinary form. The whole instrument packs into a box 28 × 12 × 18 cm. and only weighs four kilograms. The author does not say with what accuracy the horizontal component can be measured, but from some figures given it would appear that the declination can be determined to within about three minutes of arc; which, considering the small size of the instrument, is remarkably good. In order to facilitate the measurement of the bearing of landmarks, the telescope is supported on horizontal trunnions, so that it can be tilted in a vertical plane about 10° on either side of the horizontal.

THE "Proceedings of the Royal Physical Society of Edinburgh," Session 1893-94, is now ready, and may be purchased at the Society's rooms, George-street, Edinburgh.

PROF. J. SHIELD NICHOLSON'S lecture on "Historical Progress and Ideal Socialism," delivered at the Oxford meeting of the British Association, has been published in handy volume form by Messrs. A. and C. Black.

WE learn from the *Journal of Botany* that the monograph of the Mycetozoa, on which Mr. Arthur Lister has been engaged for some years, founded on the collection in the herbarium of the British Museum, will shortly be published.

UNDER the title "Nomenclator Coleopterologicus," H. Bechhold, of Frankfort-on-Maine, has published, for Herr S. Schlenkling, an etymological index, together with a list of species and their varieties, of the beetles of German districts. The book should be extremely useful to students of Coleoptera.

MR. BERNARD QUARITCH, Piccadilly, has issued a list of choice and valuable books he has for sale, including the library of the late Warren De la Rue. Many important works on physics, chemistry, astronomy, electricity, mathematics, photography, and microscopy are contained in the catalogue.

WE have received from the Skandinavisk Antiquariat, Copenhagen, a catalogue of books, ancient and modern, of Iceland and Scandinavia, which they have for sale. The catalogue, which will be sent free to all applicants, contains particulars of books relating to bibliography, periodical literature, the languages of the north, runology, mythology, archæology, topography, &c.

CHILL October has come, and with it a new number of "The Country Month by Month," in which Mrs. Owen and Prof. Boulger describe the characteristics of the plant-world and bird-life during the month. The entomologist's main occupation in October is digging up subterranean pupæ, so the authors give a brief account of insect metamorphosis. The chapter on bird-life deals with the autumnal migration of our birds in a very interesting manner.

THE Zoological Society of Germany has conferred a great boon upon students of natural history by editing a reprint of the tenth edition of Linnæus' "Systema Naturæ." The first volume, dealing with the animal kingdom, has lately been published by Wilhelm Engelmann, Leipzig. It is well printed, and will be very acceptable to those who are not the fortunate possessors of a copy of the original tenth and standard edition of Linnæus' work.

THE sixteenth edition of their "Catalogue of Minerals and Mineralogical Subjects" has been issued by Messrs. G. L. English and Co., New York. The illustrations are all new, and a complete revision of all Messrs. English's systematic collections has been made. The species are classified according to Dana's new "System of Mineralogy" (1892). The index to the catalogue is particularly valuable, for it enumerates all species, and refers to the proper species all important synonyms and varieties.

A REMARKABLE new substance, obtained by the action of ordinary alcohol upon peroxide of sodium, is described by Prof. Tafel in the current *Berichte*. When alcohol is poured upon sodium peroxide, about half of the latter disappears to form a strongly alkaline solution which contains practically no active oxygen, while the remaining half undergoes a complete change. The pale yellow colour of the commercial peroxide becomes changed to pure white, and the substance assumes the nature of a fine granular powder, totally different from peroxide of sodium. This substance is soluble in water, but with much less rise of temperature than the peroxide. While the latter compound is stable up to a high temperature, evolving no oxygen when pure below red-heat, the new substance evolves large quantities of oxygen upon gently warming, and if rapidly heated in a tube closed at one end explodes with violence and production of flame. The powder behaves very curiously if touched in one place with a heated rod; the particles are set in rapid whirling motion by the escaping oxygen, and the rise of temperature is so great as frequently to terminate in local combustion. This unusual phenomenon gradually extends throughout the whole mass, oxygen being copiously and continuously evolved in an almost perfectly dry state. When much more strongly heated the substance melts and then evolves water vapour, the residue consisting of ordinary sodium hydrate. Analyses indicate that the substance possesses the composition $HNaO_2$. Its production from sodium peroxide and alcohol in all probability occurs in accordance with the following equation, sodium ethylate being the secondary product:

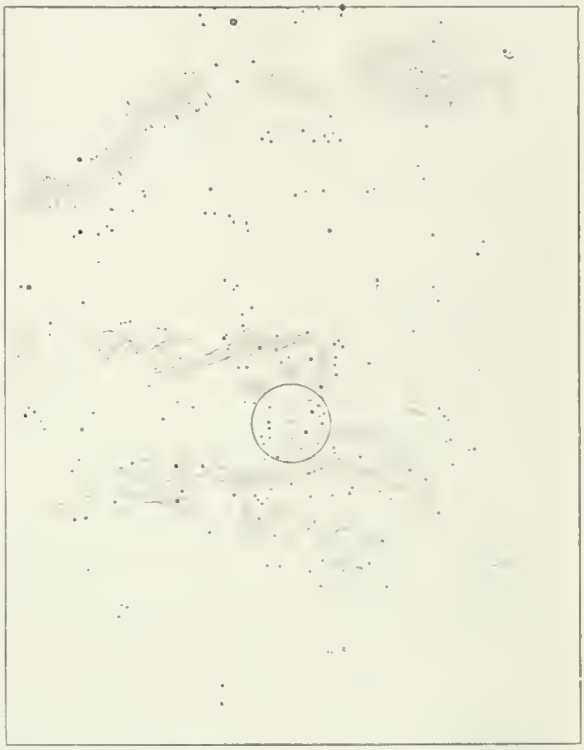
$$Na_2O_2 + C_2H_5OH = C_2H_5ONa + HNaO_2.$$

The probable existence of this new sodium compound was pointed out by Prof. Tafel in a previous communication concerning the action of alcoholic mineral acids upon sodium peroxide, and he has now been able to isolate it. He considers it to be the hydrate of a trioxide of sodium Na_2O_3. It dissolves in ice-cold water without decomposition, but at temperatures very little higher the solution slowly evolves oxygen. If alcohol is added to this solution the evolution of gas is considerably augmented and the solution deposits after some hours crystals of Mr. Vernon Harcourt's hydrate of sodium peroxide, $Na_2O_2.8H_2O$. Hydrochloric acid converts it into sodium chloride, hydrogen peroxide, and gaseous oxygen. In order to prepare the new compound, twelve grams of sodium peroxide and two hundred cubic centimetres of ice-cold absolute alcohol are convenient quantities to take; they should be well shaken together in a closed flask, the liquid and the fine white sandy product separated from any undecomposed lumps of peroxide, rapidly filtered, the white sand-like substance washed with cold alcohol and ether, and stored in a desiccator.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*, ♀) from West Africa, presented by Mrs. Collcutt; a Mozambique Monkey (*Cercopithecus pygerythrus*, ♀) from East Africa, presented by Mr. H. J. Clowes; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mrs. Morris; a Leopard (*Felis pardus*) from East Africa, presented by Mr. Thomas E. Remington; a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Dr. Sydney W. Thompstone; a Moose (*Alces machlis*, ♂) from Sweden, presented by Mr. Guy Nickalls; a Bennett's Wallaby (*Halmaturus bennettii*, ♂) from Tasmania, presented by Captain G. W. Brook; two Horned Screamers (*Palamadea cornuta*) from Para, presented by Mr. H. A. Astlett; a Banded Parrakeet (*Palæornis fasciatus*, ♀) from India, presented by Mr. Thomas Hodgson; a Green Turtle (*Chelone viridis*); a Hawks-billed Turtle (*Chelone imbricata*) from the East Indies, deposited; a Mexican Guan (*Penelope purpurascens*) from Central America, two American Wigeon (*Mareca americana*) from Brazil, a Short-tailed Parrot (*Pachyrus brachyurus*) from the Upper Amazon, purchased; two Raccoons (*Procyon lotor*); a Persian Gazelle (*Gazella subgutterosa*, ♂), born in the Gardens, three Bar-tailed Pheasants (*Phasianus reevesii*), an Amherst Pheasant (*Thaumalea amherstiæ*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEBULOSITIES NEAR THE PLEIADES.—For many years, says Prof. E. E. Barnard in the *Astronomische Nachrichten*, No. 3253, he has known of a vast and extensive nebulosity north of the Pleiades. This is not to be confounded with the nebulosities round the cluster revealed by photography during the last ten years, and all of which are included within the circle on the accompanying illustration. The wisps and patches of nebulous matter outside the circle are shown upon a photograph taken by Prof. Barnard with the Willard lens which he has rendered famous, the plate being exposed for ten hours, fifteen minutes.



The curved and streaky streams of celestial mist in the illustration are apparently connected with the Pleiades, though some of them extend irregularly for several degrees each side of the cluster. Prof. Barnard hopes to obtain still clearer pictures of the nebulosities by extending the time of exposure.

SCIENCE IN THE MAGAZINES.

EAST and west, as everyone knows, are merely relative terms. Elisée Reclus, in the *Contemporary*, traces the normal line of separation between the two halves of the ancient world which best deserve these names, considering the matter from an historical point of view. The true and natural partition between east and west of the ancient world is a transverse zone running from north to south between the Arctic Sea and the Gulf of Oram. This almost uninhabited zone begins just west of the plains of the Lower Indus, in the desert tracts of Lower Beluchistan, and ends in the barren reaches between the Obi and the Yenisei. Such a zone divides the world into two halves having continental masses of nearly equal size. The evolution of humanity was worked out differently on the two sides of this line, and the two developments are traced in the article referred to.

A very exhaustive article is contributed by Mr. John Rae to the same review, under the title "The Work of the Beer Money." The author describes what the County Councils have done for technical education since the passing of the Local Taxation (Customs and Excise Act) of 1890, when funds for the purpose of furthering such instruction became available. To those who expected great things, the survey will be disappointing; for it shows that in many cases the moneys have been expended almost uselessly. Better results, however, could hardly be expected, for it must be remembered that the County Councils had to create the machinery with which to carry on the work. On this account many mistakes have been made, "but," says Mr. Rae, "they [the Councils] have gone about matters in a practical way, and when they have made mistakes they have shown themselves quick to repair them. Much of the work was necessarily tentative, and that indeed is part of its value. Each local authority has started the work in its own way, according to its own circumstances, industries, and resources; so that the country has for two years been one great experimental station, with some hundreds of separate plots of educational varieties." The sums spent upon the erection of important technical schools during the last six or seven years will astonish many people. To quote Mr. Rae: "Bolton has built a technical school at a cost of £15,000; Bury, at a cost of £16,000; Blackburn, of £40,000. Oldham and Rochdale are now spending £12,000 each in building one; Halifax and Derby are spending £20,000 each; Bath, £21,000; Worcester and West Ham, £40,000; Birmingham, £48,000; and Manchester, on a site worth £100,000, is erecting a technical school estimated to cost £130,000 more, the most elaborate and magnificent product of the whole movement." So far as we can gather from the article, the work which has been done shows good promise of practical fruit. It is pointed out that the grant should be secured permanently for education by statute, and this should be done as soon as possible. Mr. Rae thinks that the worst deficiencies which the experience of the past three years has revealed are (1) the startling illiteracy of the men and the lads who have passed the standards of elementary schools, and (2) the general want of the means of good secondary education. These are the deficiencies which must prevent the effectual diffusion of technical instruction. Mr. Rae's article should certainly be read by everyone interested in the progress of technical instruction.

Another article in the *Contemporary* is entitled "Joseph Priestley in Domestic Life," by Madame Belloc. The mother of the authoress was taught to read by Priestley, and she gave her daughter a very clear idea of his personality. The article thus contains a description of the investigator as he really was according to the last echo of oral tradition. And though it deals chiefly with Priestley's private life, students of the history of chemical science will find parts of it interesting. The *Contemporary* also contains an article by Mr. Herbert Spencer, whose theme is "Weismannism Once More." Mr. Spencer harks back to the original points of discussion between Prof. Weismann and himself, in order to show (1) that certain leading propositions having been passed by unnoticed, remain outstanding; and (2) that when leading propositions have been dealt with, the replies given are invalid.

In the *National Review*, Mr. F. W. H. Myers writes on "The Drift of Psychical Research." Wonderful things are told of telepathy and kindred powers, and the author is very sanguine as to future developments. He recognises that men of science fight shy of the "gloom researches," and are ever ready to put their fingers upon the weak points in psychical reasoning and investigation. This dislike is accounted for by the rude approximate character of the work carried on by its votaries; but, on the other hand, Mr. Myers holds that psychology is a new science, and has, therefore, to grope its way up to the exactness of older branches of knowledge. He inclines to the opinion that the methods of science cannot at present be extended to the realm in which he is an explorer. After Mr. Myers' article, and as an antidote to it, one contributed by Mr. Ernest Hart to the *Century* should be read. Mr. Hart's paper should convince every even minded person of the imposture widely practised under the names of hypnotism, spiritualism, telepathy, "spookism" in its various manifestations, Mahatmism, Matteism, and other phenomena of an occult character. The same magazine contains the conclusion of the series of articles, "Across Asia on a Bicycle," contributed by Messrs. T. G. Allen and W. L. Sachtleben; and Mrs. C. L. Franklin gives a short biography of Sophie Germain, whose mathematical works and philosophical writings gained for her such a high reputation at the beginning of this century.

Sir Robert Ball continues his articles on "The Great Astronomers," in *Good Words*, the subject this month being Galileo. He handles the matter of Galileo's trial for heresy very carefully, and does not give vent to the feelings which every astronomer must experience when describing the events which led up to the abjuration which the founder of physical astronomy was forced to pronounce. Mr. T. Munro combines imagination with science in an article, "Sun-rise or the Morn," in *Cassell's Family Magazine*. The Mammoth Cave of Kentucky is the subject of an article, by Prof. W. G. Blaikie, in the same magazine. Under the alliterative title, "Seers of Science," Mr. Munro shows, in the *Leisure Hour*, how poets and story-tellers have anticipated some of the discoveries of science. It would have been strange if, in all the vague speculations which have been given to the world, some coincidences of the kind referred to had not been found. Salt, and sleeplessness are the subjects of two other articles in the *Leisure Hour*.

An extremely interesting account of "Tarahumari Dances and Plant Worship" is given by Dr. Carl Lumholtz in *Scribner*, with illustrations from photographs by the author. Another article of ethnographical importance is "Customs connected with Burial among the Sihanaka," by the Rev. J. Pearse, in the *Sunday Magazine*, which also contains a paper entitled "A Thousand Miles up the Irrawaddy," by the Rev. W. R. Winston. *Chambers's Journal* contains, as usual, a number of short and popular articles on more or less scientific subjects. Among those we note a description of some remarkable artesian wells, and a paper on the utilisation of waste products. Mr. Grant Allen writes pleasantly on "The Night Jar," in the *English Illustrated*, and Colonel Howard Vincent describes the scientific measurement and identification of criminals.

In addition to the magazines mentioned in the foregoing, we have received the *Fortnightly*, *Longman's*, and the *Humanitarian*, neither of which, however, contain articles that call for comment here. The first number of the *Phonographic Quarterly Review* has also been sent to us. The *Review* is edited by Mr. T. Allen Reed, and it bids fair to take a permanent stand among phonographic literature. Some of the articles have been furnished by phonographers, and others by well-known writers, the writings of the latter having been transcribed. The editor evidently recognises the importance of a knowledge of science to the shorthand writer of the present day, for among the articles we note "The Native Tribes of East Africa," by Dr. J. W. Gregory; "Experiences of a Naturalist," by Dr. A. S. Murray; "The Myths of the Unicorn and the Griffin," by Sir Henry Howorth; and "The Formation of Flints," by Canon Bonney. The publication of articles of this kind will help on the time when scientific lectures will be reported without being caricatured.

MEASUREMENTS OF PRECISION.[1]

MORE than two thousand years ago there lived in the far East a philosopher who established his claim to the possession of a good measure of both wisdom and wit, when he wrote: "Avoid even the appearance of evil: do not stop to tie your shoe in the melon patch of an enemy."

Suppressing the humour but not the sentiment of the Oriental teacher, it is easy to see that Confucius meant to impress upon his followers the importance of taking care that, even in the performance of trivial acts, the time and place should be such as would give rise to no suspicions as to motive or design.

I am honoured by being permitted the freedom of your academic groves to-day. I realise that the opportunity of defending a theme under such circumstances is not to be lightly esteemed, and I wish, in the beginning, to make terms with everybody, by declaring that in bringing before you a proposition so simple as to need no argument, I am innocent of ulterior motive or deep design.

My desire to give formal expression to this proposition grows out of the frequency with which it has presented itself in the course of official duties during the past few years.

I wish to consider "Precise Measurement" as one of the agencies through which man has advanced from a condition of savagery to his present state; and the metrology of any age as an exponent of the civilisation of that age.

The brief time during which I can venture to ask your attention to this subject fortunately releases me from all obligations to consider literary excellence or rhetorical ornamentation, and compels me even to deviate in some degree from the logical order of presentation. It is safe, however, to take liberties with an audience so largely composed of those who are not only familiar with the facts to be presented, but who are accustomed to arrange, digest, and put in orderly sequence materials which are found in a more or less chaotic condition.

The first form of measurement to which primitive man resorted was undoubtedly simple enumeration. In narration or barter the number of units in a group was alone considered, regardless of differences among individuals. The recognition

[1] An address delivered at the Johns Hopkins University, Baltimore, by Prof. T. C. Mendenhall.

of the fact that one quantity is greater or less than another is not measurement. Measurement implies the ability to represent numerically, so that ratios can be accurately expressed. Among primitive races measurement by enumeraton is very restricted. Tribes bordering on savagery at the present time are often found to be unable to enumerate beyond three or four. This statement is quite positively made by competent authorities, in spite of the fact that the ability to enumerate the number of fingers on at least one hand would appear to be necessary to even the lowest order of intelligence. It is curious to note in this connection that experiment has apparently proved that four is the maximum number of objects whose accurate enumeration is possible *at a single glance* and without *counting*, by the most highly cultivated man.

As man emerges from savagery his powers of enumeration increase. He soon discovers the necessity for units of a higher order which themselves represent a collection, and easily finds such units provided by nature in the groups of fingers on his two hands. Thus the decimal system of arithmetic is invented; not in one place or by one people, but everywhere and whenever man finds that somewhat extensive enumeration is desirable or necessary. It is a singular exception to this general rule, however, that the Greeks failed to invent a decimal arithmetic.

With systems of notation capable of indefinite extension, measurement by enumeration becomes rigorously exact; that is, barring blunders, which can always be discovered and avoided, the number of units in a group, if capable of being counted at all, can be counted with absolute accuracy. Thus, the cash in the Treasury of the United States may be more than a hundred million dollars, that is more than ten thousand million cents, and the exact quantity can be ascertained to a single cent. By simple enumeration, therefore, this quantity of money is measured so accurately that the error cannot be as much as one part in ten thousand millions, and this might be extended in any degree, if only the cash is there to be counted.

At a comparatively early stage, therefore, this kind of measurement was perfected, but there are two systems or methods of measurement derived from it that are worthy of brief comment. The first includes that variety of mensuration in which the numerical value of a magnitude cannot be obtained by simple counting, but is derived by calculation based on rigorously exact relationship. This is of a distinctly higher order than that just considered, and it is only found among highly intelligent people, those, in short, who have cultivated a knowledge of pure mathematics. A very simple illustration is the determination of the area of a triangle when its base and altitude are known. In this and similar cases a rigorously accurate result is attainable when the data are absolutely correct, but simple counting would be impossible. There are cases, however, and these constitute another step along the line in which we are travelling, in which an absolutely accurate evaluation is impossible, but in which any *desirable degree* of accuracy, however high, may be reached. Perhaps the best known example of this is the determination of the circumference of a circle when its diameter is known. The ratio of the former to the latter, which cannot be exactly expressed, has been determined with a degree of approximation by modern computers, which makes it possible to reduce the outstanding error to an inconceivably small quantity. An attempt to illustrate this may not be without interest.

In a display of mathematical genius which has perhaps never been surpassed, Archimedes more than two thousand years ago discovered the first real approximation to the value of this constant. The accuracy of his result may be shown in the fact that if the diameter of a circle be exactly one inch, its circumference as determined by the value of the constant found by Archimedes will not be in error more than the thickness of a human hair. If the value of the constant is more accurately known, it will be possible to compute the circumference of a proportionately larger circle so that the error shall not exceed a hair's-breadth. Let us go at once from the circle one inch in diameter to one having a radius equal to the distance from the earth to the sun and a circumference of nearly 600 millions of miles. It is difficult to form any adequate conception of the enormous stretch of 93 millions of miles which separates the earth from the sun. The immensity of it is in some degree realised on reflecting that if it were possible for a child to extend an arm across this space, and plunge his hand into the white hot layer of the sun from which light is radiated, he might grow to youth, manhood, old age, and unless he lived through the almost unprecedented period of 125 years, death would come before he would feel the pain of burning, so great is the distance through which the sensation must travel. But even this circle, of 600 millions of miles in circumference, is almost immeasurably small in comparison with the one for which we are seeking. Multiply it by a million; a million million; a million, million million; in fact multiply it by a number expressed by the word million repeated 98 times, and we reach a circle of utterly inconceivable dimensions; yet so precisely do we know the ratio of the circumference to the diameter of a circle, that having given the diameter of such a circle, its circumference can be determined within the breadth of a hair. For all ordinary, practical purposes this is sufficient.

A very modern and an extremely important species of measurement involving only enumeration is to be found in the statistical method of treating certain classes of problems in which the object is to follow the fortunes of a group rather than an individual. It has long been advantageously applied to social, political, and economical questions, and within a few years, in the hands of such men as Clerk Maxwell, Boltzmann, and others, it has proved to be a powerful agent in physical investigations.

It depends in great measure on what may be called the principle of the "long run," which is, that phenomena of apparently the most accidental and lawless character will, *in the long run*, occur with regularity and obedience to law, to such an extent as to render their prediction quite possible. At least one great railroad system in this country has so tabulated and investigated all accidents happening to its employés and patrons that it is able to foretell with a good degree of accuracy the number of people who will, during the next year, meet with death on its line; how many will lose a foot, how many an arm, and so on; and its Board of Directors is thus always ready to weigh the cost of a new invention to add to the safety of travel, against the probable damages to be paid for fatal and other injuries which said invention might prevent.

Further argument is unnecessary to show that measurement by enumeration, the first to appear in the evolution of man and his accomplishments, has advanced with man and kept pace with his accomplishments; that it has contributed greatly to his advancement, and that at any given period it may fairly stand as an exponent of his condition.

But in a far greater degree is this true of the second of the two forms of measurement to which men have resorted, namely, that in which a conventional unit embodying the particular quality to be measured is compared to the magnitude to be evaluated. Nearly all operations ordinarily called measurements belong to this class, and its necessity must have followed closely upon the introduction of measurement by enumeration. Of the three fundamental measures, from which it is convenient to derive all others, namely, length, mass and time, the first and last were undoubtedly the earliest to receive attention, and it is more than likely that some rude system of time measurement constituted the earliest contribution to metrology. Nature is lavish in the number and variety of time units which she has furnished man, some of which satisfy the most rigorous demands of modern science. In the early stages of chronometric development the method of enumeration was alone available. By taking the solar day as the unit, counting the number of days in a lunar period furnished the month. The year was similarly obtained, at first from the mere cycle of the seasons, but in a somewhat more advanced stage of development, from more exact observations upon the sun. Before this, there must have existed a demand for the division of the day into smaller units of time. Much ingenuity and often genius of a high order was shown in the invention of chronometric devices. A remarkably clever determination of the angular diameter of the sun was made by the Chaldeans by the use of one of the earliest forms of time-measuring apparatus. At the moment the sun's disk appeared in the eastern horizon a fine stream of water flowing from the bottom of a vessel in which the level was kept constant, was caught in a small cup, into which it was allowed to flow until the lower limb of the sun was visible. The small cup being instantly withdrawn, another much larger receptacle was substituted for it, and into this the small stream fell during all the day and until the sun appeared in the east again on the following morning. It was found that the water in the large vessel was 720 times that in the smaller, from which it appeared that the apparent diameter of the sun was $\frac{1}{720}$ of the circumference of the heavens, or one-half a degree of arc.

It is impossible here to trace the evolution of time-measuring from the earliest period to the present, and it is unnecessary, because most of the steps are doubtless well known to you all. You are requested to reflect, however, upon the close relation of the various stages of this evolution to the progress of the human race from savagery to enlightenment.

Hardly anything is a more certain and sensitive index of the advancement of a people than the precision required in the time schedule of the ordinary events of life. Improvement in time-measuring instruments, watches and clocks, is in response to a demand for this precision, and not the cause of it, as is sometimes asserted. Watches are now regulated to seconds where formerly minutes were near enough, and the few remaining civilised people among whom the hour has been the smallest division of time in common use, are fast mending their ways in this respect.

Unfortunately in the development of systems of measurement of length and mass, we have not succeeded as well as with the measurement of time. The greater excellence of the latter is unquestionably due to the universality of the fundamental unit, which is everywhere the day. While there have existed some differences among different nations as to the divisions and multiples of this unit, certain natural phenomena have directed all, along nearly the same lines, and at this moment, in all essential particulars, the chronometric systems of nearly all civilised nations are identical. Although not the best that could have been devised had existing knowledge and experience been available in the beginning, the prevailing subdivisions of the time unit are not seriously objectionable, and as they are so nearly universal and so firmly established by long usage, they are almost certain to continue unchanged.

In measures of length and mass or weight, the tendency from the beginning, up to a very recent period, has been, as in the case of time, towards the selection of natural units.

Dimly comprehending the importance and necessity of invariable units of measure, primitive man looked to nature to find the invariable. The nomenclature of every system of measure known bears testimony to the original use of natural units. Of measures of length familiar to all may be mentioned the hand, foot, pace, fathom, cubit, ell and span, all of which are derived from the dimensions of the human body. The inch, as everybody knows, was originally the length of three barley-corns from the middle of the ear, placed end to end. At a later period among some of the Oriental nations the unit of length was the length of a bamboo pipe, which when blown would produce a certain musical pitch. This argues a reckless indifference as to units of length, or an extraordinary power of detecting variation in the pitch of musical tones.

Units of weight or mass also had their origin in natural magnitudes, although in this case much greater difficulty is experienced. Almost the only natural unit of mass that was suggested or used was the mass of a grain of wheat from the middle of the ear, and from this our use of the grain weight of to-day is derived.

But all men are not alike in stature, nor are grains of wheat of great uniformity in dimensions or mass. As might have been anticipated, under such conditions there grew up, not only in different parts of the world, but in different sections of the same country, a variety of systems of weight and measure having no exact relations to each other, or among themselves, and which developed, as intercourse between nations became easier and more general, into one of the greatest calamities ever visited upon mankind. Various efforts were made at various times by various nations, each to improve its own system, but little good resulted up to almost exactly one hundred years ago. At the close of the Revolutionary War the weights, measures and coins in use in this country were almost innumerable in kind. Although mostly inherited from our Anglo-Saxon ancestors, many other European systems had gained a foothold, and considerable diversity in names and values had grown up throughout the colonies. An opportunity was presented at that time which we shall never see again, and which was lost by what one is forced to call the moral cowardice of men in high places. No one appreciated this opportunity more thoroughly than Thomas Jefferson, perhaps the most scholarly man of his time; the patron and friend of science and scientific men.

Jefferson recognised the incongruities of existing systems of weight and measure, but not wishing to depart sensibly from the foot as a unit of length he offered ingenious suggestions for a perfected scheme of linear measurement in which the foot was to be related decimally to the length of a seconds' pendulum and was to be decimally subdivided.

The Constitution of the United States provides that Congress shall have power to coin money, regulate the value thereof, and to fix the standard of weights and measures. At an early day this power was wisely exercised to provide escape from the bondage of the unphilosophical pounds, shillings and pence of the mother country by the establishment of a decimal system of coin ratios, the use of which during the past hundred years has been a greater gain, as compared with the discarded system, than the value of all the money in the country at the time of its adoption.

The second prerogative, that of "fixing a standard of weights and measures," was not at that time and, as a matter of fact, has never yet been exercised by Congress; indeed, considering the great danger which continually existed that when Congress did act it would act wrongly, it is a matter of congratulation that legislation on this important matter has thus far practically gone by default. But the opportunity existing during the early days of our national life was great, for the reason that just at this time there was conceived and perfected on the other side of the Atlantic the most decided, the most important, and the most far-reaching advance in metrology that the world has ever seen.

It had its beginning in the wisdom and foresight of the distinguished Talleyrand, who in 1790, while still a bishop, impressed by the excessive diversity and confusion of the weights and measures then prevailing, proposed to the Assembly of France a scheme for their reformation. Realising that not only national but international reformation was desirable, other nations were invited to join in the development and execution of this magnificent scheme. The co-operation of the Royal Society of London and of the English Government was sought, but unfortunately the English were not then in the mood for giving support to the French.

For the preliminary steps, looking to the determination of the value of the fundamental units and their relation to each other, a committee of the French Academy, including the most eminent mathematicians of Europe, was appointed, among its members being Borda, Lagrange, Laplace and Condorcet. Others engaged in the various measurements necessary to this determination were Lavoisier, Coulomb and Delambre.

Throughout the stormy scenes that accompanied the great political and social changes which occurred in France during the last decade of the eighteenth century, these noble scholars steadfastly pursued the problem upon the solution of which they had set out. At one time Borda, Lavoisier, Laplace, Coulomb and Delambre were dismissed from this public service by Robespierre's Committee of Safety, because their political views were suspected of being not quite in harmony with those of the aggressive party in power. (That was a hundred years ago.) But Robespierre was ambitious as well as cruel, and the project was afterwards allowed to go on. Finally, on June 22, 1799, the two new perfected standards—a metre, the unit of length, made of platinum, and a kilogramme, the unit of mass, of the same metal, were presented with great solemnity at the bar of both houses of the National Assembly of France by the celebrated Laplace, who addressed the assembled legislators; and on the same day the two standards were deposited in the archives of France, destined to be, a century later, the accepted units of measure of more than half of the civilised world, and eventually to become universal. In a report filed just seventy-three years ago to-day, John Quincy Adams, then Secretary of State, says of this event: "The spectacle is at once so rare and so sublime . . . that not to pause for a moment, were it even from occupations not essentially connected with it, to enjoy the contemplation of a scene so honourable to the character and capacities of our species, would argue a want of sensibility to appreciate its worth." "This scene," he says, "formed an epoch in the history of man, and an example and an admonition to the legislators of every nation, and of all after-times."

Just one hundred years ago, in 1794, copies of the preliminary metric standards were sent to this country, and our Government was urged to join in this memorable undertaking. Then, and during the thirty years following, the question of our adopting a system of weights and measures in harmony with our admirable monetary system was much agitated; but the counsel of the timid prevailed, and the wretched system which we had inherited mainly from England, but which is not in harmony with the English, was allowed to fasten itself upon the industrial interests of the country. The report on the subject by John Quincy Adams, already referred to, is a monument of exhaustive research and philosophical discussion. Nowhere is the decimal system praised so highly as in this report. In it he says of this system that, "considered merely as a labour-saving machine, it is a new power, offered to man, incomparably greater than that which he has acquired by the new agency which he has given to steam. It is in design the greatest *invention* of human ingenuity, since that of printing." This is high praise, and it is difficult to understand how the author of this and much more like it, could lack the courage to recommend that his country should at once put itself in the way of sharing the benefits of so remarkable a reformation. The spirit of conservatism, which came from his ancestors along with the yard and the pound, led him to advise that it was better to await the action of other nations, especially Great Britain.

At the close of the last century, in different parts of the world, the word *pound* was applied to 391 different units of weight, and the word foot to 292 different units of length. Not only were no two of these identical, but in only a few cases were their relative values known with anything like precision. In the wonderful march of the nineteenth century, most of these have been swept away; until now, of the enlightened nations of the earth, only the English-speaking people cling to what Lord Kelvin has so felicitously characterised as our "brain-wearying and intellect-wasting system of weights and measures."

I must now return to a very brief consideration of the indirect influence of precise measurement upon the welfare of man. Thus far the development of exact standards has been considered in relation to man's convenience, as facilitating the transaction of business, by diminishing the uncertainty and labour involved in commerce and trade. But indirectly it has been even more powerful. The use of correct standards of weight and measure has been regarded from the beginning as necessary to and indicative of integrity and fair dealing, among nations as well as individuals. Ultimate standards of reference, even in the earliest history of metrology, were carefully guarded and usually considered a part of the paraphernalia or accessories of the king or ruler. Although these standards were, until a comparatively recent period, very rude in their construction, they represented in a large measure the integrity of the nation, and to depart from or modify them was regarded as akin to a crime. According to Josephus, when Cain had settled in the land of Nod, and built a city, he invented weights and measures. In the law as given to Moses it is declared, "Thou shalt not have in thine house divers measures, a great and a small." The renowned Chinese Emperor, Yeo, who flourished 4000 years ago, kept the weights and measures which were used in the markets in a part of his own palace. In many countries standards were deposited in temples, and priests were their custodians. One of the principal objects sought to be secured by the Magna Charta was uniformity of weights and measures throughout the kingdom, and the one small spot in the world to-day whose neutrality is secured by the joint agreement of all civilised nations, including even the United States and Great Britain, is a bit of land near Paris, where stands the building in which the international prototype metre and kilogramme are preserved.

But in a far greater degree has precise measurement influenced the character, condition and destiny of man through its relation to the development of modern science. Volumes might be written about this, although not much is necessary before an audience to many of whom it is almost a daily lesson, and before another, smaller, audience of those who have contributed so largely during the past quarter of a century to the advancement of science and the improvement of the art of measuring.

Precision in measures demands and produces precision in language, and exact language makes exact thinking possible.

One cannot but admire the genius which enabled some of the philosophers of a few centuries ago to triumph over the obstacles growing out of the lack of exactness both in language and experiment. When Newton was converting his theory of the spheroidal form of the earth into established fact, he could only ascertain the possible effect of change of temperature upon the period of a pendulum by means of comparisons of the length of an iron bar when exposed to the sun's rays on a hot summer's day, with its length on a frosty morning in winter. Even in the earlier Transactions of the Royal Society of London, one may find time measured in *misereres* and temperature in inches. In the wonderful progress that has characterised the present age, by which business methods and social life have been well-nigh revolutionised, exact science has been the dominant factor. It is impossible here even to mention the many interesting devices by means of which during the last half-century the precision of measurements has been enormously increased. They are to be seen in nearly every laboratory, and are familiar to you all. Their invention has made possible many brilliant and useful discoveries in science, and it is gratifying to know that on this line our own country has been and is well to the front. Many proofs of this might be given, but among the most notable contributions of modern times to the science and art of delicate and precise measurement, one cannot fail to note the splendid work of Rowland in his measurement of light wave-lengths, of Langley in his solar researches, and of Michelson in his determination of the metre in terms of the ether vibration. The glory of the nineteenth century is exact experiment and honest logic, and precision in measurement has done much to make both possible.

In the matter of the metrology of the affairs of daily life, however, it is humiliating to confess that we are still skulking in the rear. Our sixty millions of intelligent citizens are far less intelligent, and less fit for the responsibilities that rest upon them, than they might be, were they not continually wearying their brains and wasting their intellects in constant struggle with the difficulties inherent in the system of metrology to which we so blindly cling. I yield to no one in my appreciation of the accurate learning and profound scholarship of the gentlemen of the Faculty of the institution before which I have the honour of appearing to-day, but I unhesitatingly affirm that not one of them, not even all of them together, can correctly set forth the system of weights and measures in common use at the present time in this country. Let us hope that this burden will be lifted in the near future, and that the pound and yard with their innumerable and irrational derivatives, relics of the dawn of civilisation, will be replaced by the beautifully simple kilogramme and metre. We can then rest with the pleasing assurance that when the next cataclysm shall have passed, and the archæologist of the future shall be burrowing among the ruins of the present age, he will not be misled by the crudeness of our metrology to catalogue us along with earlier civilisations. At best he will exhume much which we could wish to remain for ever buried, but let us hope that the evidence of integrity and simplicity in commercial transactions, of delicacy and precision in scientific investigations, and especially of honest and independent thinking, will be such that he will be compelled to put us down as a race in which, to apply the eloquent words of Buckle, "the greatness of men has no connection with the splendour of their titles, or the dignity of their birth; it is not concerned with their quarterings, their escutcheons, their descents, their dexter-chiefs, their sinister-chiefs, their chevrons, their bends, their azures, their gules, and the other trumperies of their heraldry; but it depends upon the largeness of their minds, the powers of their intellect, and the fulness of their knowledge."

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, October 1.—M. Lœwy in the chair.—The mass of Mercury and the acceleration of the mean movement of Encke's comet, according to the recent work of M. O. Backlund. A note by M. O. Callandreau.—On the automatic transmitter of steering directions, by Lieut. H. Bersier. The alternating current from a Ruhmkorff's coil passes from the pivot of a compass through the aluminium pointer, and leaps from the extremity of this needle to one of six vertical plates placed at intervals round the inside of the compass-box. This alternating current has no effect on the magnet, but serves to work six corresponding relays, and hence to cause the illumination of corresponding signal lamps placed in various parts of a vessel, and to set in motion the steering apparatus. The least deviation from the set course is automatically and immediately corrected in this way. The course is altered by simply rotating the drum carrying the plates.—A description of a bundle of descending cerebral fibres disappearing in the olivary bodies (cerebro-olivary bundle), by M. Y. Luys.—Influence of low temperatures on the laws of crystallisation, by M. Raoul Pictet. The author shows the essential difference in the manner in which the crystallising body loses heat at the moment of solidification in the two cases where the substance is (1) adiathermanous and (2) diathermanous. All substances become diathermanous below −70°, and hence the true temperature of crystallisation is only obtained when the surrounding medium is maintained at a temperature very slightly below the solidifying point. Hence an explanation of the anomalies occurring in determinations of the crystallisation point of such substances as chloroform.—On the development of the latent image in photography by alkaline peroxides, by M. G. A. Le Roy. Aqueous solutions of alkaline peroxides or alkaline solutions of hydroxyl can be used as developers, but are inferior to the ordinary reagents.—Action of hydrogen phosphide on potassammonium and sodammonium, by M. A. Joannis. When hydrogen phosphide is passed into a solution of potassammonium or sodammonium in liquefied ammonia, it is absorbed with the production of the solid white substances PH_2K and PH_2Na. Heat destroys these compounds in accordance with the equation $3PH_2K = 2PH_3 + PK_3$. Water decomposes them with liberation of hydrogen phosphide. Nitrous oxide does not yield any substance corresponding with the salts of hydrazoic acid.—Researches on mercuric picrate, by M. Raoul Varet. The preparation and properties of mercuric picrate are described. Thermal data are given in detail, and from them it is seen that the picrate ranges itself along with the acetate rather than with the other soluble salts, the chloride and cyanide. Picric acid displaces hydrocyanic acid from its potassium combination with disengagement of + 10·7 Cal., whereas hydrocyanic acid completely replaces picric acid in the mercuric salt with liberation of + 12·2 Cal.—Action of picric acid and picrates on metallic cyanides. The isopurpurates. A note by M. Raoul Varet. When picric acid can replace hydrocyanic acid in its compounds with evolution of heat, isopurpurates are formed; when, as with the mercuric salt, the hydrocyanic acid replaces picric acid with evolution of heat, isopurpurates are not formed.—The antiseptic properties of the vapours of formaldehyde, by M. A. Trillat. The vapours of formaldehyde, produced by the incomplete combustion of methyl alcohol, have proved very efficacious in destroying germs in sick rooms, and have no action on metals or instruments, and but little action on dyed fabrics.—Observations on flours, by M. Balland.—On the anterior extremity of the dorsal cord in the superior vertebrates, by M. G. Saint-Remy.—Evolution of the sexual elements in the composite Ascidians, by M. Antoine Pizon.—On one of the Chytridineæ parasitic on the vine, by M. A. Prunet.—On the calcareous tuffs of the col de Lautaret (Hautes-Alpes), by M. W. Kilian. From this preliminary study of the Lautaret tuffs, it may be concluded: (1) That these tuffs are relatively recent, their disposition indicating that the present aspect of the surface is much the same as that obtaining at the time of their formation. They are more or less mixed with moraine deposits. (2) The vegetable débris contained in these tuffs, notably the cones and branches of *Pinus sylvestris*, indicate the existence at the epoch of their formation of a forest vegetation which has since abandoned these altitudes.—On the presence of carboniferous earth in the Sahara, by M. F. Foureau.—Thermometric observations on the summit of Ararat, by M. Venukoff. M. Gimmer visited the summit of Ararat on August 16, 1894, and found two thermometers left by M. Pastoukoff the preceding year in a tin-plate box. The maximum registered + 17·25° C., the minimum −40° C. Another minimum instrument, attached in the open air to a vertical object, indicated −38 C. At the time of the visit, the temperature of the air in the shade was + 3° C.—On an aerostatic ascension effected in Russia, by M. Venukoff.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Complete Poetical Works of Constance Naden (Bickers).—Electric Transmission of Energy: G. Kapp, 4th edition (Whittaker).—Fruit Culture for Profit: C. E. Whitehead (S.P.C.K.).—Our Secret Friends and Foes: Prof. P. F. Frankland, new edition (S.P.C.K.).—Edible and Poisonous Mushrooms: Dr. M. C. Cooke (S.P.C.K.).—The Country Month by Month: Owen and Boulger, October (Bliss).—Alpine Climates for Consumption: Dr. H. J. Hardwicke (Churchill).—What is Heat?: F. Hovenden (Whittingham).—Life in Ancient Egypt: A. Erman, translated by H. M. Tirard (Macmillan).—A Text-Book of Inorganic Chemistry: G. S. Newth (Longmans).—Watts' Dictionary of Chemistry: M. M. P. Muir and H. F. Morley, Vol. 4 (Longmans).—Popular Astronomy: C. Flammarion, translated by J. E. Gore (Chatto).—Visions of the Interior of the Earth, &c: the Prince of Mantua, &c. (Simpkin).—Historical Progress and Ideal Socialism: Prof. J. S. Nicholson (Black).—Lectures on Human and Animal Psychology: W. Wundt, translated by J. E. Creighton and E. B. Titchener (Sonnenschein).—A Laboratory Manual of Physics and Applied Electricity: arranged and edited by Prof. E. L. Nichols, Vol. 2 (Macmillan).—An Elementary Manual of Zoology designed for the use of Forest Officers in India: E. C. Cotes (Calcutta).

Pamphlets.—Regeln für die Wissenschaftliche Benennung der Thiere, &c. (Leipzig, Engelmann).—Bahnbestimmung des Kometen 1851 III. (Brorsen): Dr. R. Spitaler (Wien).—Philosophical Transactions of the Royal Society of London: Experimental Investigations on the Effective Temperature of the Sun, made at Daramona, Streete, co. Westmeath: W. E. Wilson and P. L. Gray (K. Paul).—Äussere Einflüsse als Entwicklungsreize: Prof. A. Weismann (Jena, Fischer).—English Institutions and the American Indian: Dr. J. A. James (Baltimore).

Serials.—English Illustrated Magazine, October (198 Strand).—Longman's Magazine, October (Longmans).—Century Magazine, October (Unwin).—Chambers's Journal, October (Chambers).—American Naturalist, September (Philadelphia).—Natural History of Plants: Kerner and Oliver. Part 6 (Blackie).—Contemporary Review, October (Isbister).—Humanitarian, October (Hutchinson).—Phonographic Quarterly Review, October (Pitman).—Journal of the Royal Agricultural Society of England, Vol. v. Part 3, No. 19 (Murray).—Journal of the Scottish Meteorological Society, third series, No. x. (Blackwood).—Geographical Journal, October (Stanford).—National Review, October (Arnold).—Natural Science, October (Macmillan).—Fortnightly Review, October (Chapman).—Mind, October (Williams).—Geological Magazine, October (K. Paul).—Journal of the Royal Statistical Society, September (Stanford).—Asclepiad, No. 41, Vol. xi. (Longmans).—Medical Magazine, October (Southwood).—Astronomische Mittheilungen von der Königlichen-Sternwarte zu Göttingen, Dritter Theil (Göttingen).—Journal of the Chemical Society, October (Gurney).—Annals of Scottish Natural History, October (Edinburgh, Douglas). Himmel und Erde, October (Berlin, Paetel).—Science Progress, October (Scientific Press, Ltd.).

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THURSDAY, OCTOBER 18, 1894.

THE OPTICS OF PHOTOGRAPHY.

Handbuch der Photographie: II Theil: Das Licht im Dienste der Photographie und die neuesten Fortschritte der photographischen Optik. By Prof. Dr. H. W. Vogel. (Berlin: Robert Oppenheim (Gustav Schmidt), 1894.)

THIS second part of Dr. Vogel's well-known handbook is the fourth edition, completely revised and enlarged, as we are informed on the title-page. With the index it runs to 367 pages, and is embellished with numerous figures and a coloured frontispiece illustrating the Vogel-Kurtz process of printing in three superposed colours. The result is very satisfactory, and the grapes, pineapple, lemon, and other fruit appear very natural. There should be a promising future for this chromo-lithographic development of photography, which, it may perhaps be not altogether unnecessary to state, has nothing to do with the great question of direct photography in natural colours.

It is difficult within reasonable compass to give an adequate notion of the wide range of subjects dealt with in the present work. Everything likely to be of use to the scientific and practical photographer is treated of with more or less completeness. While the first part, which we noticed in these columns some years ago (vol. xliii. p. 3), deals with the chemical aspect of the subject, the instalment under consideration is devoted to the optical aspect, using the term optical in the wide sense of comprising the general nature of light regarded as a chemically active natural force. The optics of photographic lenses finds a place in the present part in the form of an appendix covering some ninety odd pages, and copiously illustrated. The appendix covers all that is usually comprised in this country under the term "photographic optics," and it is treated in a manner intended to be generally understandable; the actual German heading is, "Gemeinverständliche Darstellung der Grundzuge der photographischen Optik." The seven chapters forming the appendix deal with the methods of forming images, lenticular refraction, faults of lenses, intensity of illumination and "field," differences in photographic objectives, the stereoscope, panorama apparatus, and the principles of photographic surveying. The seventh chapter is of especial interest because it deals with the latest advances in the construction of photographic objectives, and comprises, among other things, a description of the teleobjectives of Miethe, Steinheil, and Zeiss. The remarkable efficacy of this new addition to the resources of the photographer is shown by two pairs of reproductions of photographs of views taken from the same spot, one with an ordinary, and the other with the teleobjective.

We have called attention to the appendix first, not because we desire to follow the practice of certain readers of fiction who form an opinion as to whether a book is worth reading by beginning at the last chapter, but because it treats of that portion of the subject which we here are too apt to regard as comprising the whole of photographic optics. The main portion of the work under notice treats of subjects quite distinct from that of the properties and construction of lenses, but which are of equal importance in modern photography. This portion of the book consists of thirty-one chapters extending over 266 pages. A brief analysis of the contents will give the reader a general idea of the scope:—Intensity of light and Lambert's law, measurement of intensity, the optical photometer, standards of light, Weber's definitions, the brightness of transmitted and reflected light for different substances, the photographic photometer or sensitometer, photographic standards of light, Miethe and Michalke's law of photographic reciprocity in developed films, dependence of the transparency of the negative on the period of exposure and on the intensity of the illumination, the chemical intensity of day and sunlight (Bunsen and Roscoe), intensity under limited sky illumination, continuing rays and the effects of previous and subsequent illumination, sources of artificial light for photography, reflection, halation, composition of light and photography of coloured objects, chemical action and absorption, properties of optical sensitisers, action of colouring matters on collodion and gelatine plates, shifting of the maxima of photographic activity (Wiedemann's law), relations between sensitiveness to light and optical sensitisers of the eosin series, other optical sensitisers, action of simple and mixed optical sensitisers on sensitiveness, ray filters (*i.e.* colour screens), instruments for the study of the colour sensitiveness of photographic films (*i.e.* spectrographs), testing of colouring matters and films for colour sensitiveness, reproduction of natural colours by multiple photography, direct photography in natural colours, colour perception and complementary colours, observations on the colour transparency of the atmosphere.

To those who are acquainted with photography as a science,[1] the headings to the various chapters will give sufficient indication of their contents. There are, however, many topics of importance hidden away, as it were, among the mass of information contained in the book, and to some of these we may direct the attention of the general reader who, without being an expert, may wish to ascertain the present state of knowledge with regard to such subjects as are of physical or chemical interest beyond their immediate application to photography. Thus, with regard to the standards of light we learn that preference is given over all others to the amyl acetate lamp of Hefner-Alteneck—a preference which many in this country will no doubt be prepared to dispute. Then, again, with respect to the amount of light reflected from various surfaces (chapter v.), some useful measurements are given, partly from the author's observations and partly from determinations by Kirschmann. The photographic efficiency of various sources of light (chapter vii.) is also a subject of general interest, apart from its practical bearing. The enormous chemical activity of the light of burning magnesium is well known, but the results stated quantitatively will be startling to many. According to Eder (to quote a few examples) the light in a

[1] We are much in want of some term to distinguish the scientific student of photography from the ordinary camera-carrying picture-taker. The relationship between the two classes is much about the same as that between the bird and animal stuffer and the "naturalist" whose designation he adopts. The designation "luciscribe" is quite as applicable to those who practise the art only, but it does not seem sufficiently harmonious to suggest its adoption.

well-lighted studio expressed in normal candles) is 50,000–100,000; direct sunlight (October), 450,000; electric arc light of 8000 candle visual intensity, 100,000–300,000; flash light with four grammes magnesium powder, potassium chlorate and perchlorate, 10,000,000.[1]

The chapter on sensitometers is particularly good, and the critical discussion of the various systems in vogue will be found most useful. It is true that the author urges the advantages of his own "tubular photometer," but this does not prevent his doing justice to other forms. The discussion of the so-called law of photographic reciprocity according to Miethe and Michalke (chapters viii. and ix.) comes most opportunely at the present time. The relationship between the density of the silver deposit formed on development and the time of exposure, intensity and quality of light, &c., is a subject which has given rise to a great amount of discussion in this country lately. Strange to say, however, Dr. Vogel gives no reference to the work of Abney, Hurter and Driffield, and others who have taken part in the recent discussions. This is certainly an omission. It appears that Dr. Miethe undertook to investigate the accuracy of the law of reciprocity in order to ascertain whether photography could be applied to the measurement of the brightness of the stars. [*A priori*, one would have thought that the ordinary photographic plate would be inapplicable to this purpose because the photographic efficiency is dependent on the *quality* of the light emitted by a star, and this does not necessarily coincide with visual intensity.] Among other points brought out by his investigation is the fact that for very feeble illumination the law in question does not hold good, but when the light is about four times the intensity necessary to produce a visible result (on development) the relationship is true up to 1000 times this intensity. Other deviations from the law are discussed by Michalke in the paper which Dr. Vogel partly reprints, but enough has been said to indicate the importance of these two chapters.

The portions of the work to which those who have followed the recent developments of photography will naturally turn with great interest, are those dealing with the action of special sensitisers, a subject which will always be identified with Dr. Vogel as the discoverer to whom we are indebted for this advancement. The greater portion of the volume—viz. chapters xvi. to xxvii. inclusive—are devoted to this and related subjects. In connection with the sensitiveness of the silver haloids to the colours of the spectrum, the author brings out one point very clearly, and that is the futility of using the sun as a source of light in such experiments. It appears that the photographic transparency of the atmosphere is subject to such very great fluctuations, that the maxima of chemical activity are apt to be considerably shifted from day to day, so that concordant spectrum prints must not be expected from the solar spectrum in cases where accuracy is required. The action of organic colouring matters as special sensitisers receives very full treatment, and all the recent investigations on this subject are brought together. Of these the experiments of Dr. E. Vogel on the colour sensitiveness of the eosin colouring matters by themselves (chap. xx.), and on the special sensitising action of the *pure* colouring matters of this group on gelatino-bromide emulsion films (chap. xxii.), are of considerable importance. It appears now that the fugitive character of these colouring matters is due to photochemical reduction, and not oxidation (pp. 163–164); but the evidence on this point does not appear to the writer to be quite conclusive. It is shown, further, that the best of these colouring matters as special sensitisers are those which are by themselves the most sensitive to light—viz. tetraiodo- and diiodo-fluorescein—that the silver salts are better than the alkaline salts for this purpose, and that the sensitising power increases as the fluorescent power diminishes.

Other organic colouring matters are treated of in connection with this same photographic property, and the details, as given in the book, will be found well worthy of study. We may here call attention to the interesting work of Wollheim (chap. xxiii.) on chlorophyll, from which it appears that the efficient special sensitiser in the case of this substance is the phyllocyanin. The uncertain action of chlorophyll is well accounted for by these researches. Among recent work on the action of organic colouring matters, the author gives an account, almost verbatim, of that published by Mr. J. Acworth in 1890. This writer has made a detailed study of all the most efficient special sensitisers, and, as a general conclusion, confirms the view that the maxima of absorption and chemical activity do not absolutely coincide, but that a displacement occurs in accordance with a law which has been developed theoretically by E. Wiedemann. Figures of some of the absorption and photographed spectra are given (p. 192), and a plate giving Acworth's curves for the various colouring matters.

We might have dwelt upon many other topics discussed in the book; enough has been said, however, to show that photographic literature has been enriched by a work which will take rank among the classics in this subject. If, in concluding this notice, some defects are pointed out, it is not that the writer feels bound as a critic to find fault with something, but because in a work of high standard, such as this, small faults obtrude themselves and become great by contrast. In the first place, then, the author does not give sufficient recognition to work done in this country. One such omission has already been pointed out. Similarly the work of Abney on colour measurement, which is so closely related to the subject-matter of chapter xxx., is not referred to. Although J. J. Acworth's experiments on orthochromatic photography are given *in extenso* (because originally published in *Wiedemann's Annalen*?), the prior work of C. H. Bothamley is not described. In connection with the theory of direct photography in colours by the method of interference, Zencker alone is mentioned, and all reference to Lord Rayleigh's work on this subject omitted. But still more serious is the introduction of polemical matter into the work—in some parts to such an extent as to become an actual disfigurement. The whole of chapter xvii., on the history of the discovery of the action of special sensitisers, might very well have been omitted; what is the use of reprinting a series of polemical papers published twenty years ago, especially when one of the combatants (Schultz-Sellack) is dead?

[1] These numbers are referred to the *photographic*, not *visual* intensity of the standard candle.

Then, again, the passage of arms between the author and Dr. Neuhaus in this same chapter, and Herr Hruza (chapter xxviii.) and, above all, Mr. Ives (pp. 239-240), is conducted in a manner that in this country would be regarded as very bad form. Perhaps German notions of scientific literary taste differ from ours, but the writer of this notice has never yet come across a German work professing to be a scientific text-book, in which such bad taste is shown as in the introduction of the personalities which are here indulged in.[1] Discounting these imperfections, Dr. Vogel is to be congratulated on this second instalment of his book; it will be found valuable as a compilation, and still more valuable as embodying much original work. No scientific student of the subject can dispense with it, and beyond the domain of pure photography the chemist and physicist will find much in its pages worthy of consideration. R. MELDOLA.

THE MEASUREMENT OF ELECTRICAL RESISTANCE.

A Treatise on the Measurement of Electrical Resistance. By William Arthur Price, M.A., A.M.I.C.E. (Oxford: Clarendon Press, 1894.)

OF all electrical measurements probably that of measuring a resistance is the most important, since the resistance of many bodies is a permanent quality, and resistances can be compared by means of apparatus of comparatively simple construction, while the results obtained are much more accurate than in the case of any other electrical measurement. Most books on practical electricity contain more or less complete descriptions of the methods generally employed in the measurement of resistance, and in some cases give what may be called "diagrammatic" descriptions of the construction of the different forms of apparatus employed. The work under consideration, however, goes much further, for in it the mechanical details of the construction of the apparatus are described in a manner which shows that the author is practically acquainted with his subject.

The book may be roughly divided into two parts: in the first of these the materials used in the construction of resistances and the different methods of winding and mounting resistance coils are fully dealt with; while the second part contains full descriptions of the methods ordinarily employed in the measurement of resistances, both high and low.

The first chapter is introductory, and contains a definition of the term resistance, while the conditions to be fulfilled by a material suitable for the construction of standard resistances are shortly discussed. The properties of the different alloys employed in the construction of resistances are fully dealt with in the second chapter.

After referring to the artificial "ageing" of manganine wire, and to the extremely small value of the thermo-electric force between this alloy and copper, the author says that the electrical properties of this material seem to be quite permanent. This opinion, however, is at variance with the experience of most people who have tested this alloy, and it would be of interest to know whether any satisfactory experiments have been made to settle this point. Although it may be important in many commercial operations, where accuracy is not so much aimed at as simplicity and freedom from troublesome corrections, to make resistances of alloys having a low temperature coefficient, yet in any experiment where accuracy is necessary it is much more important to have a constant and linear function for the temperature correction than to have an extremely small but variable and uncertain one. A comparison of the curves for the variation of the resistances of the different alloys, which have been reproduced from Profs. Dewar and Fleming's paper, shows at once the fatal objection to manganine. Another objection to this alloy, as at present manufactured, is the extreme variation in physical properties between the different samples supplied.

Two very interesting chapters are devoted to the construction of resistance coil bobbins, and the methods employed for winding the wire. In connection with the question as to the best form to give standard resistance coils in order that the temperature may be accurately known, the author recommends that the coil be enclosed in a thick copper case, with a recess filled with mercury for the insertion of a thermometer, the whole to be covered in with a wooden case, to protect it from dust and draughts, instead of the usual thin case and water-bath. This method of securing a uniform temperature is very satisfactory when no heat is generated within the apparatus, but in the case of a resistance coil and a thermometer placed in a hole filled with mercury in the enclosing case, where the passage of the testing current heats the wire, the thermometer would probably "lag" considerably behind the wire; and the chief effect of the thick case would be to screen the thermometer from the changes in temperature of the wire.

The heat developed in a coil, and the rate at which the temperature rises, are shortly considered, data being given for calculating these quantities. It would be a great improvement, however, if in a subsequent edition a table were given showing at a glance the maximum current which can with safety be passed through the different coils of resistance boxes wound with the sizes of wire ordinarily used. Whether it would be possible to indicate this quantity on the boxes of coils as sent out by the makers, is perhaps doubtful; but if it could be done, it might perhaps stay the hand of the too venturesome student, who is continually trying to ruin any resistance boxes he may be using by passing an excessive current.

While the chapter on the Post Office and Dial forms of Wheatstone's Bridge is very complete, and contains a very useful table of the best resistances to be used in the ratio arms of a Post Office Bridge, that on the Slide Wire Bridge can hardly be said to be so. The only form of Slide Wire Bridge at all fully described and illustrated is of the ordinary design to be found in elementary physical laboratories. Although this is sufficient for teaching purposes, it is hardly suitable

[1] Out of consideration for those concerned, I refrain from giving specimens of the paragraphs complained of. Can it be that the style of discussion is incidental to the subject? Similar lucubrations are sometimes to be seen embellishing (?) the pages of photographic journals. In passing the above strictures it is to be understood that the question of the author or his antagonists being right or wrong is not raised: it is the style which is objected to– the transference of personal polemics from journals in which they might possibly be tolerated, to the pages of a text-book in which they are intolerable.

for very accurate work. No mention, either, is made of any form of switch-board, such as that designed by Prof. S. P. Thompson, for the interchange of the coils when using Carey Foster's method of comparing resistances. A good description, accompanied by several excellent diagrams, is, however, given of Kelvin and Varley's slide, and of Kelvin's apparatus for the comparison of low resistances.

The remaining chapters are devoted to the measurement of high resistances, of batteries, and of electrolytes. There are six appendices, in which the mathematical theory of the Wheatstone's Bridge, Lord Kelvin's method of measuring low resistances, and Manse's method of measuring the resistance of a battery are given, together with discussions on the E.M.F. of contact at the junctions of a metre bridge, on the discharge of a condenser through a high resistance, and on the electrostatic analogue of a Wheatstone's Bridge.

The work would have been more useful if its scope had been enlarged, and if it had contained a detailed description of some complete set of instruments used in the comparison of standard resistances, such as are used by the British Association Committee on Electrical Standards at the Cavendish Laboratory. Nevertheless, it is a good book, written by one who is practically engaged in the manufacture and testing of these instruments, and who, not content with rules of thumb, gives the reason for each point involved in the design and construction.

There is no doubt the book will be found of great use in every laboratory and testing-room, and is, as the advertisers of patents are wont to say, "calculated to fill a long felt want." W. W.

AN ASTRONOMICAL ROMANCE.

A Journey in Other Worlds; a Romance of the Future. By John Jacob Astor. With ten Illustrations. Pp. 476. (London: Longmans, Green, and Co., 1894.)

SINCE Jules Verne wrote his "Journey from the Earth to the Moon," many writers have tried their hands at similar productions, but none have excelled their prototype. A good grasp of the principles of science, a vivid imagination, and a brilliant descriptive power, are essential faculties in the man who proposes to give the public a view of the future as seen through his prophetic eye. We do not think the author is blessed with a bountiful share of these qualifications; nevertheless, he has been able to bring forth a book in which instruction and entertainment are happily combined.

Looking forward to the epoch A.D. 2000, the author saw that many things had come to pass which are undreamt of in the philosophy of this enlightened century. The incidents of the story are centred round a scheme for changing the obliquity of the ecliptic, and a machine in which trips are taken to Jupiter and Saturn. It is a source of regret to many people, and especially to those who are doomed to linger in an erratic climate like ours, that the earth's axis is not perpendicular to the ecliptic. If such a condition of things existed at the present time, it could truly be said, "Blessed are they that inherit the earth." Every latitude would have its own almost uniform temperature all the year round, and the slight eccentricity of the earth's orbit would be sufficient to awaken recollections of the succession of the seasons. Life would indeed then be one perpetual spring.

The idea of decreasing the obliquity of the ecliptic is only an incidental part of Mr. Astor's story. The greater part of the book is taken up by an account of a journey to Jupiter and Saturn. But, before passing to this section, we must point out that a certain looseness of expression is manifest in the previous one. The project of changing the obliquity is constantly referred to as one of "straightening the terrestrial axis." The impression that the general reader will obtain from such an expression is that the earth's axis is only "straight" when it stands bolt upright, as it were, in the plane in which our globe revolves round the sun. How the author came to use the word "straight" in the sense which he does, passes our comprehension. Another and really less important matter, is that the earth's axis is said to be "inclined to the ecliptic about $23\frac{1}{2}$ degrees." To be correct, the author should have said that the inclination to the ecliptic is $66\frac{1}{2}^{\circ}$, and that the angle between the axis and a perpendicular to the ecliptic is $23\frac{1}{2}^{\circ}$.

We come now to the flying machine. Jules Verne utilised known powers when he sent his imaginary car from the earth to our dreary satellite. Others who have followed in his wake have had to hypothecate their forces. *Apergy* is the force employed by Mr. Astor's characters. Similarly electrified bodies repel one another, argues he, then why may not matter exist in such a condition that gravitational attraction becomes apergetical repulsion? Given such a source of perpetual energy under control, and, heigh presto, away we can go into the realms of space, with concentrated extracts for food, and liquid oxygen for air supply. Three individuals undertook this kind of voyage in the year A.D. 2000; at least so the story goes. One is a learned bore who discourses sapiently on all and sundry circumstances of the journey. For instance, the information he hurls at his companions as Jupiter's largest satellite, Ganymede, is passed, is as follows. "This was discovered by Galileo in 1610. It is three thousand four hundred and eighty miles in diameter, while our moon is but two thousand one hundred and sixty, revolves at a distance of six hundred and seventy-eight thousand three hundred miles from Jupiter, completes its revolution in seven days and four hours, and has a specific gravity of 1·87."

This individual is brimful of knowledge which wells up at every opportunity, and, after a time, becomes very oppressive. His two companions, on the other hand, though assigned acute understandings and good educations by the author, listen in silence to these tiresome lectures on the most elementary facts of astronomy—an incongruity which is a very weak point in the story. Furthermore, the obtrusive dispenser of scientific scraps is much behind his time, for his astronomical knowledge does not go beyond that of the present day. If Mr. Astor were thoroughly conversant with astronomical investigations, he could have made his professor a much more interesting person. As it is, the man pours forth his spirit in and out of season, and is just the sort of individual that the majority of people are anxious to avoid.

We will pass over the little incidents of the journey to Jupiter. Suffice it to say that Mars and his moons were observed, that a few asteroids were met and a comet penetrated, and eventually the Callisto—that was the name of the car—was landed on a hard part of the planet's surface. Jupiter was found to be in the Palæozoic period; and a smattering of geological knowledge has enabled the author to conjure up multitudes of "extinct monsters," which quite eclipse those in Mr. Hutchinson's book.

Having passed through Saturn's ring, and seen for themselves that it was composed of meteoritic particles, the party arrived safely on the planet. Our belted brother was found to be an abode of spirits, upon the characteristics of which we are not competent to express an opinion. The height of the ludicrous is reached at a dinner given to the travellers by one of these airy nothings, who, we are gravely told, "took only a slice of meat and a glass of claret." The idea of a diaphanous bishop consuming meat and claret is very rich.

A word or two on the general character of the book may not be out of place. The author rightly terms his production a romance—that is, a story hung upon seeming impossibilities. There is no plot, and the characters are merely mechanical puppets used to expound didactic ideas, so the book cannot be called a novel. It is, in fact, little more than a reading-book suitable for beginners in astronomy. We doubt whether many people will read it through without skipping the prosy parts, but they who conscientiously do so will undoubtedly acquire a certain amount of more or less useful knowledge. The author is usually accurate in his astronomy; and this, considering that writers of romances generally play fast and loose with astronomical phenomena, is saying a good deal. We commend the book to readers who like instructive tales.

R. A. Gregory.

OUR BOOK SHELF.

Ueber die geometrischen Eigenschaften homogener starrer Structuren und ihre Anwendung auf Krystalle. Von W. Barlow. (Leipzig: Engelmann, 1894.)

This paper, which was recently published in the twenty-third volume of Groth's *Zeitschrift f. Krystallographie*, is an interesting contribution to the theory of crystal structure.

Mr. Barlow investigates the nature of a homogeneous structure, by which he means an arrangement of any material of constant form which is uniformly repeated throughout its whole extent. To every point in such a structure correspond other points homologous with it, and these must constitute one of the sixty-five regular assemblages of points as defined by Sohncke in his well-known treatise on crystal-structure. But the symmetry of the structure is not always identical with that of the assemblage of points derived from it, and it is sometimes necessary to extend the latter by a geometrical process of reflection or inversion in order to arrive at the symmetry of the structure. This process results in the addition of 164 possible homogeneous structures to the sixty-five already established. Incidentally it is shown that the assemblages of Sohncke are not in reality independent, but can all be regarded as compounded of one or other of ten assemblages belonging to the least symmetrical types in the various systems of crystallography. Fedorow and Schönflies have independently advanced a new theory, and agree in the result that there are 230 possible types of homogeneous structure. Since their methods are based upon Sohncke's definition extended by the principle of reflection or inversion, Mr. Barlow's investigation should lead to the same result. Now he finds 229 types, and expressly states that he is unable to account for a certain one of Fedorow's structures, so that his work is an absolute confirmation of the general accuracy of their calculations.

When this trifling question of 229 or 230 is settled, the problem of homogeneous structures, which was approached by Hauy 100 years ago, may be regarded as completely solved *from the purely geometrical point of view*.

Mr. Barlow's analysis of Sohncke's assemblages, and his laborious synthesis of the 164 new types, make the relations between the old and the new theory intelligible, and enable the reader to form a mental picture of all these complicated groupings: a task which is by no means easy from the writings of Fedorow and Schönflies without the aid of Mr. Barlow's tables.

H. A. M.

Theoretical Mechanics.—Solids. By Arthur Thornton M.A. Longmans' Advanced Science Manuals. (London: Longmans, Green, and Co., 1894.)

The manuals published in this series are written specially to meet the requirements of the advanced stage of science subjects, and the present book will be found a very worthy addition. It is not surprising to hear, as the author tells us in the preface, that in preparing this work he was confronted by the syllabus of this department. The range which these 400 odd pages then cover, can on this account be at once gathered: and it can safely be stated that the book includes all that is generally necessary for any school course. The order in which the subject has been treated is first kinematics, in which the geometrical science of motion is dealt with, then statics, and finally kinetics, in which force is treated in its relation to motion. In each part the author feels himself by no means bound up as regards the choice of proofs and definitions; and he places before the reader, in a well-arranged series of paragraphs, all the theorems and problems, illustrating them when necessary with clear figures. The real essence of the subject, that is, the "book-work," has had special attention devoted to it, and each chapter contains a special number of problems to be deduced directly from it. Stress has been laid, too, on the importance of solving problems from first principles, and not from a direct substitution in formulæ. Formulæ can easily slip the memory, if not totally, then partially, and it is for this reason that numerous methods and samples of solution have been given.

Examples of all kinds, and especially those introducing great diversity of style, are scattered throughout the work, some being original, while others are obtained from numerous well-known sources. A useful appendix, containing a brief summary of trigonometrical formulæ, and a short index, brings the book to a conclusion. For the convenience of those who are preparing the subject for special examinations, a short list is given of the portions which may be omitted.

The Earth: an Introduction to the Study of Inorganic Nature. By Evan W. Small, M.A. University Extension Series. (London: Methuen and Co., 1894.)

In this very acceptable addition to the well known University Extension Series, we have a set of chapters which are not intended to form a text-book on physiography, but to serve as a book containing a certain amount of accurate and definite knowledge for the general reader. Such being the case, the author has not dealt fully with any of the various branches, but has treated, in a sketchy manner, some of the more striking phenomena of the earth. The earth as a planet is first referred to, then the materials of which it is composed, which include the composition of the lithosphere, of the atmosphere, and of the hydrosphere. Next are discussed the laws of energy, and the past history of the earth as gathered from its present aspects, while the last chapter is devoted to the evolution of the earth, with sections on spectrum analysis, and theories of planetary origin. To anyone wishing to obtain a general survey of this many-sided subject, physiography, these pages should be of great service. As has been said before, the information in many cases is brief, and in some cases too brief for explanatory purposes. This is, however, counterbalanced to some extent by a number of useful references at the end of each chapter. An appendix, which may prove handy to teachers, gives a list of suitable lantern-slides for illustrating the subject-matter.

Songs of the Russian People. Collected in the Governments of Arkhangelsk and Olonetz, by Th. M. Istomin and G. O. Dütsch. (St. Petersburg, 1894.)

The northern provinces of Russia are the parts of the empire where the old popular songs are still kept in the memory of the people in their greatest purity. Elsewhere they are often forgotten, or are altered by the intrusion of modern music, very often of the music-hall type. In 1886 the Russian Geographical Society sent out a small expedition in order to collect the really old popular songs—religious, epic, wedding, and so on—and 119 of them are now published, both words and music, in the above-named collection. The words have been taken down by M. Istomin, and the music by M. Dütsch, who have both had a great deal of previous experience in that sort of work. Several songs of the collection are quite new, but the book's chief value is in the melodies of the epic songs (*byliny*), which now become known for the first time. It had always been supposed that the epic songs had no melodies, and were simply delivered in a sort of monotonous recitative; but it now appears that some of them have their special melodies, grave, most beautiful, and bearing the stamp of great antiquity. A map appended to the book shows the places visited by the expedition.

Visions of the Interior of the Earth, and of Past, Present, and Future Events. By H.R. and M.S.H. the Prince of Mantua and Montferrat. (London: Simpkin, Marshall, and Co., 1894.)

"Shadows to-night have struck more terror to the soul of Richard,
Than can the substances of ten thousand soldiers
Armed in proof, and led by shallow Richmond."

These lines are brought to mind by Prince Mantua's visions, which are calculated to produce a more or less terrifying effect upon the gentle reader. We cannot review the book seriously, for it is merely a record of what the author heard and saw while in a state of trance, and such revelations can hardly add to our knowledge of the earth's interior. Mr. Baxter, and the Society for Psychical Research, may find the volume interesting.

The Complete Poetical Works of Constance Naden. (London: Bickers and Son, 1894.)

In one of his essays, Macaulay, with his usual leaning to antithesis, holds that "as civilisation advances, poetry almost necessarily declines." His opinion was that science and poetry are antagonistic. The late Poet Laureate, however, showed that scientific facts and phenomena could be clothed in language at once poetical and impressive. Miss Constance Naden, who died at the end of 1889, won for herself a high place among poets of science and philosophy, and her admirers include many distinguished votaries of these branches of knowledge. Astronomy, geology, evolutionary ethics, and the nebular theory are a few of the subjects which inspired her to write, and that in a manner which commands admiration. She was a devoted disciple of Mr. Herbert Spencer, and, indeed, was a witness to the truth of his words: "It is not true that the cultivation of science is necessarily unfriendly to the exercise of imagination and the love of the beautiful. On the contrary, science opens up realms of poetry where, to the unscientific, all is a blank."

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.*]

Some New Facts with regard to "Bennettites."

The remarkable state of preservation of many Palæozoic plants, and some few Mesozoic forms, has raised palæobotany to a position of considerable importance in certain fields of botanical investigation. Endless synonyms, and specific determinations of more than doubtful value, have not unnaturally prejudiced botanists against the study of plant fossils. The scientific treatment of the mineralised tissues of extinct forms has, however, been productive of exceedingly important data towards the better understanding of the lines of plant evolution. Synthetic types and intermediate forms of plant structure are already fairly abundant, and the various suggestive facts revealed by a study of their remains are gradually assuming a more definite shape.

The genus *Bennettites* is an example of special interest among ancient plant types. This name was introduced by Mr. Carruthers in his important monograph of 1868, on the fossil Cycadean stems from the Secondary rocks of Britain.[1] The excellent preservation of the species *B. Gibsonianus* enabled this observer to give a detailed account of certain reproductive organs, which were embedded in the armour of the persistent petiole bases enclosing the plant stem. The affinities of this species have since been presented in a somewhat different light by Solms-Laubach,[2] and he is led to the conclusion that the *Cycadeæ* are the nearest known allies of the *Bennettiteæ*. There are, however, important differences between the two groups which preclude the idea that one has been directly derived from the other. The Marquis of Saporta and various other writers have contributed to the literature of *Bennettites*, and the speculations propounded as to its true position have been numerous enough.

We are indebted to the careful researches of Prof. Lignier, of Caen, for some recent additions to our knowledge of this genus, and his exhaustive monograph carries us a step further towards the solution of the Bennettites problem.[3] The specimen which forms the subject of Lignier's work was found by Morière, in 1865, in the Oxfordian beds of Vaches-Noires; two years later the fossil was described by its discoverer as part of a true Cycadean plant. In 1881, Saporta and Marion referred this Oxfordian fruit to the genus *Williamsonia*: and subsequent writers have assigned the fossil to various positions in the plant kingdom.

The specimen of *Bennettites Morierei* (Sap. and Mar.) described by Lignier is ovoid in form, and has a length of 55 mm., with a breadth of 35 mm. At the base a fractured surface reveals the existence of a slightly convex receptacle, from which is given off a compact cluster of long peduncles, each of which bears at its apex an oval seed. The seed-bearing peduncles are surrounded by several involucral bracts closely applied to

[1] *Trans. Linn. Soc.* vol. xxvi., 1870, p. 663.

[2] *Annals of Botany*, vol. v., 1890-91, p. 419 (translation from *Bot. Zeit.*, 1890.)

[3] "Végétaux fossiles de Normandie. Structure et affinités du *Bennettites Morierei* (Sap. et Mar.)." With six plates. Octave Lignier. (*Mém. Soc. Linn. Normandie*, vol. xviii., 1894.)

the surface of the fruit. Unfortunately the fruit is isolated, and affords no clue as to the nature of the organ to which it was originally attached. Numerous thin lamellæ occur in association with the seminiferous peduncles; to these Lignier has applied the term interseminal scales. The seeds are arranged side by side close to the upper surface of the mass of peduncles and interseminal scales; the latter pass between and beyond the seeds, and their swollen distal ends form a protective covering to the blunt hemispherical apex of the fruit. In surface view, the upper part of the specimen appears to be made up of a large number of small projecting areas with polygonal bases and rounded summits. Here and there the projections arrange themselves in the form of rosettes round a small central cavity, marking the position of a seed.

Involucral Bracts.—Some important facts have been brought to light as the result of a detailed histological examination of these structures by means of a series of transverse sections. In section each bract has the form of an isosceles triangle with the base directed towards the surface of the fruit. The excellent preservation of the tissues affords indisputable evidence of the existence of stomata and numerous lamellar epidermal outgrowths, similar to certain structures described by Carruthers in *B. Gibsonianus.* The most interesting part, perhaps, of Lignier's account of the bract tissue, is the inference he draws from an examination of the course and structure of the several vascular strands traversing each bract. It would seem that the vascular bundles are far from their termination, and that the involucral bracts as shown in the specimen are merely the petiolar portions of leaf-structures, of which the pinnate or flabellate laminæ have not been preserved. Immediately underneath one of the scaly hairs of an involucral bract a section has cut through what is apparently a lenticel; in this case, suggests Lignier, lenticel development has probably taken place as the result of irritation consequent on the fall or decay of a hair.

Seed-bearing Peduncles.—The main portion of the fruit itself is made up of well-developed peduncles having a length of 30–45 mm., and a diameter of 1·5 mm. Each peduncle consists of fundamental tissue traversed by a single axial bundle, and surrounding the whole there is a very characteristic epidermal layer, which is gradually replaced towards the upper part of the fruit by a "tubular envelope" of variable thickness. This change is probably the result of the elongation of the peduncles, and of the epidermal cells which increased in length without undergoing transverse division, and thus became transformed into tubular elements. A similar alteration of epidermal cells occurs in *B. Gibsonianus*, but in that species its true nature was apparently not recognised by Carruthers and Solms-Laubach.

Seeds.—Each peduncle terminates directly in an orthotropous seed with a single integument; the seeds are elliptical below, and assume a tetragonal or pentagonal form towards their apices. In the neighbourhood of the seeds, the tubular envelope of the peduncles is reduced in size, and becomes differentiated into a small tubular, and a folded layer of cells. The former is prolonged to the apex of the seed; the latter retains its special character in the lower half, but towards the upper half of the seed its cells become radially elongated, and give place to a tissue described as the "assise rayonnante." Passing up to the micropylar canal the two layers undergo a further modification; the tubular envelope has now assumed the *rôle* of an ordinary epidermis, and the "assise rayonnante" passes into a simple sub-epidermal layer of cells. The inner face of the micropyle consists of narrow and radially elongated elements, which become isodiametric as we pass down to the pollen-chamber. The fundamental tissue of the seed-coat is divided into an external fleshy and an internal fibrous portion. In describing the cells of the fleshy part of the integument, Lignier points out that the thin cell walls show here and there numerous fine pits, and the cell cavity contains a dark substance which may possibly represent the remains of protoplasmic and other cell contents. In some cases the contracted protoplasm (*sic*) shows slender prolongations which appear to correspond to the pits in the cell wall; these are interpreted as strands which originally traversed the cellulose walls, and connected cell with cell. It is perhaps questionable how far the tissues of fossil plants will stand the strain of the minute descriptions which characterise the work of some French writers; but if protoplasmic continuity can be thus partially demonstrated in a fossil seed, it suggests possibilities beyond the wildest dreams of palæobotanical histologists! The greater part of the nucellus is occupied by a large embryo with two cotyledons. On the whole, the general disposition of the peduncles and seeds is the same as in *B. Gibsonianus*, but various differences in detail sufficiently establish a specific difference.

Interseminal Scales.—These may be compared to the scales in a pine cone; they are associated with the seminiferous peduncles, but extend beyond them, and form a continuous protective layer at the exposed surface of the fruit. External to the interseminal scales there are the so-called superficial scales, which have a fairly definite structure, and are not to be confounded with the external involucral bracts.

The above imperfect *résumé* conveys but a poor idea of the thorough and careful treatment of the fossil at the hands of Prof. Lignier.

In his concluding remarks as to the nature of *B. Morierei*, the author of the monograph expresses himself somewhat as follows:—Regarding the supporting trunk as an axis of the first order, the fruit-bearing axis is of the second order, and has its apex contracted in the form of a convex receptacle; the leaves below the receptacle are transformed into involucral bracts, the leaves inserted on the receptacle itself have become interseminal scales, and the seed-bearing peduncles are fertile leaves belonging to unileaved shoots of the third order.

The inflorescence of *Bennettites* is clearly distinguished from that of the Cycads in the following points:—(1) Ovules are terminal and erect; (2) each fertile bud is of a higher order and much reduced; (3) the inflorescence is compound, formed by the grouping together of several fertile shoots, with a supporting branch and its leaves, &c. "The *Bennettiteæ* are therefore posterior to the *Cycadeæ*, at least as regards the reproductive structures."

On the other hand, the inflorescence of *Bennettites* presents many points of agreement with the *Coniferæ*; *e.g.* in its compound nature, small seeds, unileaved fertile shoots with erect ovules, &c. The points of difference between *Bennettites* and the *Coniferæ* include (1) larger number of sterile leaves associated with the single-leaved buds; (2) the position of the fertile shoots, which is not perhaps strictly axillary, &c. Summing up the whole matter, Lignier says:—"I regard the *Bennettiteæ* as a family which has been derived with the Cycads from common ancestors, but not from the Cycads themselves. Of these common ancestors the two families have preserved the form of the trunk, the structure of certain tissues (large pith, gum canals, diploxyloid leaf-traces, and sclerenchymatous mesophyll), the foliar origin of the ovule, &c. But whilst the Cycads have retained a grouping of carpophylls on a single axis, and have acquired special characters, such as the complication of the leaf-trace and the lateral position of the ovules; the *Bennettiteæ* have retained the simple leaf-trace and have acquired a terminal position of the ovules, the reduction of the fertile axes to a single corpophyll, the grouping of these fertile reduced axes, and the modification of the neighbouring leaves as the result of *précurrence sexuelle*.[1] Perhaps the future will bring to light a greater affinity than is at present suspected between the *Bennettiteæ* and certain fossils referred to the *Cordaiteæ*."

A. C. SEWARD.

Science Teaching in St. Mary's Hospital Medical School.

MY attention has just been called to an article in the issue of NATURE of September 20, headed "Science in the Medical Schools." This article professes to demonstrate by means of a table, compiled from lists given in the students' number of the *Lancet*, the extent to which instruction in science subjects not purely medical is provided in the medical schools. According to this table, no instruction is provided in biology or zoology, botany, physics, practical physics, bacteriology, and hygiene, or public health, in this medical school. If you will refer to the prospectus of the medical school, which I forward with this letter, you will find that very complete courses of instruction are given in all those subjects here, and that the instruction includes lectures, classes, demonstrations, and laboratory work in all the subjects.

[1] In explanation of this term Lignier adds:—"Je designe sous le nom de *précurrence sexuelle* le phénomène par lequel certains organes soit porteurs de la glande sexuee soit voisins de celle-ci et formes antérieurement à elle, sont peu à peu englobés dans l'appareil sexuel à mesure que celui-ci se complique dans la généalogie des plantes. La précurrence sexuelle ainsi comprise se rencontre partout dans le règne vegétal."

I cannot help thinking, that before publishing such an article, it would have been but in accordance with common accuracy and equity if you had verified the list of subjects taught in this medical school, by reference either to the prospectus or to one of the officials, who would have been pleased to give you all necessary information. The list relating to St. Mary's Medical School, in the number of the *Lancet* from which you prepare your table, teems with inaccuracies and omissions. It is not a list issued with any authority from this school, nor is it submitted for revision or correction to any official of the school. The statement in your article, that "the table does not pretend to be complete," is one that I cordially endorse; but the subsequent statement, that "it will serve to show the kind of science subjects on which lectures are given to medical students," is one that, as regards the teaching at St. Mary's Medical School, is both misleading and untrue.

My colleagues concerned in the management of this school feel with me that such a reference to our science teaching in a paper of such wide circulation as that of NATURE, is calculated to be most damaging to the interests of our medical school, which we have used every endeavour, and spared no expense, to render efficient from the educational point of view. We therefore trust that you will publish this letter in full, and that you will take the earliest opportunity of correcting the erroneous statement in connection with the science teaching here that appears in your issue of September 20 last.

ARTHUR P. LUFF.

[The students' number of the *Lancet* contains lists of the "classes, lecturers, and fees" at the medical schools of Great Britain, for the session 1894–95. We assumed that these lists were fairly complete, and the table referred to by Dr. Luff was prepared from them. It occurred to us that our contemporary may have omitted some courses inadvertently, and this led us to state distinctly that "the table does not pretend to be complete," and, later on, "courses of lectures on bacteriology are advertised to take place at nine medical schools, but it must not be supposed that they are the only schools having facilities for carrying on this work." The table served its purpose of showing the kind of sciences taught in medical schools in addition to the usual professional subjects. It was not intended to be used as a criterion of the efficiency of the schools individually.—ED. NATURE.]

Gohna Lake.

THE notices in NATURE (August 30, p. 428, and September 20, p. 501), on the overflow of the lake dammed up by a landslip at Gohna, in the Kumaun Himalayas, leave the impression that the dam burst and the lake was completely drained. This is incorrect. The accompanying extract shows that Mr. Holland's forecast, an abstract of which, with illustrations, appeared in NATURE, July 5, was singularly accurate. The whole occurrence is of remarkable geological interest, and it is important the correct facts should be known.

W. T. BLANFORD.

Weyburn, near Godalming, October 9.

Mr. Michie Smith, the Madras Astronomer, referring to the Gohna Lake, writes to the *Madras Mail*:—"My excuse for writing to you again on this subject is that I have now received trustworthy information regarding the present state of the lake, which makes it possible to compare Mr. Holland's forecast with what has actually taken place. In Mr. Holland's official report, he laid stress on three main points. (1) That the dam would not yield until the water overflowed it. This, as is admitted, was correct. (2) That the water would overflow the barrier about the middle of August. This was the result of a very intricate calculation, the data for which were obtained with great difficulty; yet, as we now know, this estimate was within ten days of the actual time, and on the safe side. Both these points were of much practical importance for the purpose of making arrangements in the valley below, and Government accepting the conclusions allowed traffic to continue in the valley for 160 miles till August 15. (3) Mr. Holland held that it was probable that 'there will be preserved above a lake 3½ miles long and 1¼ miles wide, whose destruction by gradual erosion of the dam and silting up of the basin, though a matter of time geologically considered short, will be sufficiently slow for what historically may be called a permanent lake.' Now, what are the facts of the case? According to the latest trustworthy report from Gohna, a lake has been left which is over 3 miles long and 400 feet deep, and so far as it is possible to judge it will have the permanence predicted for it. I hold no brief for Mr. Holland, but it seems to me that his predictions, founded on careful research and accurate reasoning, have been fulfilled to a most remarkable degree, and that he has fully justified the confidence placed in him by the authorities."

Instinctive Attitudes.

DR. LIVINGSTONE makes this interesting observation: "Manyuema children do not creep, as European children do, on their knees, but begin by putting forward one foot and using one knee. Generally a Manyuema child uses both feet and both hands, but never both knees. One Arab child did the same; he never crept, but got up on both feet, holding on till he could walk." ("Last Journals," p. 381.) The last instance suggests arboreal survival, the Manyuema style being pure plantigrade, but rarely seen in civilised life. Creeping of infants as instinctive activity certainly throws light on human evolution, and it may be that racial differences will be revealed by investigation. It would also be interesting to inquire how far idiosyncrasy in walking is connected with peculiarity in creeping. Swinging the arms seems quadrupedal survival. Looking down from a high building on people walking below, their movements thus projected on a plane are strikingly suggestive of a quadruped, and the professional pedestrian who makes the utmost use of arm-swinging to accelerate gait suggests the rapid shuffle of a bear.

Again, the various attitudes instinctively assumed by persons for sleep are significant for the evolutionist. I know those who naturally dispose themselves flat on the stomach, with the limbs placed much like a dog asleep.

So far as habits of creeping, walking, and sleeping have not been taught, but are purely instinctive, they throw light on the history of man. It is very desirable that travellers and residents in all countries secure photographs of these attitudes, and deposit them with anthropological societies, where they would be of great use to the investigator. HIRAM M. STANLEY.

Lake Forest University, October 3.

The Tetrahedral Carbon Atom.

IN the letter which he has addressed to you on this subject, it seems to me that Dr. Turpin has not succeeded in justifying his position. Whether your reviewer is or is not acquainted with all that has been written on the subject, is not a matter of great importance, though reference to the *Proceedings* of the Birmingham Philosophical Society (vii. part ii. p. 264) will be sufficient to show that the views of Wislicenus and Wunderlich have not been overlooked. The question is whether the writer of a text-book bearing on its title-page the word "Elementary," is justified in presenting without preface, and almost without explanation, a bald statement such as that complained of, which represents not the deliberate conclusions of the majority, or even of a considerable body of chemists, but speculations still in the earliest stage of evolution. (Wislicenus himself says, in reference to his own views, "Ich lege ihnen keineswegs den Werth einer wissenschaftlichen Ueberzeugung bei und möchte nicht auf ihnen 'festgenagelt' werden." *Ber.* xxi. 584.) I hope and believe that this sort of thing is not commonly taught to beginners in organic chemistry, and it may be as well for Dr. Turpin and his pupils to note that tetrahedral carbon is not referred to in any way in the syllabus of the first stage of organic chemistry in the Directory of the Science and Art Department. W. A. T.

"Abstract Geometry."

I SEE your reviewer of Prof. Veronese's book on "Abstract Geometry" says: "Apparently this method" (that of pure geometry, free from axes, algebraic processes, &c.) "has not previously been applied to the discussion of space of more than three dimensions." Will you allow me to point out to him that this is a mistake? The case of four dimensions is discussed, and a general method indicated, in my "Foundations of Geometry," which was reviewed in your issue of April 6, 1891 (vol. xliii. p. 554). I have not yet read Prof. Veronese's book, but from your review I gather he treats the subject rather differently. EDWARD T. DIXON.

Cambridge, September 28.

ON THE DOCTRINE OF DISCONTINUITY OF FLUID MOTION, IN CONNECTION WITH THE RESISTANCE AGAINST A SOLID MOVING THROUGH A FLUID.[1]

IV.

§ 25. ANOTHER decisive demonstration that the doctrine of discontinuity is very far from an approximation to the truth, is afforded, in an exceedingly interesting and instructive manner, by Dines' observations of the pressures on the two sides of a disk held at right angles to a relative wind of 60 statute miles per hour (88 ft. per sec.), produced by carrying it round at the end of the revolving arm of his machine. The observations were described in a communication to the Royal Meteorological Society in May 1890. In his paper of June of the same year, in the Royal Society Proceedings already referred to, he states the results, which are, that at the middle of the front side an augmentation of pressure, and at the middle of the rear side a diminution of pressure, measured respectively by 1·82 i and ·89 i of water, were found. These correspond to heads of air, of density 1/800 of that of water, equal respectively to 121$\frac{1}{3}$ and 59$\frac{1}{3}$ feet. The former is in almost exact accordance with rigorous mathematical theory for an inviscid incompressible fluid; which gives 88· 64·4, or 122$\frac{1}{3}$ feet for the depth corresponding to the pressure at the water-shed point or points, of a solid of any shape moving through it at the rate of 88 feet per second. The latter shows that there is a "suction" at the centre of the rear side very nearly equal to half the augmentation of pressure on the front; instead of there being neither suction nor augmented pressure as taught in the doctrine of discontinuity!

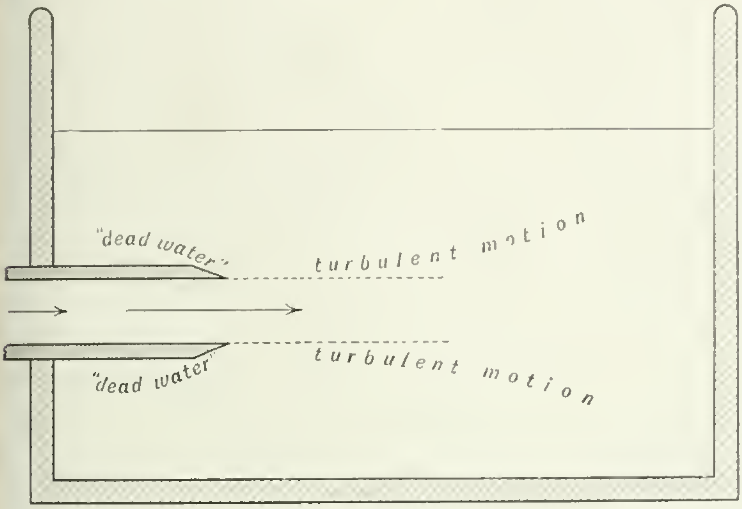

FIG. 2.

§ 26. The accompanying diagrams (2, 3, 4, 5) represent several illustrations of the doctrine of discontinuity in the motion of an inviscid fluid, less attractive to writers on mathematical hydrokinetics than that represented in Fig. 1, (whether as it stands, or varied to suit oblique incidence), because each is instantly soluble without mathematical analysis, and they do not, like it in the two-dimensional case, constitute illustrations of the beautiful mathematical method for finding surfaces of constant fluid velocity in prolongation of given surfaces along which the velocity is not constant, originated by Helmholtz,[1] developed in a mathematically most interesting manner by Kirchoff,[2] and validly applied to the theory of the "vena contracta" by Rayleigh.[3]

§ 27. A cylindric jet (not necessarily of circular cross-section) issuing from a tube with *sharp edge*, into a *very large* volume of fluid of the same density as that of the jet, is represented in Fig. 2. This case was carefully considered by Helmholtz,[4] both for the ideal inviscid incompressible fluid and for real water or real air. He gave good reason for believing that, with real water or real air, and at distances from the mouth as great as several times the diameter of the tube (or the least diameter, if it is not of circular cross section) the surrounding fluid is nearly at rest, and the jet is but little disturbed from the kind of motion it had in passing out of the tube: and therefore that the efflux is nearly the same as, other circumstances the same, it would be if the atmosphere into which the jet is discharged were inertia-less. This conclusion, which is of great importance in practical hydraulics, has been confirmed by careful experiments made eight years ago in the physical laboratory of the University of Glasgow by two young officers of the American Navy, Mr. Capps and the late Mr. Hewes. I believe it has been tested and confirmed by other experimenters.

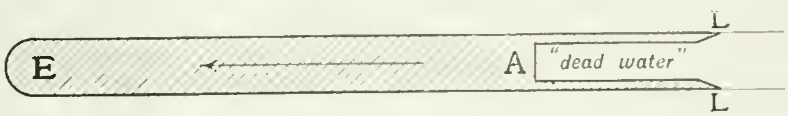

FIG. 3.

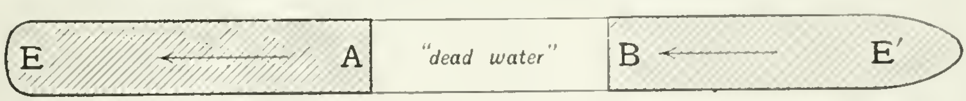

FIG. 4.

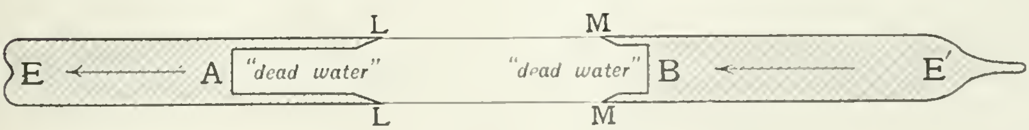

FIG. 5.

§ 28. The very simplest application of the doctrine of discontinuity to the theory of the resistance of fluids to

[1] Continued from page 575.

[1] "Wissenschaftliche Abhandlungen," vol. i. pp. 153-156.
[2] "Vorlesungen über Mathematische Physik," vol. xxi.
[3] "Notes on Hydrodynamics," *Phil. Mag.* 1876, second half-year.
[4] "Wiss. Abh.," vol. i. pp. 152-153.

solids moving through them, is represented in Fig. 3, and the result is no resistance at all! Surely this case, requiring no calculation, might have been a warning of the extreme wrongness of the doctrine in connection with resistance of fluids against solids moving through them. The nullity of the resistance in the case represented by Fig. 3 according to the assumption of a wake of "dead water" having the same pressure, Π, as the distant and near water flowing uniformly in parallel lines, follows immediately from an easily proved theorem which I stated in the combined meeting of Sections A and G in Oxford last August, to the effect that the longitudinal component of the pressure on each of the ends, E, E′, in Figs. 3, 4, 5, whatever their shapes, and whether "bow" or "stern" provided only that it ends tangentially in a cylindric "mid-body" long in comparison with the greatest transverse diameter of the solid, is equal to ΠA, where A is the area of the cross-section of the cylindric part of the solid.

§ 29. Figs. 4 and 5 represent two varieties of a case wholly free from the inconceivable endlessness of Fig. 1, and carefully chosen as thoroughly defensible by holders of the doctrine of discontinuity if it has any defensibility at all. I venture to leave it with them for their consideration.

KELVIN.

PARACELSUS.[1]

"THEOPHRASTUS VON HOHENHEIM was adjudged by most eminent physicians to be a man of genius, indeed of superlative genius. . . . By others, who refused to follow him, he was thought to be less deserving than the cooks, the bellows-blowers, and the charcoal-burners." Thus spoke Lukas Gernler, Rector of the University of Basel, in 1660. Haser, in his "History of Medicine," says: "Probably no physician has grasped his life's task with a purer enthusiasm, or devoted himself more faithfully to it, or more fully maintained the moral worthiness of his calling, than did the reformer of Einsiedeln." And of this same reformer, Zimmermann, who was physician to Frederick the Great, wrote: "He lived like a pig, looked like a drover, found his greatest enjoyment in the company of the most dissolute and lowest rabble, and throughout his glorious life he was generally drunk."

As with these, so with others who have tried to form an estimate of the character of Paracelsus. Some praise him inordinately; others as inordinately abuse him. It is only men of power and character who are thus extolled and thus abused. You may neglect an ordinary man; you must either praise much, or anathematise more, a great man.

Even as regards the name of the "reformer of Einsiedeln" there are divergencies of opinion. Kahlbaum, in the pamphlet cited below, says that he never called, or signed, himself by the sounding name that was given him by some of his followers, who thought to awe the common people by styling their master "Philippus Aureolus Theophrastus Paracelsus Bombastus ab Hohenheim." For himself, Theophrast von Hohenheim was sufficient. On one occasion, says Kahlbaum, he used the name Aureolus, to distinguish himself from Theophrastus a disciple of Aristotle. The father of Paracelsus was a natural son of a member of the noble family of the Bombasts of Hohenheim, and he adopted their name as his own. In accordance with a fashion of the times, the name von Hohenheim was paraphrased into the classical tongues. *Paracelsus*, which may perhaps be rendered as "belonging to a lofty place," seems to be a kind of Græco-Latin form of von Hohenheim, the family name of Theophrastus. As von Hohenheim became *Paracelsus*, so Lieber became *Erastus*, and Schütz became *Toxites*; and in modern times the Jewish Neumann emerged from the baptismal font as *Neander*.

Paracelsus was born at Einsiedeln, in the canton of Schwyz, towards the end of the year 1493. He was educated for a time by his father, then by the monks of a convent in the valley of Savon, and then in the University of Basel. After leaving the University, Paracelsus studied under Johannes Trithemius, Abbot of Sponheim, and then under Siegmund Füger, a rich nobleman at Schwaz in the Tyrol. Both Trithemius and Füger were celebrated adepts and students of occultism, and from them Paracelsus may have imbibed the doctrines which he afterwards developed. Paracelsus was a great wanderer: he visited Tubingen, Heidelberg, Ingoldstadt, Vienna, Leipzig, Cologne, Toulouse, Paris, Salerno, and many other towns; he probably also spent some time in the East, and he is said to have received the stone of wisdom from an adept at Constantinople. Wherever he went he always eagerly sought fresh knowledge.

In 1527 he delivered lectures in the University of Basel, with the sanction of the Rector. Paracelsus attempted to institute a method of testing the apothecaries of the town as to their knowledge of the business of making drugs and determining the purity of the materials they dispensed. He spoke scornfully of the decoctions, tinctures, extracts, and syrups that the apothecaries delighted to prepare, calling them all "soup-messes" (*Suppenwust*). Of course the dealers in decoctions were up in arms against the man who attacked their trade. Paracelsus also roused the physicians. He taught that they should go to nature, and not to books, for their knowledge; he rebelled against the doctrine that was then held by almost every medical man, "the truth is to be found only in the ancients." He boasted that for ten years he had not opened a single book written by a follower of Galen, and he spoke of the Galenists as men who tried to hide their folly under red cloaks; and, worst of all, he delivered his lectures in German. The physicians and apothecaries of Basel could not stand these things. Paracelsus was abused not only publicly, but also in anonymous pamphlets; it is said that one of these productions was found on a Sunday morning affixed to the door of the Minster, with the superscription, "The Shade of Galen to Theophrastus, better called Kakophrastus." Of the attacks made on him Paracelsus exclaimed, "These vile ribaldries would raise the ire of a turtle-dove." Matters came to a head when a Canon of St. Clara, who had been cured by three laudanum pills, refused to pay Paracelsus the 100 florins he had promised, and sent six florins instead. Paracelsus sued the Canon for the money, but the court dismissed his suit. In his indignation Paracelsus seems to have put himself into the wrong; hearing that the magistrates had resolved to arrest him, on the advice of his friends he fled from Basel in 1528. After wandering about over a great part of Europe, Paracelsus found a resting-place at Salzburg, under the protection of the Archbishop Ernest. But he did not live long to enjoy the repose that had come at last. He died on September 24, 1541, after a short illness, in his forty-eighth year.

It is not possible to form a just estimate either of the character or the work of Paracelsus. The evidence is not sufficient, nor sufficiently trustworthy. Nevertheless we can draw some kind of picture of the man, and we are able to trace, in a hesitating way, the effects of his labours and his teaching on the progress of science. The pamphlet by Kahlbaum is concerned with dates, and the outward paraphernalia of the life of Theophrastus. Kopp gives a short account of the work of Paracelsus in

[1] "Theophrastus Paracelsus, ein Vortrag gehalten zu Ehren Theo[illegible] am 17 December [illegible] im Bernoullianum zu Basel." [illegible] 72 pp. [illegible]

chemistry, pharmacy, and medical chemistry. The essential doctrines inculcated by the cosmogonist of Hohenheim are put into the language of modern mysticism by Hartmann, in his "Life of Philippus Theophrastus, Bombast of Hohenheim, known by the name of Paracelsus; and the substance of his teachings," published in 1887. A collection of the works of Paracelsus was made by Dr. E. Schubert; that author, and also Dr. Karl Sudhoff, have thrown much light on the history of Paracelsus. A pamphlet entitled "Theophrastus Paracelsus, Eine Kritische Studie," was published by F. Mook in 1876; and a criticism of this critique, by Prof. Ferguson, of Glasgow University, appeared in 1877 with the title "Bibliographia Paracelsica."

The difficulty of estimating justly the influence of Theophrastus von Hohenheim on his age is enhanced by the fact that the greater part of the writings that go under his name was compiled after his death by his followers, from fragmentary manuscripts left by their master. Hartmann gives a list of the works attributed to Paracelsus in the edition published by Huser, at the request of the Prince Archbishop of Cologne, in the years 1589–90. The list contains the names of fifty works on medicine, seven on alchemy, nine on natural history and philosophy, twenty-six on magic, and fourteen on various other subjects. In 1893, Prof. Ferguson printed (privately) a very complete annotated catalogue of the different editions of the works of Paracelsus.

The preparation of an inflammable gas by the action of oil of vitriol on iron filings is usually attributed to Paracelsus. He also examined the differences between metals and substances that are like metals, and he asserted ductility to be the characteristic property of all true metals. The differences between the vitriols and the alums were referred by Paracelsus to the presence in the former of metals, and in the latter of earths. He introduced into medicine many new and potent drugs, notably laudanum; and he constantly sought to determine the medicinal effects of the chemical substances that he worked with. Paracelsus was the first to make medicinal use of preparations of mercury, lead, and iron. He held that substances that were poisonous when administered in quantity might have healing properties when given in smaller doses and under proper conditions. In his endeavour to obtain definite substances, freed from admixture with extraneous and unnecessary, or perhaps hurtful, materials, he made tinctures and essences of various plants, and used these in place of the sweetened decoctions of the entire plants that were generally employed at that time. Paracelsus asserted that the aim of chemistry should be not to make gold, but to produce healing medicines. Medicine was for him a branch of chemistry. He insisted that apothecaries ought to be acquainted with the chemical characters of the drugs they compounded, and that only by a knowledge of chemical reactions could the physician restore to the perturbed bodies of his patients that chemical equilibrium which is health.

It is evident that a man who held and practised such views as these could not pay much respect to the physicians of his own time, whose highest ideal was to do what Galen had done, and to administer this or that drug because Avicenna laid it down, on such or such a page, that the drug ought to be administered. What the authorities of the schools were to his contemporaries, nature was to Paracelsus: the supreme court of appeal. Surrounded by prejudices, separated from nature by the thick veils that mediæval philosophy had drawn over men's eyes, bound by the formulas of his age—as we are bound by those of our age—Paracelsus nevertheless knew that the sun was shining on the other side of the mist, and that could he and others break through they would find the light. We can surely sympathise with his struggle. We may perhaps even recognise the essential rightness of the daring claim of the man who felt that the vision of nature could alone give understanding:—"After me, you, Avicenna, Galen, Rhasis, Montagnana, and the others. You after me, not I after you. You of Paris, you of Montpellier, you of Swabia, of Meissen, and Vienna; you who come from the countries along the Danube and the Rhine; and you, too, from the islands of the Ocean. Follow me. It is not for me to follow you, for mine is the monarchy.'

But while we admire the audacity of the man, and even admit the force of his claim, we know that one who attacked the citadel of nature in this mood would dash himself to pieces before the outworks were carried. Yet he might make a breach through which a way for others should lie open. And Paracelsus succeeded in this; we are entering nature's strongholds by some of the ways he helped to open. With few appliances, with no accurate knowledge, with no help from the work of others, without polished and sharpened weapons, and without the skill that comes from long handling instruments of precision, what could Paracelsus effect in his struggle to wrest her secrets from nature? Of necessity, he grew weary of the task, and tried to construct a universe which should be simpler than that most complex order which refused to yield to his analysis.

The struggle is so arduous, nature is so infinitely complex, men are so easily led astray, that the giants alone keep to the quest, and they only go always forward to the goal. The syren-songs of the miracle-men are very soothing, and few escape. It is so pleasant to lie still and dream; it is so hard to get up and act. In the time of Paracelsus the air was filled with the soporific murmurings of industrious human bees. They were all busy secreting the wax of philosophising, that with it they might construct symmetric cells to be filled with the syrup of their own wisdom. Paracelsus, too, was obliged to become a wax-gatherer and a universe-maker. And a very remarkable universe he produced. The facts of nature that he sought were found so slowly that, in his impatience, he supposed the aim of science was to produce a completed scheme of things; and such a scheme he set himself to construct.

It would be out of place here to attempt more than the briefest sketch of the outlines of the Paracelsian conception of the order of nature. Paracelsus was essentially of the order of mystics. He would have adopted with enthusiasm the words of Blake: "I assert for myself that I do not behold the outward creation, and that to me it is a hindrance, and not action. 'What,' it will be exclaimed, 'when the sun rises do you not see a round disc of fire somewhat like a guinea?' Oh, no! no! I see an innumerable company of the heavenly host crying 'Holy, holy, holy, is the Lord God Almighty. I question not my corporeal eye any more than I would question a window concerning a sight. I look through it, and not with it." Paracelsus insisted on the unity of all things; he taught that in everything in nature there is an inner and essential principle, which is itself a part of the universal life. There was for him an absolute and attainable knowledge; and although he admitted that much is to be learned from external nature, he taught that this real knowledge must be discovered by each man in himself. "Each man has . . . all the wisdom and power of the world in himself; he possesses one kind of knowledge as much as another, and he who does not find that which is in him cannot truly say that he does not possess it, but only that he was not capable of successfully seeking for it." Chemistry was regarded by Paracelsus as a spiritual art; an art that deals with the spiritual principles of things. Everything in nature was thought of by him as having a threefold character.

as consisting of "a body and a soul held together by the spirit, which is the cause and the law." "To grasp the invisible elements, to attract them by their material correspondences, to control, purify, and transform them by the living power of the spirit—this is true alchemy." The pure, invisible, intangible, universal elements constituted the highest of the three orders of things; the second order was composed of "elements that are compounded, changeable, and impure, yet may by art be reduced to their pure simplicity"; and the third order contained the "twice compounded elements" which served as vehicles for drawing down the pure ethereal elements and fixing them in the substances of the second order. The laboratory was the place for learning the properties of the things of the second order; "for from these proceed the bindings, loosings, and transmutations of all things." Paracelsus speaks of the three substances of which all things are composed; these three things are "sulphur, mercury, and salt"; but he adds, "they are acted on by a fourth principle which is life." "These three substances," he says, "are not seen with the physical eye. . . . If you take the three invisible substances, and add the power of life, you will have three invisible substances in a visible form. . . . They are hidden by life, and joined together by life. . . . All things are hidden in them in the same sense that a pear is hidden in a pear tree and grapes in a vine. . . . A gardener knows that a vine will produce no pears, and a pear-tree no grapes"

I think it is possible from these extracts to construct, in a general way, the non-natural scheme of nature that was upheld by Paracelsus. A great deal may be said in its favour, if only we agree to construct the nature that is to be explained from our own consciousness with closed eyes. This certainly may be asserted in favour of the so-called spiritual science of Paracelsus and the mystics of his school, that their method is infinitely easier than the method of natural science, or, as it is called by the modern Paracelsians, materialistic and sceptical science. Whatever judgment may be passed on natural science when it is contrasted with supernatural mysticism, it is at any rate ludicrously erroneous to say that the former is proud, dogmatic, and conceited, while the latter is humble, suggestive, and ready to learn. The answer to the conception of the universe that Paracelsus framed is to be found in the history of science, and in the history of humanity, since the Middle Ages.

But however radically a modern naturalist may differ from the mediæval alchemist, he must recognise the great debt which those who to-day seek the knowledge of natural laws owe to the man of the sixteenth century who boldly declared against authority, and besought his followers to go to nature, who insisted on the interdependence of the various branches of natural knowledge, who taught the essential unity of the forms of matter and of the forms of energy, and who, by his discoveries in medicine, helped forward the blessed work of alleviating the miseries and soothing the sorrows of human beings. Whatever else he was, Paracelsus was certainly a true man; he lived earnestly; he was not regardful of the conventionalities of life; he received blows, and he returned them; he suffered much, and he bore his troubles on the whole with patience and some nobility. With his own words we may leave him:—"Have no care of my misery reader; let me bear my burden myself. I have two failings: my poverty, and my piety. My poverty was thrown in my face by a Burgomaster who had perhaps only seen Doctors attired in silken robes, never basking in tattered rags in the sunshine. So it was decreed that I was not a Doctor. For my piety I am arraigned by the parsons, for I am no devotee of Venus, nor do I at all love those who teach what they do not themselves practise."

M. M. Pattison Muir.

ON HOLLOW PYRAMIDAL ICE CRYSTALS.[1]

I. *The Lava Cavern of Surtshellir.*—The lava cavern of Surtshellir forms a long subterranean channel—over a mile in length—in the post-glacial lava-field which encompasses in a vast semicircle the ice-covered Eyríksjökull (Iceland). The farthest recess forms a chamber about 30 feet high, and from its floor and ceiling spring ice-stalagmites and stalactites of rare beauty. (Fig. 1.)

The north-western wall is gracefully draped by a long curtain of icicles resembling somewhat the pipes of an organ. From those parts of the vault not covered by icicles a thousand glitterings and sparklings are seen, at every movement of the candle, to be reflected from ice crystals which stud the walls.

The ice crystals have the form of hexagonal funnels, or hollow hexagonal pyramids. In size they range up to two inches long, with a hexagon side of half an inch. The triangular sides of the pyramids are built of most delicate steps of ice, arranged in the manner of a staircase.

The attachment is invariably by the apex, and the hexagonal bases turn trumpet-like towards the interior of the cave. (Fig. 2.) When these observations were made in June 1892, the temperature of the air in the cave was $+0.5^{\circ}$ C.

There are some minute cracks in the roof of the cave, through which water trickles scantily. At such places *icicles* are formed, but not crystals. The crystals are not formed from the water percolating into the cave, but from the moisture contained in the air, and as such they must be regarded as a kind of *hoar-frost*.

II. *Hoar-frost.*—During Christmas week 1892 an unusually fine hoar-frost prevailed over the North of England. In various parts of Yorkshire, Lancashire, and Cheshire, we found the rime to consist almost entirely of hexagonal "hopper" crystals. (Fig. 3, *a*, *b*, *c*.) The basal hexagons varied up to about ⅜ inch in diameter, and the majority of the crystals measured in height about twice the diameter. (Fig. 3, *a*.) Some, however, were more obtuse. (Fig. 3, *b*.) The forms were often obliquely truncated (Fig. 3, *c*), certain faces having grown more rapidly than others. A spiral arrangement was noticed in some cases, and occasionally a double spiral resembling the helix of an Ionic capital. (Fig. 3, *d*.)

There was a marked tendency for the simple pyramids to group themselves into compound forms. (Fig. 3, *e*, *f*.) The groups exhibited hexagonal outlines (Fig. 3, *f*), and the primary pyramids on the periphery were, as a rule, better developed than those in the interior. The secondary hexagons often measured more than 1½ inches in diameter. Even a tertiary grouping could be made out in a few cases. In a few rare instances the primary hexagons were studded at the corners with small hexagons resembling bastions. These bastions were either solid or hollow. (Fig. 3, *g*.)

III. *Crystals under Ice-Crusts.*—On January 3, 1894, we found in Cheshire, during a severe frost, similar hexagonal hoppers on the under-surfaces of ice-crusts covering hollow spaces over ruts in clayey soil, or covering ponds where an air-space divided the ice from the water. No ice crystals were found on the sides and bottom of the ruts, and there was no trace of *hoar-frost* on adjacent objects.

These observations suggested the idea that *hoar-frost might be made at will* on any cold night. We accordingly spread pieces of black cardboard and black velvet over grass, and on examining these after two days of hard frost we found the *under*-surfaces coated with an abundance of hollow pyramidal and other forms of ice

[1] From a paper read before the Royal Society, by Dr. Karl Grossmann and Joseph Lomas.

crystals. No hoar-frost formed on the upper surfaces of the velvet or cardboard, and none existed on the grass.

IV. *Artificial Hoar-frost.*—Experiments had been planned before Christmas 1892, for the artificial production of hoar frost It was thought advisable, before completing our arrangements, to search for any possible traces of hoar-frost in the refrigerating chambers used for the frozen-meat trade in Liverpool. This visit rendered experiments unnecessary, as it yielded a rich harvest of simple and compound forms of hollow pyramidal crystals. All the variations observed in natural hoar-frost were met with, and the details of the forms were registered by microphotographs taken with magnesium light The ice chambers were cooled down to -13° C.[1]

Very large and beautiful simple hoppers were obtained from ships used in the frozen-meat trade. During the four to six weeks of transit from the River Plate to Liverpool the hold is cooled down to about -5° C., and the enclosed air is perfectly calm.

On the occasion of a visit to Berlin, in June 1893, the large cooling cellars connected with the "Muenchener Brauhaus" were examined (by kind permission of Director Arndt), and small hopper crystals were discovered on the cooling pipes.

V. *Comparison with other Skeleton Crystals.*—The simple hollow hexagonal pyramids of ice naturally suggest comparison with the well-known cubic "hopper" crystals of rock salt and skeleton crystals of other substances.

In crystal-building there is always a marked tendency towards excessive growth along the diagonal axes of the crystal. At the angles of crystals there is, for a given area, a larger supply of material for growth than in the middle of a side. Beautiful skeleton crystals of potassium chloride can be formed by rapidly cooling concentrated warm solutions. First, a great number of micro-crystals are formed, which float about in the brine. Any of these may form a centre of attraction round which crystalline matter will aggregate. A small cube will form the centre, and from each solid angle a straight axial row of small cubes will arise.[1] The intervening parts will gradually get filled up if sufficient time is allowed.

This type of skeleton crystal is evidently due to *overgrowth.*

Quite differently formed, though with the same result, are the hopper crystals of sodium chloride. NaCl is almost equally soluble in cold and hot water. Unaffected by cooling, it will therefore crystallise out of brine most rapidly where the concentration becomes greatest through evaporation, viz. at the surface. Suppose, then, a single cube to be formed at the surface. Beginning to sink, there will be deposits of fresh cubes on the four upper edges of the cube in the form of a step. This goes on until we have a floating hollow pyramid, apex downwards. At the corners of these hoppers additional cubes are formed. (Compare the analogy with the hexagonal form, Fig. 3, *g.*) These skeleton crystals are due to *growth at the upper edges of floating crystals.*

A third type of hollow skeleton crystals we have in hoar-frost.

When crystallisation of atmospheric vapour takes place in absolute freedom, we find the crystals mainly

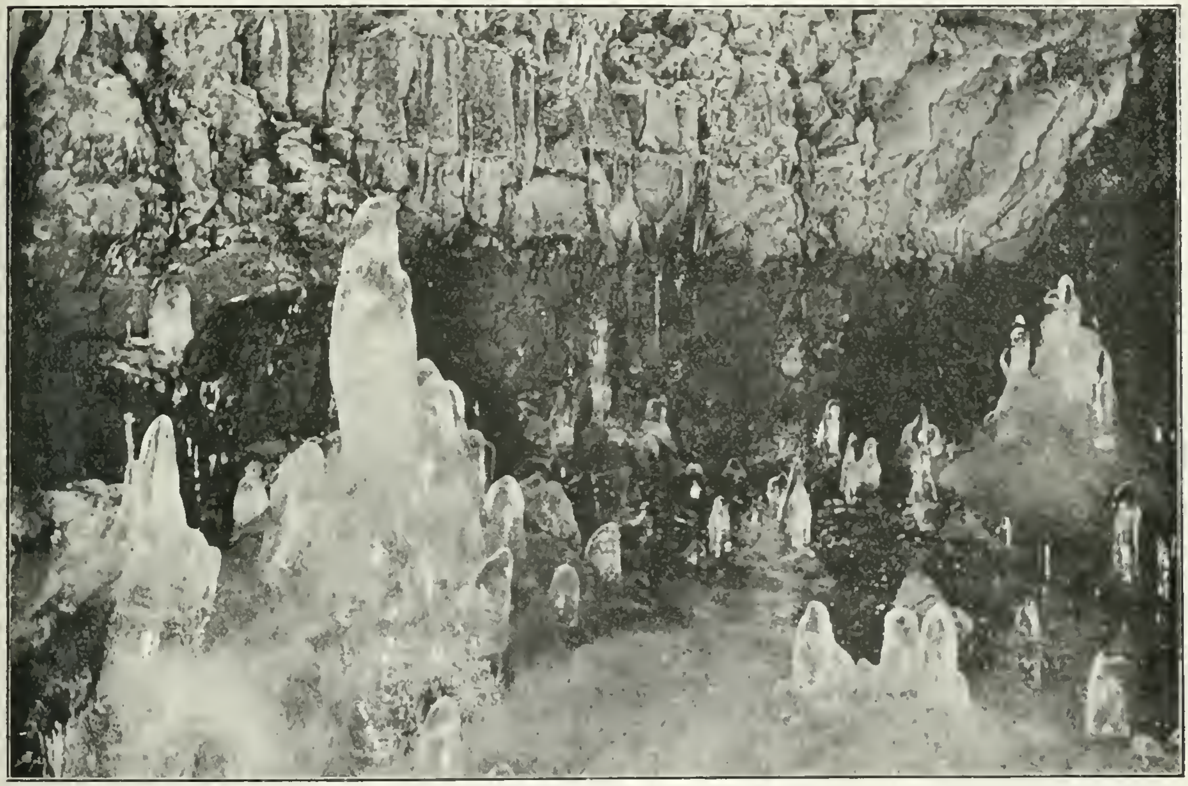

FIG. 1.—Ice Stalagmites in the Lava Cavern of Surtshellir (Iceland).

[1] Our thanks are due to Mr. Ward for permission to work in the chambers of the Sausineoa Company, and to Mr. Lintott, through whose help we were enabled to exhibit some of the ice crystals at the soirée of the Royal Society.

[1] See A. Knop. "Molekularconstitution und Wachsthum der Krystalle," p. 52. (Leipzig: 1867.)

developed in a plane perpendicular to the principal axis, as *flat* snow crystals. When, however, the atmospheric space is limited by a wall, first a small hexagonal disc of ice attaches itself to that wall. Then, as growth proceeds, in a calm or comparatively calm medium, the middle portion of the disc will be in contact with air

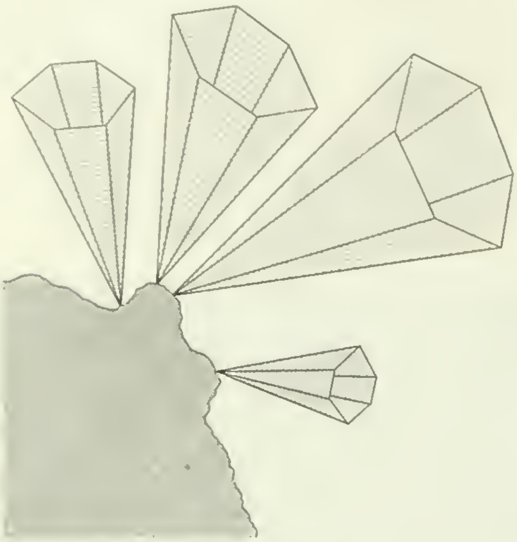

FIG. 2.—Hollow Hexagonal "Hopper" Crystals of Ice found in Surtshellir. (Natural size.)

robbed of its moisture, while the edges will grow outwards, the rate depending on the amount of food material. The open ends of the funnels will point towards the middle of the wall-bound air-chamber or cavern, or away from the wall; in the case of hoar-frost the funnels will be open towards the sky.

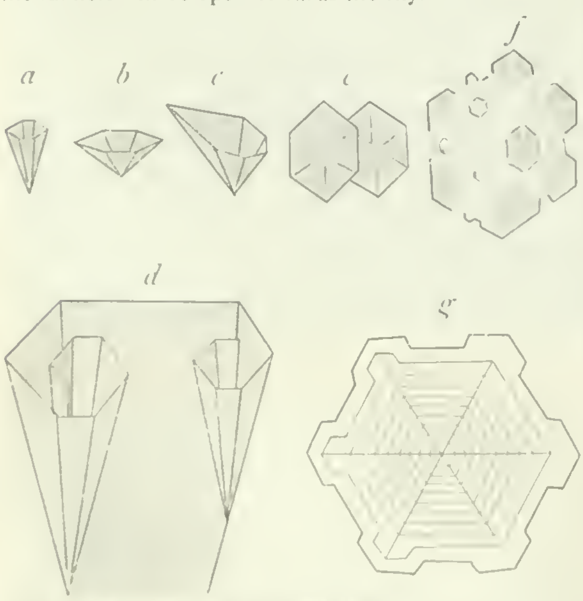

FIG. 3.—Natural Hoar-frost (Christmas [illegible]). (*a* and *f* natural size; *b*, *c*, *d*, *e* and *g* enlarged.)

This type of skeleton crystal may be termed *starvation crystal*.

By reflections from the steps seen on the triangular faces of the pyramids, we were able to show that they consist of combinations of faces of the hexagonal prism (∞ P) and the basal pinacoid (OP).

VI. *Literature.*—In 1697, Camerarius of Tübingen ("De figura nivis et pruinæ." *Misc. ac. natur.* Jenæ, Dec. 1697, p. 480) describes some hoar-frost on the lead bindings of windows as hexagonal discs, some of which had a central depression.

Dr. J. Krenner mentions, in his description of the ice cave of Dobschau ("A Dobsinai Jégbarlang." Budapest, 1874), flat hexagonal ice crystals, some depressed in the middle, or obtusely funnel shaped.

In a paper entitled "Eine Krystallgrotte" (Groth's *Zeitschr. fur Krystallographie*, 1888, xiv. p. 250), C. A. Hering mentions and illustrates fan-shaped ice crystals which probably are identical with those seen by Krenner, except that they are quite flat. On the upper surface of the fans some hexagonal hopper-shaped ice crystals were found.

VII. *Conclusions.*—(1) Water when changing direct from the gaseous into the solid state is highly crystalline.

(2) The tendency to crystallisation is so strong that in those cases where the area of supply is limited by a wall or other surface, skeleton crystals—hexagonal "hoppers"—are formed, growing away from the wall, even under circumstances of excessively slow growth.

(3) Calmness of air seems to be an essential condition for their formation.

(4) From our observations there can be no doubt as to the identity of the ice crystals of Surtshellir, of the refrigerating chambers and ships in Liverpool, and of the cooling cellars of the Berlin breweries, with natural hoar-frost.

THE GLACIAL SYSTEM OF THE ALPS.

ON the day following the close of the Sixth International Geological Congress an excursion, organised and conducted by Profs. Penck of Vienna, Brückner of Berne, and Dr. L. du Pasquier, left Lugano to visit the chief glacial deposits of the Alps. An excellent guide-book of permanent interest, entitled "Le Système Glaciaire des Alpes," had been prepared by the conductors of the excursion.

On the first day (September 17) the party, numbering thirty-five, took train to Sesto Calende, and descending the Ticino in boats, walked over the moraines of Lago Maggiore to Borgo Ticino. An excellent view of the morainic amphitheatre, which forms a loop round the southern end of the lake, and rises to 470 feet above its level, was obtained from the morainic Monte del Bosco. In the evening the party proceeded to Ivrea by rail.

Next day was spent in examining the celebrated moraines of Ivrea, which testify so eloquently to the size of the glacier that descended the valley of Aosta. From the northern morainic ridge (the Serra), which rises to a mean elevation of 1300 feet above the central depression, a good view of the great amphitheatre was obtained. Late at night Milan was reached.

On the 19th train was taken to Lonato at the southern end of the Lake of Garda, whence carriages were taken to Salò, on the western shore of the lake. On the way to Salò, most interesting evidence of three successive glaciations was seen. It is found that the moraines of the last glaciation show only a very thin weathered crust, whereas the moraines of the two previous glaciations are marked by a weathered crust called "ferretto," many feet thick, in which the pebbles, even of granite and gneiss, are so much decomposed as to be readily cut with a knife. The whole weathered crust has assumed a deep red-brown rust colour, whence the Italian name for it.

At Mocasina the unaltered lower part of a moraine of the second glaciation was seen overlying the much-weathered "ferretto" crust of a moraine of the first glaciation. At Benecco the unaltered moraine of the last glaciation overlies the "ferretto" crust of a moraine of the second glaciation. In the evening, Riva, at the head of the Lake of Garda, was reached by steamer.

On the 20th the party took train to Innsbruck. The following day was spent in examining the deposits at Hötting, close by the town.

The breccia of Hötting, considered by Penck a cemented cone of dejection or talus of rock-fragments, contains fossil plants (all but four of existing species). It overlies one moraine and underlies another, and is held to indicate an inter-glacial epoch.

On the 22nd Munich was reached, and some most interesting sections at Höllriegelskreut, seven and a half miles south of the city, were examined. Three successive fluvio-glacial deposits were seen, superposed one upon another, each corresponding to a separate glaciation. Here again the weathered (though not red) crust of the older fluvio-glacial deposits underlies the unaltered lower part of the succeeding deposit. The oldest of the three deposits (viz. the Deckenschotter, *alluvion des plateaux*) consists here almost exclusively of limestone pebbles, which are so solidly cemented together as to form a conglomerate used as a building stone.

The 23rd (last day of the excursion) was rainy, but the morainic amphitheatre of the Isar glacier around the Starnberger (Würm) See, near Munich, was examined as far as the weather would permit, and at the close of the excursion all members joined in an enthusiastic vote of thanks to its most excellent conductors.

B. Hobson.

NOTES.

A few weeks ago the Paris *Figaro* opened a subscription list in order to enable the Pasteur Institute to supply Dr. Roux's anti-diphtheria serum to all medical applicants. The appeal has resulted in a sum equivalent to about £10,000 being raised. It is hoped that institutes in which experienced physicians will administer the cure will soon be established. The Paris Academy of Medicine has reported in favour of Dr. Roux's treatment.

We learn with much regret that Mr. George Knott died at Cuckfield, Hayward's Heath, Sussex, on the 8th inst., at the age of fifty-eight. He was an eminent authority upon double and variable stars, to the observation of which he devoted his astronomical life. So long ago as 1861 he read his first paper before the Royal Astronomical Society, the subject being the variable star R. Valpecula. From that date to April 1892, when he communicated a series of observations of the magnitude of Nova Aurigæ, he contributed no less than twenty-four papers to the Society. In 1877 he completed a valuable series of micrometrical measures of double stars, taken by himself between 1860 and 1873. For many years he was a member of the Council of the Society. He was highly respected by his fellow workers, not only for his astronomical labours, but also for his sterling character. His death will be deeply regretted by all who were acquainted with him.

From a circular bearing the imprint of the University of Minnesota, Minneapolis, we learn that Mr. Clarke Barrows proposes to supply a complete up-to date reference to all zoological literature by means of a card catalogue arranged alphabetically by authors, and supplemented with a subject catalogue. It is proposed to begin the catalogue with the current volumes of the more important periodicals devoting the whole, or a portion, of their space to zoology, to print the new titles as they appear, and take up the back volumes as rapidly as possible. It is hoped that arrangements will soon be made to get the titles of all other important zoological writings, and thus a catalogue of all the zoological literature not recorded in the "Bibliotheca Zoologica" up to 1861 will be produced. Each card will have printed upon it the name of the author of a zoological paper, the full title of the paper, and the name and date of the periodical in which it was published. The cards will be punched so that they can be stacked in drawers with a wire through them. They should be of great assistance to curators of zoological libraries.

The Sunday Lecture Society will commence a new series of lectures next Sunday afternoon, at St. George's Hall, Langham Place, when Sir B. W. Richardson, F.R.S., will discourse on "Muscle and Athletic Skill."

The steam yacht *Windward*, with Mr. Jackson's party on board, which left Archangel on August 5, is reported by the captain of a Norwegian walrus-hunting vessel, but the news is vague, being without exact dates, and the ship does not appear to have been "spoken." She was first seen about the middle of August off Matochkin Schar, the strait separating the two islands of Nova Zembla, where the ice was very heavy; and again about the end of August in lat. 75° 45′ N., and long. 44° E., steaming up a clear lead through rotten ice in the direction of Franz Josef Land.

Mr. A. Trevor-Battye and Mr. Hyland landed on the island of Kolguef, south-west of Nova Zembla, at the end of last June, with the special object of studying the ornithology of the island. His companion, Mr. Powis, returned for him in the steam-yacht *Saxon* on August 6, but not finding him at the landing place considered further search unnecessary and returned. Another Arctic steam-yacht made a remarkably cautious attempt to reach the island at a later date, but returned unsuccessfully, and Mr. Trevor-Battye has been left behind to face the Arctic winter without an adequate outfit. It is probable that when the winter ice unites the island to the continent, he will be able to cross to the mainland, a distance of less than sixty miles, and thence travel overland to St. Petersburg by sledge. It is to be hoped that he will be able to bring back his collections, which should be of considerable scientific value. A rescue expedition is proposed by Captain Battye-Trevor, but it is doubtful whether it can be carried out by sea at this advanced date. There seems no reason for anxiety, as game is usually plentiful on Kolguef, and there are habitable houses used temporarily in summer by Russians and Samoyedes.

We have received a letter, written by Lieut. Peary to the President of the American Academy of Natural Sciences, which contains more detailed accounts of his expedition last season. When on the ice-cap in the spring of 1894, the average air-temperature experienced for forty-eight days was -31.5 F., and the average wind velocity for forty-three days 15·9 miles an hour. During the worst weather there were thirty-four hours with an average temperature of $-50°$ F. and a minimum of $-62°$, the average wind velocity being 48·1 miles per hour. The experience has convinced Mr. Peary that the human frame can stand any degree of natural cold without permanent injury. He intends to spend the coming winter in studying the Eskimo dog, and devising means to keep this invaluable animal alive and in health during extreme cold. There has evidently been some friction amongst the members of the exploring party, most of whom seem to have had enough of Arctic hardships, as the leader refers to the two men who remain with him as those who "decline to desert." The letter concludes: "You may rest assured that I shall not return until I have done everything that is possible for one who believes in ultimate success, and whose every fibre is in sympathy with and straining for the desired end."

We are always glad to welcome any journal having for its object the extension of scientific knowledge; hence we note with pleasure the publication of the first number of the *Agricultural Journal of the Leeward Islands*, edited by Mr. C. A. Barber, the Superintendent of Agriculture at St. John's, Antigua, West Indies. The journal will ensure the rapid and wide publication of the results of investigations of interest to West Indian planters. It will be the medium through which the work carried on in the Government laboratories, and in experimental and botanical stations of the West Indies, will be made public. But besides being the organ of the scientific officers of the Government, the journal will contain reports of the proceedings of the agricultural societies in the colony, and facts of interest connected with the agriculture, natural history, and meteorology of the different islands will be recorded. To the number before us, the editor contributes some notes on the nature of the irritating ticks from which the cattle of the West Indies suffer. The journal also includes an article on the planting of eucalyptus trees; one on hurricanes, by Mr. F. Watts; and a third, on coffee planting in the Leeward Islands. The editor hopes to keep the journal scientific throughout, although it must be made eminently practical. We hope and believe that this addition to periodical literature will take a permanent stand among the scientific journals of the tropics.

The current number of the *Comptes-rendus* contains a paper by M. R. Blondlot, on the propagation of electromagnetic waves in ice, and on the specific inductive capacity of this material. In a previous communication the author had shown that for turpentine and castor-oil the wave-length of the radiation given out by an oscillator, in these substances, is the same as in air; and enunciated the general law that the wave-length depends only on the dimension of the oscillator, and not on the medium in which the oscillator is plunged. There was, however, considerable doubt whether this law would be found to hold in the case of ice, for M. Bouty had found that the specific inductive capacity of ice was 78, that is enormously greater than in the case of any other dielectric. The apparatus employed consisted of two copper wires stretched horizontally and parallel at a distance apart of 80 cm. A resonator made of gilt copper, the same as that employed in the previous experiments on liquids (*Comptes-rendus*, July 25, 1892), was placed between these wires; the portion of the wires beyond the resonator pass through a wooden trough four metres long. This trough being empty, a bridge is moved along the wires beyond the resonator till the sparks disappear, the distance between the bridge and the resonator then being equal to the quarter wave-length of the resonator. The resonator is then surrounded with a water-tight bag filled with freshly-boiled distilled water, which is then frozen. The quarter wave-length is now found to be greater than before, in the ratio of 141 to 100 The trough is then filled with water which is frozen, and by breaking away the ice the place at which the bridge has to be placed in order to stop the sparking found. The wave-length under these conditions is exactly equal to that obtained when the resonator and wire are surrounded by air. The experiment was repeated four times, using resonators of different capacity, and in every case gave the same result. The results obtained can be utilised for calculating K the specific inductive capacity of ice, and give for K the value 2, which value the author considers correct to within about $\frac{1}{5}$. M. Blondlot having mentioned the above result to M. Perot, who, working by means of electric oscillations, had found a very high value for K in the case of ice, the latter examined his results, and found that he had made an error in the formula he employed. Having applied this correction to his results, he now obtains the value 2·04 for the specific inductive capacity of ice.

A recent number of the *Atti della Reale Accademia dei Lincei* contains a paper, by M. Ascoli and F. Lori, on the radial distribution of the induced magnetism in an iron cylinder. The authors have investigated this question experimentally, using cylinders of different lengths in magnetic fields of varying strength. The cylinders employed were composed of 127 iron wires, each of 0·095 cm. in diameter. These wires were regularly arranged round a central wire in layers containing 6, 12, 18, 24, 30, and 36 wires respectively. Between each of the layers was wound a coil of fifty turns of fine insulated copper wire. By means of a series of mercury cups either of these six coils could be connected to a ballistic galvanometer. The authors find that for long cylinders (50 cm.) the distribution is practically uniform, while in the case of shorter cylinders there is an increase in the induction as you pass from the axis to the circumference. This increase is particularly noticeable in the case of short cylinders (5 to 10 cm.), and is greater in the case of strong than of weak inducing fields.

In the *Journal* of the Scottish Meteorological Society (No. x. third series), Dr. Buchan has published a very valuable discussion of the mean monthly and annual rainfall of Scotland for the twenty-five years 1866 to 1890. He points out that of all the climatological elements, rainfall calls for the greatest number of years' observations in obtaining fairly approximate averages. The period of twenty-five years now dealt with, for a large number of stations, and for the same years, may well be accepted as a sound basis for discussion. In addition to the tables, and a discussion of the principal features of each month, the depth of rain for each month and for the year is shown on coloured maps. The part of Scotland where the rainfall is smallest is the low-lying district round the Moray Firth, where the annual amount varies from 23 to 26 inches, the absolutely dryest place being Nairn. Three parts of Scotland have an annual rainfall of upwards of 80 inches, viz. the south-western half of Skye, the highest mean annual fall being 92 inches, at Sligachan. To the west of the Caledonian Canal, in the central parts of Ross-shire and Inverness-shire and the north of Argyll, the average at some stations exceeds 100 inches; and to the south-east of the canal the averages are still larger, amounting to over 127 inches in Glencoe. The work will be referred to as the standard authority on the rainfall of Scotland, and when the publication of similar returns for the United Kingdom, now being prepared by the Meteorological Council, is complete, the distribution of the rainfall of these islands will be fairly accurately determined.

At a recent meeting of the Berlin Physical Society, Herr E. Pringsheim exhibited some examples of the application of photography to the deciphering of "palimpsest" manuscripts. A manuscript contained in the Royal Library at Berlin, on which the process was tested, showed the second writing intensely black, while the older writing, washed off as much as possible to make way for the new, was larger, and showed a yellow tint. The problem was to bring out in a photograph the feeble yellow writing without the later black manuscript, and this was accomplished as follows. A negative was first obtained through a yellow screen, using a long exposure and a flat development. This showed the older writing only very feebly, and the later very well. Another negative was taken with an ordinary bromide plate, was developed into a hard image, and used to obtain a diapositive. This transparency showed both writings with approximately equal intensity. The transparency was then placed upon the first negative so tha the two images coincided. In this case the background was dark in one case and light in the other, as was also the later manuscript. The latter therefore was imperceptible. But the older manuscript was dark in both cases, so that it appeared alone in the combination as an intensely black writing on a shaded ground. The greatest difficulty met with was that of obtaining two perfectly congruent negatives. An apparatus suitable for this purpose, in which the object and the camera were fixed in a definite position in an iron stand, was provided by Herr H. C. Vogel at the Potsdam Astrophysical Laboratory. But perfect coincidence was only obtained on taking the second negative through a glass plate of the same thickness as the yellow glass used for the first.

THE calendar of the University College, Nottingham, for the fourteenth session, 1894-95, has been published; and also the calendar of the University College of North Wales.

PART iii. of vol. vii. of the *Proceedings* of the Bristol Naturalists' Society has just been issued. It contains some of the papers read before the Society during the session 1893-94, and a portrait and short biographical notice of Dr. John Beddoe, F.R.S.

PROF. FRANK CLOWES and Mr. J. Bernard Coleman, of University College, Nottingham, have written a new work on "Elementary Qualitative Analysis," specially for the use of beginners. The book will be published by Messrs. Churchill, early in December.

MESSRS. LONGMANS AND CO. have just published "A Shilling Arithmetic," by J. Hamblin Smith, which is suitable as an introduction to the same author's "Treatise on Arithmetic." The book contains short explanations of arithmetical processes and a large number of simple examples.

MESSRS. MACMILLAN have in preparation a "Popular History of Celestial Photography," by Mr. R. A. Gregory and Mr. Albert Taylor. The book will be divided into twelve sections, each of which will trace the development of the application of photography to a particular branch of astronomical inquiry.

THE *Electrician* Printing and Publishing Co. has lately published the substance of the lecture on "The Work of Hertz," delivered by Prof. Oliver Lodge at the Royal Institution on June 1, and fully reported in these columns on June 7. Twenty-three illustrations have been introduced into the text, and abstracts of the work of some of Hertz's successors are given in appendices.

A MONOGRAPH of the land and freshwater mollusca of the British Isles, by Mr. J. W. Taylor, is in the press, and will shortly be issued. There will be two volumes, the first of which will be devoted to a general treatment of the subject, and the second to the treatment of species individually. Intending subscribers should communicate with Messrs. Taylor Bros., Sovereign Street, Leeds.

THE physical properties of soils are very inadequately described in most text-books. With a view of enabling teachers of agricultural classes to do fuller justice to this part of their subject, Prof. R. Warington, F.R.S., has drawn up a few "Brief Notes on the Physical and Chemical Properties of Soils" (Chapman and Hall). The notes will doubtless prove of great assistance to the science teachers for whom they are intended.

MESSRS. GEORGE NEWNES (Limited) announce that they propose to issue a series of little books dealing with various branches of scientific knowledge, and treating each subject in clear concise language, as free as possible from technical words and phrases. The following three volumes will be issued immediately: "The Story of the Stars," by Mr. G. F. Chambers; "The Story of the Earth," by Prof. H. G. Seeley, F.R.S.; "The Story of Primitive Man," by Mr. Edward Clodd.

STUDENTS of human anatomy should find Mr. Gordon Brodie's "Dissections Illustrated," the third part of which has just been published by Messrs. Whittaker and Co., an invaluable handbook. The dissections illustrated and described in the new part refer to the head, neck, and thorax. There are twenty remarkably fine coloured plates, drawn and lithographed by Mr. Percy Highley, and eight diagrams. The plates are drawn so clearly, and they are so large (five are full size and the rest two-thirds natural size), that the muscles, vessels, and nerves of each dissection can be found without any difficulty.

SHORTLY before the fifth international congress of geologists, a "Geological Guide-book for an Excursion to the Rocky Mountains" was prepared by a number of geologists familiar with the different parts of the region visited, and was edited by Mr. S. F. Emmons. This book has been extracted from the *Compte rendu* of the congress, and is now published separately by Messrs. Kegan Paul, Trench, Trübner, and Co. A number of illustrations have been added to the original, and also many bibliographical references. The result is a capital account of the chief points in the geology of one of the most interesting regions of the world.

A REPORT on meteorological observations in British East Africa for 1893, by Mr. E. G. Ravenstein, has been received. The meteorological records, of which a summary is presented in the report, refer to seven stations on or near the coast, and two in the interior. At all these stations the temperature, rainfall, and other climatological factors have been recorded, and in the case of five of them the records embrace at least one year. Observations of the rainfall only have been recorded at four other stations. Mr. Ravenstein recognises that the observations are as yet far too scanty and imperfect to enable the true means of the temperature, rainfall, and humidity to be deduced.

DR. HARRISON ALLEN has revised and brought up to date his valuable "Monograph of the Bats of North America." The original work was issued nearly thirty years ago by the Smithsonian Institution, and has remained the only work on the subject. The progress made in systematic zoology since that time, however, rendered it desirable to prepare a new edition. The monograph just distributed by the Institution is essentially new. Dr. Allen has added to the species, elaborated the descriptions, and introduced several novel features. These changes have increased the usefulness of a very important work, and they will be welcomed by students of what is recognised to be a difficult group of animals.

MR. GISBERT KAPP has revised and largely rewritten his work on the "Electric Transmission of Energy" (Whittaker and Co.), the fourth edition of which was published last week. Changes were rendered necessary on account of the enormous developments which have taken place in every branch of electric power transmission since the third edition was published. The author has omitted a large amount of the descriptive matter, and has given a greater amount of space to the theoretical part of his subject. Among the omissions are "the historical account of power transmission, detailed descriptions of plants, comparison of electric with other systems of transmission, underground cables, electric tramways, and telpher lines." Altogether the book, as at present constituted, is more scientific, and less a trade catalogue than formerly.

MESSRS. J. J. GRIFFIN AND SONS have recently published the third edition of their illustrated and descriptive catalogue of chemical apparatus. A few of the new instruments are worthy of notice. For instance, a new pattern of Tate's air-pump, described in the catalogue, has been designed with valves at each end of the barrel so that no air can exist between them and the pistons, hence, at each stroke, all the air contained in the barrel is expelled. Metallurgists will be interested in a new form of gas furnace capable of carrying on operations at a white heat without the aid of a blower; the power of the furnace may be judged from the fact that one pound of cast iron can be melted in thirty-five minutes. A cathetometer which enables the operator to turn the telescope in any direction without moving the instrument bodily, is another noteworthy feature. Arnold and Hardy's apparatus for the estimation of sulphur in steel and steel-making iron; benzoline blast furnaces attaining a temperature of 2100° F.; Prof. Roberts-Austen's electrical pyrometer; and many other pieces of apparatus, for use in teaching and research, have been introduced into the catalogue.

A CONSIDERABLE addition to our knowledge of the chemical history of hydrazine or diamide and its derivatives is contributed by Prof. Curtius, its discoverer, and his assistants, to the current issue of the *Journal für praktische Chemie*. An interesting account is given of the position of diamide as a salt-forming base, and its relations in this respect to ammonia and the fixed alkalies. Diamide itself, $\begin{matrix} NH_2 \\ | \\ NH_2 \end{matrix}$, is an extremely unstable substance, so much so that it is still doubtful whether the anhydrous gas has yet been obtained, or is even capable of separate existence. On the other hand, the liquid hydrate, $N_2H_4.H_2O$, is a very stable substance, as Prof. Curtius has long ago shown. It is interesting to note that this is the opposite of what is the case with ammonia, where the gas itself is stable and the hydrate particularly unstable. Moreover, while ammonia is a mon-acid base, diamide is di-acid; and just as we accept the idea of a hypothetical ammonium radicle NH_4, so we are bound likewise to admit the conception of a divalent radicle $\begin{matrix} NH_3 \\ | \\ NH_3 \end{matrix}$, which Prof. Curtius terms diammonium, in the hydrazine salts. Thus the normal chloride of hydrazine is $\begin{matrix} NH_3Cl \\ | \\ NH_3Cl \end{matrix}$ and the sulphate $\begin{matrix} NH_3 \\ | \\ NH_3 \end{matrix} SO_4$. Diammonium would thus seem to be analogous to the divalent metals of the alkaline earths, and the parallel would appear to be further justified by the sparing solubility of the sulphates and their inability to form alums with sulphates of the alumina group. On the other hand, diammonium exhibits properties which point to a close similarity to the alkali metals. For the hydrate behaves in by far the greater number of instances as a mon-acid base, like ammonium hydrate. The neutral chloride above mentioned, $N_2H_6Cl_2$, decomposes below 100° into hydrogen chloride and the chloride $N_2H_4.HCl$, which cannot be made to lose more hydrochloric acid without destruction of the base. The hydrate $N_2H_4.2H_2O_2$ is only capable of existence in solution; it passes on evaporation into the hydrate $N_2H_4.H_2O$, which latter substance boils without decomposition. Dry ammonia gas only displaces half the acid of the sulphate $N_2H_4.H_2SO_4$, and leaves the stable sulphate $(N_2H_4)_2H_2SO_4$. Moreover, Prof. Curtius has only succeeded in preparing one nitrate, $N_2H_4.HNO_3$, and one thiocyanate, $N_2H_4.SCNH$. Hence he concludes that diammonium is capable of acting both in a monovalent capacity as (N_2H_5), and as a divalent radicle (N_2H_6), the former resulting in the production of the more stable salts.

PROF. CURTIUS has succeeded in preparing a large number of double salts containing diammonium, and describes them in a separate memoir in conjunction with his assistant, Herr Schrader. Ammonium, as is well known, forms three classes of double salts containing sulphuric acid, namely, the alums, the double sulphates with $6H_2O$, and the peculiar and as yet little understood salts usually formulated as $R''SO_4.nNH_3$ in which the anhydrous gas is assumed to enter into combination with the metallic sulphate. All efforts to obtain alums containing diammonium sulphate, $N_2H_6SO_4$, have so far failed: but salts of the other two types, containing the more stable sulphate $(N_2H_5)_2SO_4$, are readily obtained. It is somewhat singular, however, that they contain no water of crystallisation, a fact which is possibly explained by the difficult solubility of the compounds. The divalent metals present may be copper, nickel, cobalt, iron, manganese, cadmium or zinc, but not magnesium. They are at once precipitated upon mixing concentrated solutions of the metallic sulphate and diammonium sulphate. It is further remarkable that the latter may be either of the two sulphates of diammonium; indeed, the solution may contain free sulphuric acid. Moreover, the sulphate $N_2H_6SO_4$ is difficultly soluble, while the more stable sulphate $(N_2H_5)_2SO_4$ is deliquescent, and yet the sparingly soluble double salts always contain the deliquescent diammonium sulphate. In addition to these, salts of the type $R''SO_4.2N_2H_4$ and $R''SO_4.3N_2H_4$ have been obtained; in those of the former type R″ may be zinc or cadmium, corresponding to the ammonia compounds $R''SO_4.4NH_3$, and in those of the latter type nickel or cobalt, these salts being analogous to the well-known compounds $NiSO_4.6NH_3$ and $CoSO_4.6NH_3$. In direct opposition to the ammonia compounds, the salts containing anhydrous hydrazine are almost perfectly insoluble in water.

THE additions to the Zoological Society's Gardens during the past week include two Pig-tailed Monkeys (*Macacus nemestrinus*, ♂ ♀) from Java, a Vervet Monkey (*Cercopithecus lalandii*, ♀) from South Africa, presented by the Rev. Sidney Vatcher; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. E. Logan; a White-backed Piping Crow (*Gymnorhina leuconota*) from Australia, presented by Miss Vincent; a Manx Shearwater (*Puffinus anglorum*) from Cornwall, presented by Mrs. E. S. Smith: two Robins (*Erithacus rubecula*), South European, presented by Mr. A. T. Binny; a Chameleon (*Chamaeleon vulgaris*) from North Africa, presented by Mr. W. L. Strong; a Deadly Snake (*Trigonocephalus atrox*) from Trinidad, presented by Dr. A. Strading; a Yak (*Poephagus grunniens*, ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE RIO DE JANEIRO OBSERVATORY. The Brazilian National Observatory, situated on the Morro do Castello, the most easterly hill of Rio de Janeiro, is to be removed. The *American Meteorological Journal* reports that the unfavourable situation of the Castello for astronomical observations has led to the selection of a site across the bay, near Petropolis, at an elevation of about 3500 feet. A road is now being built up the mountain, and it is hoped that the new observatory will be completed within two years. The sum of five hundred thousand dollars has been voted by the Government for the installation.

OBSERVATIONS OF MARS.—The current number of the *Observatory* contains a short article in which Mr. Stanley Williams directs attention to certain important features of Mars, which, it will be remembered, is in opposition on Saturday. With regard to the canals or channels, he remarks that a few points upon which observations are desirable are: "How far is the visibility of the canals in different parts of the planet affected by seasonal changes? Their duplication, when does it occur? How long does it last? How does it occur? And again, how far is it subject to seasonal changes?" Mr. Williams commenced observations in the latter part of August, and he found that the plainer canals were conspicuous, and even those of average distinctness could be seen without much difficulty. At the date of writing (September 18) he had observed about thirty of the canals, although only about two-thirds of the planet's face had been examined. *Ganges* was seen double on August 29, but not so clearly as in 1892. *Gehon* was also seen plainly double on the same date. Three other canals—*Eunostos*, *Cyclops*, and *Cerberus*—were found distinctly duplicated, and the germination of *Phison* was suspected. The observations were made almost exactly at the time of the summer solstice of Mars' southern hemisphere. Mr. Williams has observed a few small dark spots similar to the "lakes" detected by Prof. W. H. Pickering at Arequipa in 1892.

THE MASS OF MERCURY.—M. Backlund's recent researches on the mass of the planet Mercury, and the acceleration of the mean movement of Encke's comet, are described by M. Callandreau in *Comptes-rendus* of October 1. Encke's comet is interesting not only on account of the diminution of its period of revolution (about two hours from one apparition to the next), but also from the fact that its movement is disturbed by Mercury. A discussion of the seven apparitions of the comet between 1871 and 1891 has led M. Backlund to conclude that Mercury has a much smaller mass than has hitherto been ascribed to it. The value obtained is

$$\text{Mass of Mercury} = \frac{1}{9{,}647{,}000}.$$

It would, therefore, take about 9,700,000 bodies like Mercury to make up the mass of the sun.

To account for the acceleration of Encke's comet, it has been supposed that a resisting medium of some kind is uniformly distributed round the sun. M. Backlund, however, thinks that all hypotheses of a continuous resisting medium of uniform density ought to be discarded, and that the resistance is very probably met only in certain regions. This idea is a very plausible one, for, according to Laplace's hypothesis, in the formation of the planets from the solar nebula, all the substance of the rings would not be used up in the process, and some of it would without doubt travel along the planetary orbits as clouds of very light material. It is suggested that Encke's comet passes through nebulous clouds of this kind, and that the resistance they offer causes the observed acceleration of the mean motion.

BRORSEN'S COMET 1851 III.—This comet first appeared in the month of August 1851, moving in the constellations of Bootis and Draco. On forty-one evenings observations were made, besides numerous measures of position with micrometers, and many have been the attempts to deduce an accurate orbit. Among these may be mentioned Rumker (*Astr. Nach.*, No. 771), Vogel (*Astr. Nach.*, No. 774), Brorsen (*Astr. Nach.*, No. 775), and Tuttle (*Astr. Journal*, II.), who found parabolic elements, none of which satisfied the observations sufficiently. At a later date Brorsen obtained elliptical elements (*Astr. Nach.*, No. 782), which he compared with all the then known observations. In the communication before us, on a new determination of the orbit of this comet by Dr. Rudolf Spitaler (lxi. *Denkschriften der Math. Naturwiss. Classe der k. Ak. der Wissenschaften*), the writer makes use of some new observations and more accurate places for the camparison stars. To limit this note we will state in a few words the result he has obtained. The most probable parabolic elements after two or three "verbesserungen" were

$$\tau = 1851 \text{ August } 26{\cdot}2523 \text{ Paris Mean Time.}$$

$$\left.\begin{aligned} \pi &= 310^\circ\ 57'\ 23''{\cdot}7 \\ \Omega &= 223\ 40\ 21{\cdot}2 \\ i &= 38\ 12\ 57{\cdot}5 \end{aligned}\right\} \text{Eq. } 1851{\cdot}0.$$

$$\log q = 9{\cdot}9933272$$

An attempt to improve this led to elliptic elements as follows:—

$$\tau = 1851 \text{ August } 26{\cdot}249997 \text{ Paris Mean Time.}$$

$$\left.\begin{aligned} \pi &= 310\ 57\ 19''{\cdot}2 \\ \Omega &= 223\ 40\ 33{\cdot}9 \\ i &= 38\ 12\ 52{\cdot}9 \end{aligned}\right\} \text{Eq. } 1851{\cdot}0.$$

$$\log q = 9{\cdot}9933235$$
$$e = 0{\cdot}9999151$$

Both these elements give ephemerides which agree well with the observations, and can be looked upon as accurate within the limit of error of the observations.

M. PAPAVASILIORE ON THE GREEK EARTHQUAKES OF APRIL, 1894.[1]

THE earthquake series to which this abstract refers consisted of two principal shocks and a large number of minor ones, the former felt throughout all Greece and far beyond, but chiefly affecting the north-east region of continental Greece, and especially the province of Locris.

The first great shock occurred on April 20, and was registered by a seismoscope at the observatory of Athens at 6h. 52m. p.m., Athens mean time. The region in which much damage was done may be divided into three principal zones. (1) The epicentral zone, comprising the peninsula of Ævolymion (west of Cape Theologos). Three villages were completely destroyed; 180 persons were killed, and 27 wounded. (2) The zone in which nearly all the buildings were overthrown. This is in the form of an ellipse whose major axis is 28 km. long, and extends in a south-east and north-west direction from the Bay of Larymne to near Cape Arkitza; the minor axis is 8 to 9 km. in length. Nine villages were affected; 44 persons were killed, and 20 wounded. (3) The zone in which houses were much damaged or partially fell, also in the form of an ellipse. The major axis is 90 km. in length, directed south-east and north-west, and reaches from Dritza to near Molos. The minor axis is 65 km. long, and extends from Levadia to Mantoudi in the Island of Euboea.

During the night of April 20–21, the ground in the first and second of these zones was in a state of almost incessant disturbance, interrupted often by stronger shocks. For three days shocks were very frequent throughout all three zones; then they became more and more rare until, on April 27, a second great shock occurred, more violent than the first, and registered at the Athens Observatory at 9h. 21m. 6s. p.m., Athens mean time. The same continual disturbance of the ground followed as before.

This second shock disturbed a greater area than the first. The major axis of the second zone is 30 km. longer, especially towards the north-west; it reaches from the Bay of Scroponeri to St. Constantin. The major axis of the third zone is lengthened by about 22 km. to the town of Lamia. The minor axes of these zones are also several kilometres longer, especially on the south-west side. The same villages suffered, but the amount of damage was greater.

This earthquake was a remarkable one in several ways. At the moment of the shock, the sea rose in a wave which submerged the whole coast from the Bay of St. Theologos to St. Constantin. The water afterwards retired, except in the Plain of Atalante, where the greater part of the coast is now submerged for a distance of some metres. Several springs have ceased to run, while others have increased their flow. New thermal springs have started up at Ædipsos, near pre-existing ones, and similar in nature. Numerous fissures, occasionally some kilometres in length, have been formed.

But the most remarkable phenomenon of all is the production of a great fissure about 55 km. long. Its breadth varies from a few centimetres to three metres, according to the nature of the ground, being on an average about half a metre. It extends in a constant east-south-east and west-north-west direction from the Bay of Scroponeri through Atalante, until it disappears near St. Constantin. This fissure appears to be a fault, on account of (1) its extraordinary length and its parallelism to the Gulf of Euboea; (2) the constancy of its direction and its independence of geological structure; and (3) the existence of both a throw and horizontal displacement along the fissure, causing a lowering of the Plain of Atalante and a slight shift towards the north-west. The throw is generally very small, often zero on Cretaceous ground, reaching several centimetres on the Tertiary formations, and as much as 1½ metres on the alluvial beds of the Plain of Atalante.

M. Papavasiliore regards this fault as one of the series which, at the end of Tertiary or beginning of Quaternary times, gave rise to the Gulf of Euboea, and the recent earthquakes as due to orogenic movements by which the width of the gulf may in future be still further increased.

C. DAVISON.

[1] Abstract of two papers by M. S. A. Papavasiliore: (1) "Sur le tremblement de terre de Locride (Grèce) du mois d'avril 1894"; (2) "Sur la nature de la grande crévasse produite à la suite du dernier tremblement de terre de Locride"—*Comptes rendus*, vol. 119, 1894, pp. 112-114, [illegible]

THE AFFILIATED SOCIETIES OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

In the general report of the Brooklyn meeting of the American Association for the Advancement of Science, given in these columns on September 6, it was pointed out that a marked feature of recent meetings has been the increasing number of affiliated societies which hold meetings in connection with the Association. A useful purpose may be served by recording the communications made to these Societies.

The following papers were down in the programme of the American Mathematical Society:—Theorems in the calculus of enlargement, by Dr. Emory McClintock; on the expression of the roots of algebraic equations by means of series, by Dr. Emory McClintock; elliptic functions and the Cartesian curve, by Prof. Frank Morley; concerning the definition by a system of functional properties of the function $f(z) = \frac{\sin \pi z}{\pi}$, by Prof. E. Hastings Moore; Bertrand's paradox and the non-Euclidean geometry, by Prof. George Bruce Halsted; analytical theory of the errors of interpolated values from numerical tables, by Prof. R. S. Woodward; upon the problem of the minimum sum of the distances of a point from given points, by Prof. V. Schlegel; on the fundamental laws of algebra, by Prof. Alexander Macfarlane; about cube numbers whose sum is a cube number, by Dr. Artemas Martin; reduction of the resultant of a binary quadric and m-ic by virtue of its semicombinant property, by Prof. Henry S. White.

The Society for the Promotion of Engineering Education had papers and discussions upon a number of interesting matters. Promoters of technical education in Great Britain will see, from the following list of subjects, that the matter is considered from many points of view in America.

Among the subjects discussed were:—Entrance requirements common to all engineering schools, by F. O. Marvin; engineering education and the State University, by W. M. S. Aldrich; text-books considered as such and not as works of reference, by C. H. Benjamin; graduate and post-graduate engineering degrees, by Palmer C. Ricketts, Geo. F. Swain, and Robert H. Thurston; teachers and text-books in mathematics for engineering students, by Mansfield Merriman; teaching engineering specifications and the law of contracts, by J. B. Johnson; teaching mechanical drawing and lettering in engineering schools, by J. J. Feather; early instruction in physics and mechanics, by C. M. Woodward: some German schools of engineering, by Storm Bull; the organisation and conduct of engineering laboratories and the equipment of the laboratories at the Massachusetts Institute of Technology, by Gaetano Lanza; electrical engineering laboratories, by D. C. Jackson.

The Civil Engineering section of the Society had papers and discussions on:—Minimum laboratory work and equipment in a civil engineering course, by Dwight Porter; a few mistakes in the conduct of college field practice, by O. V. P. Stout; the teaching of structural engineering, by Edgar Marburg; relation of practical to theoretical work in civil engineering courses, by Olin H. Landreth: the education of civil engineers for railroad service, by C. Frank Allen.

The subjects brought before the Mechanical and Electrical Engineering section were:—Mechanical laboratory work at Ames, Iowa, by G. W. Bissell: amount and kind of shop-work required in a mechanical engineering course, by C. W. Marx; teaching machine design, by J. H. Barr.

The programme of the Society for the Promotion of Agricultural Science included the vitality of seeds of red clover and of seeds of weeds, by W. J. Beal; the Russian thistle in Nebraska, by C. E. Bessey; climate in its relation to rust, by L. H. Pammel; (1) a possible relation between blights and exceptional weather; (2) notes upon field experiments, by B. D. Halsted; crimson clover, some observations in reference to methods and times of seeding, by E. B. Voorhees; the growth of lettuce as affected by the physical properties of the soil, by B. T. Galloway; canaigre, its cultivation and preparation for market, by F. A. Gulley; the effect of different fertiliser constituents upon the composition and combustibility of tobacco, by H. J. Patterson; the oil of the black walnut, by W. E. Stone; nurseries as factors in the distribution of insect pests, by J. B. Smith; Bordeaux mixture as a remedy for flea beetles on potatoes, by L. R. Jones; an inquiry into the relation existing between the Burrill disease of corn and the so-called "cornstalk disease" of cattle, by V. A. Moore; a simple milk-sampling tube, by M. A. Scovell.

The following papers were read before the Geological Society of America:—The nickel mine at Lancaster Gap, Pa., and the pyrrhotite deposit at Anthony's Nose, on the Hudson, by J. F. Kemp; a connection between the chemical and optical properties of amphiboles, by Alfred C. Lane; on a basic rock derived from granite, by C. H. Smyth, jun.; the process of segregation as illustrated in the New Jersey Highlands, by Ralph S. Tarr; alunogen and bauxite of New Mexico, with notes on the geology of the Upper Gila region, by Wm. P. Blake; a study of the cherts of Missouri, by Edmund Otis Hovey; use of the aneroid barometer in geological surveying, by Charles W. Rolfe; platycnemic man in New York, by Will H. Sherzer; oil and gas in Kansas, by Erasmus Haworth; dislocations in certain portions of the Atlantic coastal plain strata and their probable causes, by Arthur Hollick; faults of the region between the Mohawk river and the Adirondack mountains, by N. H. Darton; reconstruction of the Antillean continent, by J. W. Spencer; evidences as to the change of sea-level, by N. S. Shaler; the extension of uniformitarianism to deformation, by W. J. McGee; Tertiary and early Quaternary base-levelling in Minnesota, Manitoba, and north-westward, by Warren Upham; departure of the ice-sheet from the Laurentian lakes, by Warren Upham; the drumlinoid hills near Cayuga, N.Y., by Ralph S. Tarr; drumlins in the vicinity of Geneva, N.Y., by D. F. Lincoln: channels on drumlins, caused by erosion of glacial streams, by George H. Barton; review of our knowledge of the geology of the Californian coast ranges, by Harold W. Fairbanks; the geological history of Missouri, by Arthur Winslow; the magnesian series of the North-western States, by C. W. Hall and F. W. Sardeson; the stratigraphy of the St. Louis and Warsaw formations in South-eastern Iowa, by Charles H. Gordon; the Permo-carboniferous and Permian rocks of Kansas, by Charles S. Prosser; the Trias and Jura of Shasta County, California, by James Perrin Smith; cenozoic history of a portion of the middle Atlantic slope, by N. H. Darton.

A number of papers were read before the Association of Economic Entomologists, and the president, Prof. L. O. Howard, delivered an address on "The Rise and Present Status of Official Economic Entomology."

Prominent among the Societies that met in connection with the American Association is the American Chemical Society, having a membership of nearly eight hundred. The following were among the papers read:—Recent progress in the detection of adulteration in lard, by H. W. Wiley; Ucuhuba fat, by Joseph F. Geisler; oxidation of non-drying oils by air, by Walter D. Field; a new and rapid method of estimating the total proteids in milk, by E. H. Bartley; inspection of cotton for use in gun-cotton manufacture, Chas. E. Munroe; ferric acid and the ferrates, by C. A. O. Rosell; some points in making molybdate of ammonia solutions for phosphorus determinations, by Charles B. Dudley; report on abbreviations of the names of metric terms used by chemists, by Wm. H. Seaman.

In the course of an interesting address delivered before the American Association of State Weather Services, Major H. H. C. Dunwoody, the acting chief of the National Weather Service, remarked that the three thousand voluntary observers who take observations of temperature and rainfall, and record miscellaneous meteorological phenomena, render it possible to supply, through the State Weather Service, climatological information for almost any locality in the United States. Nearly every county in the whole country is now provided with a station equipped with instruments of the Government standards, and if the work of establishing new stations continues during the next two years at the same rate as during the past two years, there will not be a county within the limits of America that will not have a meteorological station.

The weather crop service of the National Bureau now undoubtedly ranks next in importance to the work of making forecasts. The system of gathering reports upon which the weather crop bulletins are based has been so perfected in recent years, that further improvement in some States can scarcely be expected. The crop bulletins of the States have been improved, and are now more complete than at any previous time, and the increased circulation that these bulletins has attained amply attests their value. It is believed that there is no other class of information to which so much space is at present devoted in the public press of America.

More than 10,000 crop correspondents are to day co-operating with the National Weather Service through the State organisations; 3000 voluntary observers are furnishing monthly reports of daily observations of temperature and rainfall; and over 11,000 persons assist in the work of distributing the weather forecasts of the National Weather Service. This latter work has been more rapidly pushed during the past year than any other feature of State Weather Service work, and it is expected that during the ensuing year the already large number of communities receiving the Government weather forecasts will be further increased from 5000 to 6000. With a continuation of the present liberal policy of the Secretary of Agriculture and the Chief of the Weather Bureau towards these services, there will be in a comparatively short time no important agricultural community in the United States, with the proper mail facilities, that will not receive the benefits of the forecasts.

The monthly reports of many of the States are model publications of their kind. It is to be hoped that in those States where as yet the more approved methods of publishing meteorological data are not practised, means may be improved and raised to the standard attained where better facilities have been available. Uniformity in size, as far as practicable, and strictness as to tabular data, is very desirable. A daily record of temperature and rainfall for purposes of detailed investigation is most essential, and these should, if possible, form a part of each report.

The following papers were read before the American Forestry Association:—The forests of Alaska, by William H. Dall; the forests of the Shenandoah Valley, their origin and present condition, forestal areas in West Virginia, by Major Jed Hotchkiss; forests in New Jersey, by Prof. John C. Smock; the petrified forests of Arizona, by Horace C. Hovey; the Adirondack Forests, by Verplanck Colvin; the condition of our public timber-lands and forest reservations, by B. E. Fernow; what the people should learn about forestry, by Prof. Selden J. Coffin; tree-planting, by George H. Minier; forest fires in New Jersey, and some notes in methods of protection, by John Gifford; the prevention of forest fires, by General C. C. Andrews; prairie forestry, by Prof. L. H. Pammel; observations on the destructive effects of drying winds and the protection afforded by woodlands and wind breaks, by Prof. F. H. King; Does the rain-gauge settle the problem? by J. O. Barrett; the conservation of soil and water supply of hill countries in cultivated areas, by Thomas J. McKie; black walnut for economic tree-planting, by B. G. Northrup; Western pine timber-lands, by H. C. Putnam; economics in railway ties, by E. E. Russell Tratman; forest fungi and an anthracnose of the poplars, by Prof. Byron D. Halsted; the relation of insects and birds to certain forest conditions, by A. D. Hopkins.

B. E. Fernow called attention to the necessity of following up the policy begun through the efforts of the Association of reserving forest tracts of public timber-land with measures for a rational use of the same. Considerable discussion followed, resulting in the unanimous adoption of the subjoined resolution:

"Resolved, that the American Forestry Association desires to express again emphatically its approval of the efforts of the Public Lands Committee of the House of Representatives, and its chairman, the Hon. Thomas C. McRae, for the enactment of a law providing for the care and protection, not only, but for the rational use also, of the timber and other resources in the forest reservation, and on all public timber-lands. The policy of reserving can hardly be considered an advantage to the forestry interests unless followed up by an intelligent and efficient administration of the reservations, since deprived of the incidental protection. This Association emphatically denies that it advocates in the policy of forest reservations the unintelligent exclusion of large territories from actual use of the resources contained therein; but on the contrary, it reiterates that it conceives that by the reservations made for the purpose of their use—rational use—under restrictions and control which come from private interests in expectation of possible occupancy and uncared for by the rightful owner, the Government, the door is opened to greater destruction and depredation than before. We therefore desire to impress upon our representatives in Congress the urgency of making provisions for the better care of the public timber and other resources, as urged heretofore by this Association."

RECENT EXPLORATION IN BRITISH NEW GUINEA.

AT the ordinary monthly meeting of the Royal Geographical Society of Queensland, on August 20, the President (Mr. J. P. Thomson) read a paper on recent exploration in British New Guinea. The paper was a continuation of one read by the Governor at the Hobart meeting of the Australasian Association for the Advancement of Science in January, 1892. Since then several tracts of new country have been visited, and geographical knowledge of it has been increased by the detailed examination made by Sir William MacGregor of the extensive river systems of the Papuan Gulf, and his more recent exploration of the hitherto unknown parts of the north-east coast. The following extracts from Mr. Thomson's paper are reprinted from the *Brisbane Courier*.

For nearly half-a-century it had been known to geographers that several rivers existed in the neighbourhood of the Papuan Gulf. The Aird, especially, was noticed by the officers of H.M.S. *Fly* some forty-seven years ago, and more recently several channels were opened up by Mr. Theodore Bevan, whose investigations in British New Guinea were chiefly confined to this part of the country. Although these were nothing more than superficial surveys of a mere coastal fringe of the Gulf district they were the means of drawing attentioo to an exceedingly interesting and important part of the Possession. Here we are made acquainted with a tract of country north of the Fly estuary, cut up by almost bewildering labyrinths of tidal channels that constitute the mouths of several important rivers, which traverse enormous areas of rich agricultural as well as low, swampy, land. To intending settlers in British New Guinea this easily accessible region offers many inducements not readily met with in other parts of the Possession. Ample facilities for inland communication exist in several of the deep-water channels along the coast, while the recently explored Purari River flows through a region possessed of many attractive features of hilly and mountainous country. Along most of the watercourses native villages are thickly scattered, and these are inhabited by numerous tribes of powerful and warlike natives, who on several occasions have opposed the friendly advances of Europeans with formidable hostility. The houses, too, are truly remarkable for their large dimensions and massive architectural structure; dwellings of from 300 ft. to 400 ft. in length and over 100 ft. high being by no means uncommon. Next to the Fly the Purari is the largest river in the Possession. It enters the sea by several large channels. In the inland reaches above tidal influence it traverses some rough, hilly country, flowing almost parallel to and skirting the base of a mountain range 1500 ft. to 2500 ft. above sea level. This river was explored by Sir W. McGregor in January and December 1893. Its average width is about 250 yards. To the north lie a range of mountains 3000 ft. to 4000 ft. high, and southerly the country is greatly broken up by low rugged hills. To the westward the main range is visible at a distance of from fifteen to twenty miles, with its bold serrated perpendicular peaks. There is very little flat land here between the hills and the mountain spurs, although sago palms are more numerous than in some parts of the country lower down the river. The geological formation consists of sandstone associated with nodules of gray limestone. At the Aure junction, some eighty miles from the sea, the Purari receives its first considerable tributary. The width of this branch is from 80 to 100 yards, with a depth of one to two fathoms. Above its junction with the tributary the Purari maintains a general course along the main mountain range, the southern spurs of which it skirts very closely. Here the general character of the country, on the south side of the river, is a continuous succession of low sandstone hills, little more than 800 ft. high. These are rugged and precipitous, covered by dense forest. There are, however, no large trees. There was no appearance of any permanent native occupation in this district, and owing to its rugged nature the country did not seem adapted for European settlement. Several specks of gold were found in the bed of the river, and an important discovery of coal was also made near the island of Abukiru, in the main channel of the Purari River. As it is thought that the presence of coal in this district may greatly influence the future of the country, it has been proposed to arrange for a detailed examination of the locality. The people are bronze coloured, a few being lighter than the Port Moresby natives, and all lighter than those of the Purari delta. West of the Purari delta, between the mouths of the Fly and Aird Rivers, lie three important streams, the Omati, Turama, and Bamu. These traverse enormous areas of low-lying country. Concerning each of these rivers, Mr. Thomson gave some interesting details, the result of Sir William MacGregor's explorations. Continuing, he remarked: "The exploration of the lower Bamu basin, besides throwing a flood of light upon a hitherto unknown part of the country, reveals to us a condition of things not easily understood, and rarely met with in any other district of the Possession. Here no cultivated areas were seen, although the soil is exceedingly rich and abundantly watered. The people appeared to live entirely on sago. Bananas were growing wild amongst the rank forest vegetation, but there were no signs of sugar-cane or sweet potatoes. A fair idea of the richness of the land in this district may be obtained when it is stated that there is nothing to be compared with it in the Fly basin within 400 miles of the sea. It is high and dry and in every respect eminently suitable for extensive and systematic cultivation, there being a much larger area of good available agricultural land than Sir W. MacGregor had 'seen elsewhere in the Possession.' This district could no doubt be thrown open to European settlement without in any way infringing existing native rights." Mr. Thomson then dealt with some of the newly-discovered features on the north-east coast of the possession examined by Sir William MacGregor during the months of February and March last. "Recent detailed examination of some hitherto unexplored parts of the coast-line," said the writer, "has discovered the existence of several navigable streams of considerable importance, while a traverse of the coastal section between Ipote and Dako shows that there are numerous sheltered channels among many coral islands along the shore of the bay. These will be available for trading crafts in all kinds of weather. Passing on from this part of the coast-line, an examination was made of the mouth of a stream slightly north of the Clyde river, within the German territory. From observations of ten pairs of meridian stars the latitude of this stream was found to be 7° 58′ 30″ S., taken at the place where it enters the sea. It is a comparatively small watercourse, forty or fifty yards wide on the lower reaches. The natives here are of a dark bronze colour and quite naked. The hair is worn in ringlets, and removed from the face. Their ornaments consist of Job's tears, earrings of turtle shell, and head tuffs of cassowary feathers. They were armed with spears of palmwood, Gothic shaped shields nearly 3 feet long, and stone clubs. At first they were friendly, but afterwards appeared hostile. The next river to claim attention is called the Mambare. This is simply one of the mouths of a river known as the Clyde, of the Admiralty charts. It lies about two miles within the British territory, and in the lower part traverses some good alluvial land, abounding with remarkably fine fields of sago palms. The river was navigable by the steam launch for the first forty miles, where further progress was impeded by rapids, and some few miles farther the channel is simply a succession of deep pools. Below the rapids some extensive areas of very fine alluvial land were met with, and the forest trees so high that the birds on the upper branches bade defiance to the marksman's firearms. Above the rapids the country was broken, and little agricultural land was to be seen. The district possesses a very fine climate. Sandflies and mosquitoes were entirely absent, and the early morning atmosphere was decidedly cool and bracing. The people have well-cleared and cultivated gardens, in which they plant taro, sugar-cane, edible hibiscus, yams, and bananas; but there were apparently no tobacco, papaya, nor pumpkins. Several villages were located on the banks of the river, some of which are situated in the midst of beautiful groves of cocoanut and betel palms. The only ornamental shrubs met with consisted of a remarkably fine variety of light yellow crotons of great beauty. Ordinary watercresses were met with at one of the villages, but they were seen at no other place on the north-east coast. The men were profusely ornamented with shells, pigs' teeth, Job's tears, cassowary feathers, red seeds, and bones. Some of the women wore a necklace or two, others a narrow mat work belt, but they were clothed with nothing else. In this part of the country they use the password 'Orokaiva,' meaning 'man of peace.' They use an adze of basalt. Their pottery is not well prepared. It is without ornament, thick, and slightly conical in shape. The people seemed to be industrious agriculturists, growing food for the entire population. They possess a great number of canoes. Sir William MacGregor is of opinion that some good agricultural land could be obtained for European settlement without interfering with native occupation, and he further believes that the natives would welcome European settlers who would be prepared to treat them fairly." The next place visited was a small sluggish river, fifty to sixty yards wide, and two fathoms deep, called the Ope or Opera. The position of its mouth was found to be lat. 8° 18′ 16″ S., and long. 148° 11′ 25″ E. It is convenient for watering ships and of value to traders. Several villages were seen in the neighbourhood, and there was evidence of a large population of friendly natives. The men were nude, but the women were covered by a petticoat of native cloth. They were armed with spears and stone clubs, ornamented with wreaths of convolvulus and red hibiscus. They danced, sang, and shouted, but appeared to be very friendly. To the south of this district the Kumusi River flows into Holnicot or Gona Bay, in lat. 8° 28′ S., and long. 148° 16′ E. The mouth is obstructed by a bar, some four feet below the surface. Most of the land on the lower part of this river is low and unfit for European cultivation, although considerable areas of alluvial deposits are occupied by many native gardens, and there are fine fields of sago palms. The highest point reached was about forty-six miles from the sea, by traverse, or lat. 8° 35′ S. and long. 148° 0′ 20″ E., where further progress was barred by rapids. Here the country "was without exception the most attractive" Sir W. MacGregor had "seen in New Guinea." Extensive tracts of splendid alluvial land stretched far and wide along the river valley, covered by forest trees, and to all appearance above the reach of flood. These flats occupy what was formerly the river bed, as indicated by the sandy substratum. Some six miles from the river lay one of the central main mountain ranges, the intervening space being occupied by small mountain streams, numerous rolling wooded hills and flats. At night the air was pure and delightfully cool. Great reluctance was felt at having to leave such a district, where the scenery is of a very fine description. There is apparently a large population here, but the people would no doubt be friendly. When descending the river the steam launch *Ruby* collided with a treacherously concealed snag and foundered. This unfortunate accident compelled the party to travel down an open unprotected coast in the whale and river boats. The Kumusi natives were unusually interesting. They are from a light to a dark bronze colour, not remarkably powerful people, but of fair Papuan physique. Their foreheads are square and rather high, with hazel eyes of fair size, large mouth, small chin, and flat cheeks and chests. The nose resembles that of Port Moresby, only slightly shorter, and the nostrils rather coarser. Both sexes wear cloth of mulberry bark. They use stone clubs, the disc and the pineapple pattern, the palmwood spear with square-shaped sharp end and barbs on one side only, and small Gothic shields, with a few examples of the great shield of Orangerie Bay. The stone clubs and adzes are made of basalt. They have no tobacco growing in their gardens, and were ignorant of its use. Their canoes are similar to those on the Ikore and Mambare Rivers. It was found that a river of considerable size enters the sea at Cape Sudest, but unluckily a bar closes its entrance to navigation. The natives call it Tambokoro. The position of Cape Sudest was determined astronomically, and found to be in lat. 8° 44′ S. and long. 148° 25′ 30″ E. In Dyke Acland Bay three streams were discovered—Kevoto and Umundi Creeks and the Musa River. The mouth of the first of these lies in lat. 9° 4′ 55″ S. and long. 148° 33′ 20″ E. Both creeks are of little importance. The lower part of the Musa River traverses low, swampy country, covered by water when the river is flooded. When ascending this stream the Administrator passed within a few miles of the western peaks of Mount Victory. "It has three principal summits, the western one of which is at present quiescent." Ashy-looking deposits were observed among the rocks on the others, and several large fumeroles, out of which little spiral clouds of smoke were issuing. The highest point reached on the river was about thirty-five miles from the sea in lat. 9° 19′ 10″ S. and long. 148° 53′ 43″ E. Here the stream was about 100 yards broad, three fathoms deep, and the current two to three knots per hour. This place was evidently on the margin of a settled country. The banks of the river were beginning to rise, and the capacity of the channel was about sufficient to carry the water. The forest trees were very large. What the upper portion of the

Musa basin may be is at present unknown, but the lower part appeared to be of little value. Several villages occupy the flooded country on the banks of the river; the houses are built on stilts a few feet above the water. The natives were friendly, but naturally shy and suspicious. They excel in making native cloth, many specimens of which were obtained. Their dead are interred in the villages, the graves being covered with a neatly thatched cage. They use palmwood spears, stone clubs, and adzes of jade. Both sexes wear a native cloth. The men wear the hair long, hanging down the back. They cook their food in clay pots, and eat lime and betel nut. The men were fairly strong and of good physique, but many were suffering from ringworm and hydrocele. They were anxious to trade, and offered adzes, clay pots, and sago for plane-irons. Some very remarkable pottery was obtained on the north-east coast. The examples are bowl-shaped with outside raised designs, not previously seen in any other part of British New Guinea. Besides these explorations the discovery of Pennegwa Harbour in the extreme north-east of Rossell Island, and a safe anchorage at Mabudaun, which very greatly increases the value of the western portion of the Papuan territory, were described. Mr. Thomson, by means of a map, indicated the territory dealt with in his paper, and at its conclusion a few pictures appropriate to the occasion were thrown on to the screen by Dr. Thomson.

In the course of some remarks, Sir William MacGregor suggested that Mr. Thomson might follow up his paper with another. The one he had just read did not embrace all the latest work that had been done. His (Sir William's) dispatches had not all been printed; in fact, he questioned whether some of them had yet reached his Excellency the Governor. There was a great deal of information which might be included in such a paper. For instance, Mr. De Vis had been examining a number of new and interesting native birds; Baron Von Muller had got a lot of new plants; but perhaps the most interesting, because the most practical, was the work being done by Mr. Jack and Mr. Rands. The geological specimens he had brought from the Purari River indicated a very large district in which there were very rich coal formations. The fossils that were under examination would show very clearly, he thought, the age of the deposit.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—In the lists of lectures announced for the present term, the most noteworthy feature is the removal of the subject of Anthropology from the list of the Faculty of Natural Science, and its insertion under that of Literæ Humaniores. The titles of the Anthropological lectures are "The Intellectual Development of Mankind," by Dr. Tylor; "The Elements of Physical Anthropology," by Prof. A. Thomson; and "Primitive Musical Instruments," by Mr. H. Balfour. There does not appear to be any adequate reason for considering that these subjects should belong to letters rather than to Natural Science, but perhaps it is a sign that a day is approaching when all the subjects of Natural Science will be recognised as forming as much a part of *literæ humaniores*, that is, of indispensable culture, as Philosophy and Ancient History. In the departments of Natural Science there is no change of importance to chronicle. Professors, Lecturers, and Demonstrators are the same as in the past academical year, and the subject-matter of the lectures refers in each case to the examinations in the Honours School of Natural Science. Mr. R. T. Günther is in residence at Magdalen College as Science Tutor, and Mr. W. Garstang is in residence at Lincoln College, and will deliver a course of lectures as Lecturer in Natural Science to the College.

The examination for the Burdett-Coutts Scholarship will be held in the week beginning October 21.

The Vice-Chancellor has appointed Mr. William Holman Hunt the Romanes Lecturer for the year 1895.

A copy of the report of the Minister of Public Instruction in New South Wales, for the year 1893, has reached us. The work of the Technical Education Board for that year was carried on under very different conditions from those of previous years. The scheme for retrenchment of expenditure in the public service led to the reduction of the vote for Technical Education from £49,800 in 1892, to £25,367 in 1893. The field of operations had therefore to be confined within comparatively narrow limits. Only 187 classes were carried on throughout the whole year, and the total number of students was 7096. In addition to the ordinary class work, popular lectures on various subjects were given at different centres throughout the colony. The success of these lectures may be judged from the fact that the Rev. J. Milne Curran lectured in Geology and Mineralogy to audiences aggregating 13,360 persons, or an average of over 300 persons at each lecture.

The *Record of Technical and Secondary Education* completes its third volume with the current number. The journal was only started tentatively, but the experience gained during the last three years has shown that it is wanted, so it will be continued. The present number is full of information of use to promoters of technical education. It includes the reports of the technical instruction committees of Somerset, Hampshire, Isle of Wight, Staffordshire, and Worcestershire. Mr. W. E. Urwick gives a description of primary and secondary education in France, first tracing the progress of an imaginary boy from the primary school upward, and then detailing the means of transition from one school to another, the help offered by the State, and the method of procuring it. So many committees have had to confess that their schemes of agricultural education have, to say the least, been unsuccessful, that an article on the promotion of such instruction in Great Britain should be widely read. It is pointed out that elementary agricultural education must be founded definitely on science, though this may be elementary. The subjects likely to be of most use are chemistry, botany, and zoology. Mathematical subjects should, if only as a matter of education, engage earnest attention, and it is suggested that elementary physics, leading up to the construction of the steam engine, might replace botany or zoology in the curriculum. There must always be stations for field demonstrations and experiments, and this class of work is of a threefold nature. "First, there is the demonstration of the known action of certain elements of plant food when used in manures; it is this which is truly educational. Next comes what may fairly be called experiment, viz. the testing in each locality of the action of different manures on different crops or typical soils. Lastly, there is pure research into the unknown, a matter which can only be successfully carried out at special places, thoroughly well-equipped for this particular purpose. While, however, it is to be hoped that Rothamsted will always form the premier research station for the kingdom, there would seem to be no reason why stations such as that which the Royal Agricultural Society have at Woburn might not, within limits, be multiplied." In addition to the articles already referred to, the *Record* contains an illustrated description of the fine Technical College at Bradford.

The "Guide to Technical and Commercial Education," first issued by the Dundee and District Association for the Promotion of Technical and Commercial Education some five years ago, and the third edition of which has recently been published, has done good service. The object of the guide was to indicate the lines along which apprentices might with advantage be urged to a systematic continuance of their education in subjects bearing on their particular occupations. In point of fact, the aim of the Committee was to do for the apprentice architect, engineer, mechanic, or other craftsman, in the Technical School, what long ago in the Universities has been done for the professions by the institution of definite lines of study. Several Technical Instruction Committees have drawn up similar courses of study to be followed by young artisans in order to become efficient workmen; and when such schemes are properly drafted, they serve a very useful purpose.

SCIENTIFIC SERIALS

Quarterly Journal of Microscopical Science, vol. xxxvi. part 4, August.—In the first of a series of "Studies on the Nervous System of Crustacea," Mr. Edgar J. Allen gives the results of a careful investigation of the structure of the brain and ganglionic chain in lobster embryos. By the employment of Ehrlich's methylene blue method he has been able to demonstrate the course of the constituent nerve-fibres, both co-ordinating, motor, and sensory, with remarkable success. The author's observations agree with those of Retzius, Kölliker, and other recent investigators, as to the absence of any form of anastomosis between the fibres of different elements. Nervous discharges must, however, pass from one element to another by means of the finer terminal fibrils, which are shown to be frequently arranged in the form of distinct tufts, having a constant position relative to each other. On this account the author hazards the suggestion "that the nervous energy resembles a static electrical charge, in the fact that the discharge takes place most readily through points," the opposing tufts of fibrils of different elements being thus comparable to the "brushes" of an electrical machine. In the second and third of his "Studies," Mr. Allen deals with the Stomatogastric System of *Astacus* and *Homarus*, with the Beading of Nerve-fibres, and with End Swellings.—Other papers in the same number are by Mr. E. A. Andrews, on some abnormal annelids, and Mr. W. E. Collinge, on the sensory canal system of Ganoids. All these papers are admirably illustrated.

American Meteorological Journal, September.—On cloud formation, by Prof. W. von Bezold. This is a translation, by L. A. Bauer, of an address delivered in the "Urania" of Berlin, November 29, 1893, and published in *Himmel und Erde*, vol. vi. No. 5. We gave a brief notice of this valuable paper in vol. xlix. p. 508. Prof. von Bezold's explanations of the formation of fogs and clouds are exceedingly interesting and instructive, and the translation into English will be of great use to many readers who may be unacquainted with German. Several of the cloud views have been made in Berlin expressly for this article.—Summer hot winds on the Great Plains, by J. M. Cline, M.D. This paper has been reprinted from the *Bulletin of the Philosophical Society of Washington*, vol. xii. 1894, and contains an account of the hot winds observed from 1874 to 1892, and of the general meteorological conditions prevailing at the time of their occurrence, together with a description of the general characteristics of those hot winds, and conclusions as to their causes.—The meteorological services of South America, by A. L. Rotch. The countries in which meteorological observatories and central stations exist are Peru, Chile, Argentine Republic, Uruguay, and Brazil. Those dealt with in this article are Peru, in which is situated the observatory of *El Misti*, the highest station in the world, and Chile, of which the National Observatory is at Santiago, and was founded by the United States Transit of Venus Expedition in 1848.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, October 8.—M. Lœwy in the chair.—On the eccentricity of the orbit of Jupiter's fifth satellite, by M. F. Tisserand. If a be the great semi-axis, e the eccentricity, and ϖ_0 the longitude of perijove at a certain epoch (October 28, 1892), we have, as a first approximation,

$$a = 47''\cdot906,\ e = 0\cdot0073,\ \varpi_0 = -14^\circ.$$

—On the groups of transformations of differential linear equations, by M. Emile Picard.—Theory of flow on a weir without lateral contraction, when the bending liquid sheet is either depressed, submerged below, or adherent to the weir, by M. J. Boussinesq.—On the propagation of electromagnetic waves in ice, and on the dielectric power of this substance, by M. R. Blondlot (see Notes, p. 604).—Mean magnetism of the globe and "isanomales" of terrestrial magnetism, by M. Alexis de Tillo. The tables given show the mean value for the magnetic elements for parallels at 10° intervals for the years 1829, 1842, 1880, 1885.—M. Haton de la Goupillière informs the Academy that M. Cotteau has left his fine collection of fossil Echinoderms to the National School of Mines. This collection, combined with the Michelin collection, already at the School of Mines, will probably be the most complete of its kind.—On the dielectric power of ice, by M. A. Pérot. On recalculation of the results published on June 27, 1892, K assumes the value 2·04.—A study of the latent heats of vaporisation of the saturated alcohols of the fatty series, by M. W. Louguinine. The latent heats of vaporisation obtained are as follows: For ethyl alcohol, mean of eleven experiments, 201·42 cal.; Ramsay and Young's value, 206.4 cal., calculated by means of the formula

$$L = (s_1 - s_2)\frac{t}{I} \cdot \frac{dp}{dt},$$

where t = absolute temperature and I is the mechanical equivalent of heat, probably differs from the experimental value owing to accumulated errors of data entering into their formula.

Normal propyl alcohol, L = (1) 164·07 cal.; (2) 163·19 cal.
Isopropyl alcohol (Sp. Ht. assumed same as N. P. Alcohol), L = 159·72 cal.
Normal butyl alcohol, L = 138·18 cal.
Isobutyl alcohol (Sp. Ht. of normal alcohol used), L = 136·16 cal.
Fermentation amyl alcohol, L = 118·15 cal.
Dimethylethylcarbinol (Sp. Ht. assumed same as amyl alcohol), L = 110·37 cal.

All determinations were made at pressures between 745 and 755 mm.—On a particular case of the action of alkalies on glucose, by M. Fernand Gaud. The reaction of the alkali on glucose has been followed by means of different metallic oxides, capable of precipitating each of the products in turn, step by step.—On the production of gaseous formaldehyde for purposes of disinfection, by MM. R. Cambier and A. Brochet.—Manufacture of alumina from clays, by M. Joseph Heibling.—On the germination of oleaginous grains, by M. Leclerc du Sablon.—Experiments on the eggs of the mulberry silkworm, an annual race, by M. Victor Rollat. It is found that hatching may be produced at any desired time by submitting the eggs to the action of compressed air at the pressure of 6 to 8 atmospheres for a fortnight—M. J. Posno describes, in a note, the results obtained by a process of distillation of house refuse.—M. F. Larroque reports the ravages produced by anthrax in the higher pastures of the Pyrenees.

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THURSDAY, OCTOBER 25, 1894.

TWO TEXT-BOOKS OF BOTANY.

A Students' Text-book of Botany. By Prof. S. H. Vines, M.A., D.Sc., F.R.S. (First half.) With 279 Illustrations. (London: Swan Sonnenschein and Co., 1894.)

The Students' Introductory Handbook of Systematic Botany. By Joseph W. Oliver. (London: Blackie and Son, 1894.)

WE are very glad indeed to welcome Prof. Vines' new book. It is the first English text-book of modern botany that has yet appeared. The book has grown out of the author's translation of Prantl's "Lehrbuch der Botanik," but, as Prof. Vines tells us in the preface, "though the form of Prof. Prantl's book is retained, and here and there paragraphs from the English edition have been inserted, it is essentially a new book, for which he alone is responsible."

The difficulties in the way of writing a good comprehensive text-book of botany are very great. Owing to the huge amount of material, much of it mere detail, which accumulates day by day, the work of selection becomes increasingly laborious to any writer who is anxious to produce a text-book which shall be of real value to the advanced student. Perhaps no botanist was so well fitted to undertake this work as Prof. Vines, and he has done the work carefully and well. Modern researches have been incorporated wherever possible, and the author has placed his facts before the reader in a very clear, but somewhat encyclopædic manner. We must protest against the terminology. The author has introduced a large number of new terms, many of which seem to be quite superfluous, and likely to render the study of botany unnecessarily confusing to the student. Added to this, the book is, unfortunately, not got up in a very attractive style; the illustrations are poor, and the majority of them will be familiar to the student of botany. They have appeared over and over again in all sorts of text-books, good and bad, and it is much to be regretted that an adherence to these old figures should have become traditional.

The volume before us is only the first half of the book. It is divided into three parts, which deal respectively with morphology, the intimate structure of plants (anatomy and histology), and the classification of plants; the latter includes the Thallophyta, Bryophyta, and Pteridophyta, the description of the Phanerogams being reserved for the second half of the book.

Part i. is divided into two chapters and an introduction. In the latter some fundamental points are considered, the meaning of the terms morphology and homology explained, and a general description given of polymorphism, or alternation of generations, as exemplified in the moss, which is taken as occupying a central position, of morphological equality in the two generations, in the vegetable kingdom.

The development of the body and its members is treated excellently. Holoblastic and meroblastic development are explained. The difference between homoblastic and heteroblastic embryology is discussed. The latter kind of development is seen most strongly marked in the Characeæ, Mosses, Lemanea, and Batrachospermum, where two distinct stages in the development of the gametophyte can be observed.

In chapter ii. the special morphology of the members, thallus, stem, leaf, root, &c., is treated in detail. The description given of the leaf is excellent. The form of the leaf and its various parts are first of all described, then the development of the leaf, its branching, heterophylly, bud scales, &c. The leaf is regarded, from Bower's point of view, as a branch system. In most plants the leaf undergoes differentiation or segmentation along its longitudinal axis or phyllopodium. The result is that we get in the most complete cases the phyllopodium differentiated into leaf base or hypopodium, mesopodium or petiole, and an apical part or epipodium. The epipodium is typically winged and forms the lamina, the mesopodium is rarely winged, the hypopodium more frequently so, forming the stipules or leaf-sheath. The branching of the leaf is commonly confined to the epipodium, and is like that of a stem or root, either dichotomous or lateral, but dichotomous branching is rare. The ribs of the lamina represent distinct axes of growth. In some cases the growth of these axes and their respective wings results in the production of leaves with an entire margin; in other cases the growth is more irregular, and lobed, or segmented leaves are produced.

The morphology of the reproductive organs is next considered, the vegetative, asexual, and sexual modes of reproduction being described in some detail. Bracts and perianth leaves are included under the common term hypsophylls. In connection with spore formation we think Prof. Vines has introduced an unnecessary distinction between spores which are produced on the gametophyte and spores which are produced on the sporophyte, especially as, in the cases where this is said to occur, the distinction between gametophyte and sporophyte is, to say the least, not well marked. When the spores are produced on a gametophyte they are called gonidia, the sporangia are called gonidangia, and he sporophores are called gonidiophores.

Part ii. deals with the intimate structure of plants, and is divided into two chapters, on the cell and the tissues respectively. The relation of multinucleated cells to uninucleate is explained. The multinucleate segment is regarded as a collection of protoplasmic units, *energids* (a term due to Sachs), and is termed a cœnocyte. But, as the author points out, true multinucleate cells are produced in some plants by fragmentation of the original nucleus, as in the internodal cells of Chara.

In connection with the minute structure of the cell, and the division of the nucleus, we find that many of the more important recent researches are included.

The important observations of Guignard on centrospheres are shortly described, and one or two of his figures are given in illustration. Here again the author's statement that "closely associated with the nucleus is a body called the centrosphere," appears to us to be too general, as centrospheres have not yet been discovered in all the groups of plants, although the observations which have been already made, lead one to the conclusion that they will ultimately be discovered in connection with all nuclei.

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In chapter ii., under the heading of Tissues, the author describes the connection of the cells, intercellular spaces, the various forms of tissue, including "sieve tissue," glandular tissue, parenchymatous, strengthening, and tracheal tissue. The general morphology of the tissue system deals with the apical growth of plants, and the morphology of the stele. The researches of Van Tieghem are here included. The variations from the primitive monostelic structure of the stem are polystelic and schizostelic. The latter term, which corresponds to Van Tieghem's old term "astelic," is, in our opinion, a great improvement.

The fundamental tissue system or ground tissue is divided into extra-stelar and intra-stelar. In monostelic stems the limits of the extra-stelar tissue are the endodermis and the layer of cells immediately below the epidermis. In polystelic stems the extra-stelar tissue includes all the fundamental tissue outside the steles. The intra-stelar or conjunctive tissue includes the pericycle and pith.

A very good description is given of the secondary extra-stelar tissue. In the description of cork formation, the classification of Van Tieghem is adopted as regards the place of origin of the phellogen. We should like to have seen in this section some account of the conditions which, probably, determine the formation of special kinds of periderm. The chapter concludes with a short account of the formation of tissue in consequence of injury.

In the third part the classification of the vegetable kingdom into four groups, Thallophyta, Bryophyta, Pteridophyta, and Phanerogamia, is described. While recognising the general usefulness of such a division, we think it would have been better to separate the Bacteria and Cyanophyceæ to form another group—which has already been done by some writers—the Protophyta. The characteristics of the Bacteria are peculiar to themselves, and are such as to warrant their separation from the Fungi; and the same may be said of the Cyanophyceæ, and their connection with the Algæ.

The author adheres to the classification of the Algæ into four sub-classes: Cyanophyceæ, Chlorophyceæ, Phæophyceæ, and Rhodophyceæ. An excellent introductory account is given of the whole class, followed by a special description of each sub-class and its principal orders and families. The Chlorophyceæ is divided into five series: Protococcoideæ, Volvocoideæ, Siphonoideæ, Confervoideæ, and Charoideæ, a classification with which we cordially agree. It has been customary to place the Charoideæ between the Algæ and Bryophyta as a separate group, but we think their inclusion as a sub-group of the green Algæ is, in spite of the differences which exist between them, more in accordance with their structure.

A short but excellent description is given of the Phæophyceæ. The author includes the unicellular forms, Syngeneticæ and Diatomaceæ, in this group. This may be convenient, but few botanists will, we think, regard it as natural. A short general account of the red seaweeds, with a list of the orders and chief genera, concludes this portion of the book.

The next group dealt with is that of the Fungi. A general account is first of all given of the structure and methods of reproduction. The asexual formation of spores is of general occurrence. In accordance with the author's terminology, these are distinguished as gonida and spores, according as they are borne on the gametophyte or sporophyte. The ordinary mycelium of mucor, for example, is the gametophyte; on this are produced gonidangia and gonidia. On the other hand, the zygospores of some mucors produce a promycelium; this is regarded as the sporophyte, and its asexual reproductive organs are therefore sporangia and spores. Again in the Peronosporaceæ, "in those species in which the oospore gives rise to a promycelium, the promycelium is the sporophyte; in those in which the oospore gives rise to zoospores, the oospore itself represents the sporophyte, and finally, in those in which the oospore at once gives rise to a sexual plant, the sporophyte is altogether unrepresented." The ordinary mycelium is here also the gametophyte.

The book concludes with an account of the vascular Cryptogams. The classification adopted by the author is more in accordance with the known facts of morphology, and is a distinct advance in the right direction. One of the most striking changes is the complete separation of the Isoëtaceæ from the Selaginellaceæ, and its inclusion among the Eusporangiate Filicineæ. A useful table is given on p. 380, showing the relations of the various groups of the Pteridophyta.

In connection with the Lycopodiaceæ, Treub's important observations on the embryogeny of the sporophyte and the structure and development of the gametophyte are incorporated. This is the first time these important researches have been described in an English text-book.

In conclusion, English students have cause to be grateful to Prof. Vines for this excellent text-book, which puts before them so clearly and definitely the main facts and conclusions connected with the science of botany; and we look forward with great interest to the appearance of the second half of the book, which has been promised for the current year.

The second book before us is, the author tells us in his preface, designed for the use of students who have passed through an elementary course of botany. It is a compilation from several English works and Le Maout et Decaisne's "Traité Général de Botanique," and the author has been at some pains to select from them such portions as will be most useful to beginners. In this he has been fairly successful, and has placed his facts before the reader in a commendably simple form.

The author is not without hope that the book may be used for private study, but we could not recommend it for this purpose. It would be perfectly useless to place such a book in the hands of a private student, unless he were better acquainted with the elements of botany than the majority of students in elementary classes.

A little more than one-third of the book deals with Cryptogams, the remainder of the volume being devoted to a description of the structure and classification of the Phanerogams. We can heartily commend the author's lucid description of some of the types he selects to illustrate the various groups. On the other hand, many of the types are described by him in such a way as to give the student very little idea of the plant he is supposed to be studying.

The second part of the work deals with the Phanerogams. A very fair account is given both of the Gymnosperms and the Angiosperms. The major portion of this part of the book, however, is taken up with a description of the natural orders of the Angiosperms.

Though there are a few new illustrations in the book, the majority of them are the old familiar ones referred to in the foregoing. We notice that the author has sometimes forgotten to acknowledge the source from which his illustrations have been taken.

In conclusion, it may be said that the book is very well suited to those students who wish to pass a somewhat advanced examination, such as that of the Science and Art Department. We cannot help regretting, however, that there should be so large a demand for this kind of text-book.

HAROLD WAGER.

LIFE IN ANCIENT EGYPT.

Life in Ancient Egypt. Described by A. Erman; translated by H. M. Tirard. (London: Macmillan and Co., 1894.)

THE appearance of an English translation of Prof. Erman's work on the manners and customs of the ancient Egyptians is most opportune, for it comes at a time when the Egyptological world is still smarting under the loss, by death, of Prof. H. Brugsch, the last and probably the greatest of the little band of German Egyptologists of which Lepsius was such a brilliant member, and proves to us that there is in Germany, besides Dr. Wiedemann, one at least who may be expected to continue the great and good work which that veteran did so much to promote. Prof. Erman is well known to Egyptologists by his papers and books on Egyptian grammar, of which from the time of his appearance at the Congress of Orientalists in 1874 until the present year he has never ceased to labour. In 1878 he published some important observations on the formation of the plural in Egyptian ("Die Pluralbildung des Aegyptischen," Leipzig, 1878), which was followed in 1880 by his "Neuaegyptische Grammatik"; in 1890 he edited, with translation, commentary, &c., the stories from the Westcar papyrus ("Mittheilungen ans den orientalischen Sammlungen—Die Märchen des Papyrus Westcar"), and last year he published a good little Egyptian grammar. A portion of his time he has devoted to contributing articles to the *Aegyptische Zeitschrift*, of which he is now the editor, and to the *Zeitschrift* of the German Oriental Society. His work on the life of the Egyptians, which in an English form we owe to Mrs. Tirard, appeared in parts, which formed two volumes, between the years 1884 and 1887, and was then, and is now the only work of the sort in Germany. The large work by Ebers, "Aegypten in Bild und Wort," which appeared at Stuttgart in 1879–81, and of which an English translation by Clara Bell was published in London in 1881–82, attracted the popular mind chiefly by the many beautiful illustrations which it contained; references to original authorities were few and far between, but it nevertheless appealed to a large class of readers successfully. Our own countryman, Wilkinson, the author of the first guide-book to Egypt, was perhaps the first to recognise that the only trustworthy descriptions of the manners and customs of the Egyptians must be derived from the native records of sculptor, artist and scribe, and he spent many years in compiling his monumental work on the subject, which, as Mrs. Tirard says in her preface, has formed one of the main sources of supply for Prof. Erman. Wilkinson's knowledge of the inscriptions was somewhat hazy according to modern views, and the defects which occur in his work from this cause are conspicuous by their absence in Prof. Erman's book, which is of course, as was to be expected, a record of the Egyptians compiled from their own monuments and books. On many points we should like to have had his opinions, as for example, on the Hyksos, and on the Exodus; as for the Hittites, on which nation more than one reputation has been wrecked, he holds no strong view, but thinks they may have been identical with the Kheta of the hieroglyphics. In matters of chronology Prof. Erman differs greatly from Mariette and Maspero, for he places the sixth dynasty as late as B.C. 2500, while they date it at B.C. 3700 and 3300 respectively. There is no doubt that serious modifications in Egyptian chronology must shortly be made, and though they may take the form of reducing the antiquity of the periods of the dynasties from the twelfth downwards, yet it seems perfectly clear that the effect of the rearrangement ought to be either to lengthen the period of the duration of the earlier dynasties, or to admit boldly a more recent date for the beginning of historical Egyptian civilisation, and to proclaim a lengthy period of prehistoric civilisation which in all probability extended over thousands of years. Such considerations, however, affect Prof. Erman's book very little, for the reader will rely upon him not for speculations as to the original home of the Egyptians and the history of their descendants who are known to us, but for the descriptions of their life as depicted on their works; in this respect no more careful guide than Prof. Erman could be found. The tasteful form in which his book is printed and bound will, we believe, add to its intellectual attraction.

OUR BOOK SHELF.

La Géographie littorale. Par Jules Girard, Secrétaire-adjoint de la Société de Géographie (Paris). (Paris: Société d'Editions Scientifiques, 1895 [1894].)

M. GIRARD says very justly in his preface that geographers have not as yet given the coast lines of the world the attention to which these features are entitled. He accordingly prepared the present little book, which has appeared, chapter by chapter, in the *Revue de Géographie*. It is unquestionably a useful compilation, but it is far from complete in any part; and it has been so carelessly revised, that a number of printer's errors remain unnoticed. In the names of places outside France the letters *u* and *n* are frequently transposed. Bab-el-mandeb appears as *Bal-el-Mandel*, and an extraneous *r* creeps into several names beginning with G, *e.g. Granges* for Ganges, and *Gruppy* or *Grupy* for Guppy. More serious are blunders in statements of facts, such as describing the whirlpool of Corryvrechan as being near the island of "Scabra," *dans les lacs d'Ecosse*, the transference of the Grey Man Path from the north of Ireland to the west of Scotland, and the description of the Old Man of Hoy as the result of erosion in schistose rock, whereas it is a mass of horizontally stratified Old Red Sandstone. These examples might be considerably reinforced were detailed criticism necessary, but a graver defect is the way in which work done by others than Frenchmen has been ignored. Reference is certainly made to several British, German, Russian, and American writers, but rarely at first hand, and many works of the first importance have been entirely overlooked.

There are seven chapters dealing successively with the movements of water in the sea, coast erosion, the movements of sand (the two most satisfactory chapters), the origin of beaches, deltas, estuaries, and the evidence of movements of the land along the coasts, including the origin of fjords.

The treatment of estuaries is particularly inadequate. The Amazon and Congo are scarcely seriously touched on, the part of salinity in determining the *régime* of tides in an estuary is practically overlooked, and the relation of the volume and velocity of a river to the volume of its estuary is not worked out at all. Perhaps the most marked omission is Prof. Osborne Reynolds' magnificent experiments on the synthesis of sandbanks by tides, and the controlling relation of the configuration of the coasts to that of the banks.

But with many faults of execution, the plan of the book is sound, and the work supplies a framework for a treatise of great value, which might be furnished if the author would first prepare a bibliography of the subject, and then undertake a thorough and leisurely revision.

H. R. M.

The Mechanics of Hoisting Machinery. By Dr. Julius Weisbach and Prof. Gustav Herrmann. Translated from the second German edition by Karl P. Dahlstrom, M.E. (London and New York: Macmillan and Co., 1893.)

This book is a translation from Prof. Herrmann's revised edition of Weisbach's great work on engineering mechanics. Several volumes of this work are familiar to English readers. The present section, however, has not previously appeared in English print, although its value has long been recognised. Mr. Dahlstrom was induced to undertake the translation, because he felt that there was a want in our technical literature for a text-book suitable for the higher grades of mechanics of machinery.

As the title implies, the contents of the work are entirely concerned with hoisting machinery; commencing with the simple lever and screw-jacks, and going on with all kinds of pulleys and blocks, windlasses and lifts, as well as hydraulic plant, concluding with hoisting machinery for mines, cranes and sheers, excavators, and dredgers, &c.

The treatment of these subjects is such that criticism is nearly unnecessary. The examples and illustrations are nearly all taken from every-day engineering practice; some are, however, old-fashioned. Senior students will obtain many useful hints in this book, more especially on studying the methods of working out the examples through out the volume. The diagrams are very clear and to the point. One cannot help noticing that the illustrations have in many cases a decidedly foreign appearance, and the design would not be followed in this country; nevertheless, they serve the very useful purpose of illustrating theoretical constructions by means of every day objects. Fig. 65 represents the usual woodcut of the essential arrangement of an hydrostatic press. The ram of the force-pump is shown the full diameter of the cylinder, and therefore no passage exists for the water to pass from the suction to the delivery valve on the down stroke. Fig. 105 represents a two-cylinder geared steam winch, fitted with a peculiar slide valve. A description of this valve would have been interesting, because only one eccentric appears to be necessary, thus doing away with the noisy link motion, especially when badly worn.

The many references given add considerably to the value and usefulness of this work, while the able mathematical treatment of the more difficult examples leaves nothing to be desired. The translator may be congratulated on having added one more useful book to the library available to the student and engineer.

N. J. L.

An Elementary Manual of Zoology. By E. C. Cotes. Pp. 119. (Calcutta: Government Printing Office, 1893.)

The encouragement given to scientific instruction and research by the Indian Government is known to all who see the many interesting and important publications which issue from the different departments. Most branches of natural knowledge are fostered in India with a care which could be followed with advantage in the British Isles. The work before us is not a voluminous report, nor is it a richly illustrated monograph of the kind that often emanates from the various departments of the Government. In its way, however, it will do excellent service by providing a course of zoology suitable for the use of students at the Imperial Forest School, Dehra Dun. The author, who is lecturer on zoology in that school, and deputy superintendent of the Indian Museum, points out that the particular animals with which the Indian Forest officer is concerned are not treated in sufficient detail in the general text-books. His manual admirably supplies the requisite information, and furnishes a sound elementary course on the classification and habits of the commoner Indian animals. The work is divided into two parts, the first of which is a systematic course, while the second consists of directions for the dissection and examination of specimens. Theory and practice are thus each given a proper share of consideration. The book is a practical one, and the theoretical matter included in it is only such as is likely to be of use to the students for whom it has been designed. Little reference is therefore made to the fundamental theories of modern biology.

Preservation of Health in India. By Sir J. Fayrer, K.C.S.I., F.R.S. Pp. 51. (London: Macmillan and Co., 1894.)

The young European who is about to take up a long residence in India, could not do better than "read, mark, learn, and inwardly digest" what Sir Joseph Fayrer has to say about the preservation of health there. In this primer, so small that it will almost fit into the waistcoat-pocket, we find a good summary of information with regard to the physical characters and the climate of India. To obviate the deleterious action of the latter, and preserve health, the author lays down a few simple hygienic rules which must be observed. He describes the diseases and accidents in which immediate aid is required, and states briefly the antidotes to be employed in each case. Readers of the book will acquire, pleasantly and easily, a fund of useful knowledge on the most important points concerning health and possible sickness in our Eastern Empire.

First Principles of Building. By Alex. Black. Pp. 329. (London: Biggs and Co.)

They who build houses will find many matters connected with their occupation, presented in a practical light, in the book under review. The choice and preparation of a site, the planning of the dwelling, and the nature and use of the materials to be employed, are considered by the author from a technical point of view. The work is a practical handbook for architects and builders, and contains a mass of highly-compressed information on all points pertaining to the erection of residences.

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 Inheritance of Acquired Characters.

IT may be of interest to your readers to know that two guinea-pigs were born at Oxford a day or two before the death of Dr. Romanes, both of which exhibited a well-marked droop of the left upper eyelid. These guinea-pigs were the offspring of a male and a female guinea-pig, in both of which I had produced for Dr. Romanes, some months earlier, a droop of the left upper eyelid by division of the left cervical sympathetic nerve.

This result is a corroboration of one series of Brown-Séquard's experiments on the inheritance of acquired characteristics. A very large series of such experiments are of course needed to eliminate all sources of error, but this I unfortunately cannot carry out at present, owing to the need of a special farm in the country for the proper care and breeding of the animals. LEONARD HILL.

Physiological Laboratory, University College, London, October 18.

"Rhynchodemus Terrestris" in Ireland.

IT is now nearly twenty-five years ago since Sir John Lubbock discovered this Land-planarian for the first time in England. Although it is very doubtful whether the two other species, viz. *Geodesmus bilineatus* and *Bipalium kurense*, can be looked upon as truly indigenous in Europe, it is not so with *Rhynchodemus terrestris*.

Since Müller's original discovery of this worm in 1774 in Denmark, it has been taken in the Balearic Isles, near Lille, and on the Mediterranean coast in France, and near Würzburg in Germany. Finally, Sir John Lubbock speaks of it as having been found in Shropshire and Kent in England. More recently Mr. Harmer discovered it near Cambridge, and I have now to add a new locality, having received some specimens from Black-rock, near Dublin. R. T. SCHARFF.

October 22.

Dr. Watson's Proof of Boltzmann's Theorem on Permanence of Distributions.

IN working over Dr. Watson's proof of Boltzmann's H-theorem (Watson, "Kinetic Theory of Gases," second edition, p. 43), it appeared that, probably through a slip, the reasoning given depends on an assumption palpably absurd, *i.e.* that the function whose vanishing defines the beginning or end of an encounter between a molecule belonging to a set with m degrees of freedom and one belonging to another set with n degrees of freedom *is a function of the coordinates of the last molecule only*, the one belonging to the n set. For while he takes the number of molecules of the n set whose momenta and coordinates lie between

$$p_1 \text{ and } p_1 + dp_1 \;\; . \; . \; . \; . \;\; q_n \text{ and } q_n + dq_n$$

as

$$f(p_1 \; . \; . \; . \; . \; q_n)\, dp_1 \; . \; . \; . \; . \; dq_n,$$

he also takes $q_n = 0$ as the condition of encounters between those molecules and others from a set whose coordinates are

$$P_1 \; . \; . \; . \; . \; Q_n.$$

I do not know Boltzmann's proof, but while I suppose it is all right, I find it very hard to understand how any proof can exist. *A priori* the only physical property assumed in Watson's proof is that

$$dp_1 \; . \; . \; . \; . \; dq_n = dp_1' \; . \; . \; . \; . \; dq_n',$$

together with the fact that the number of molecules about a configuration $p_1 \; . \; . \; . \; . \; q_n$ is

$$f(p_1 \; . \; . \; . \; . \; q_n)\, dp_1 \; . \; . \; . \; . \; dq_n;$$

and therefore it would, if true, apply to a system obtained by reversing the velocities when the permanent configuration had been very nearly reached. Such a system would retrace its path and go further and further from the permanent configuration.

Hence it would appear as if the whole conception of Dr. Watson's proof was founded on a mistaken idea of what can be proved, and that all that any proof could show is that, taking all the values of $\frac{dH}{dt}$ got from taking all the configurations which approach towards a permanent configuration of the molecules, *and* the configurations which recede from the permanent configuration (obtained by reversing velocities), and then striking some kind of average among them, the average $\frac{dH}{dt}$ would be negative.

Will some one say exactly what the H-theorem proves?

EDWD. P. CULVERWELL.

Trinity College, Dublin, October 12.

The Meteor-Streak of August 26, 1894.

SINCE the publication of my paper in NATURE of September 27, in which I discussed observations of the fireball of August 26 and its drifting-streak, I have received many additional descriptions which show that some of the earlier reports were not very accurate. The results I derived for the direction and rate of motion of the streak have therefore to be considerably amended to agree with the new materials.

From all the data I find that the height of the streak was fifty-four miles above a point seven miles north-east of Denbigh. From thence it travelled horizontally to south-east, passing successively over Ruabon, Denbighshire, and Wem and Wellington, Shropshire, finally becoming extinct six miles west of Wolverhampton, at just about the same height as at first. It traversed sixty-one miles in thirty minutes, which is equivalent to 176 feet per second.

This deduction differs from the previous one, which assumed the meteoric or cosmic cloud to have been rapidly ascending in the atmosphere during the time it remained visible. Mr. Wood, of Birmingham, obtained a similar result from the earlier observations. I feel certain, however, that no such upward movement of the cloud really occurred, but that it maintained, throughout its rapid drift to the south-east, a nearly uniform elevation of about fifty-four miles above the earth's surface.

Bristol, October 14. W. F. DENNING.

Flight of Oceanic Birds.

JUDGING from Mr. Kingsmill's photograph, it would appear that the bird is just in the position of the half-stroke of the wings when making a fresh start or a sudden spurt. While these birds generally sail about, yet at times they do flap their wings. The movement of the wings in all these oceanic birds is very deliberate. I might here be allowed to point out the interest attaching to such photographs as these; and as many have hand-cameras now, snap-shots of animal life at sea, or of any natural phenomena, would be valuable and interesting additions to our knowledge of sea life. D. WILSON BARKER.

Greenhithe, October 13.

A LONG-PERIOD METEOROGRAPH.

IN order to obtain a record of the principal meteorological variations at the summit of Mont Blanc, M. Jules Richard, of the well-known firm of scientific instrument makers, has constructed for Dr. Janssen a meteorograph which will run through the winter and spring without being re-wound.

The instrument (Fig. 1) is set in action by a weight of about ninety kilograms, which falls from five to six metres in eight months. This weight moves a pendulum, which regulates the movement of the various parts of the apparatus. It was essential that the motion of the pendulum should not be greatly affected by considerable variations of temperature. A modified form of Denison's escapement was therefore adopted by M. Richard (Fig. 1, A.). An advantage of this escapement is that it only requires a very minute quantity of oil. Denison was unable to detect any variation in the uniform motion of the pendulum when the oil had frozen to the consistency of tallow.

All the movements of the meteorograph are given to the respective instruments through a horizontal shafts

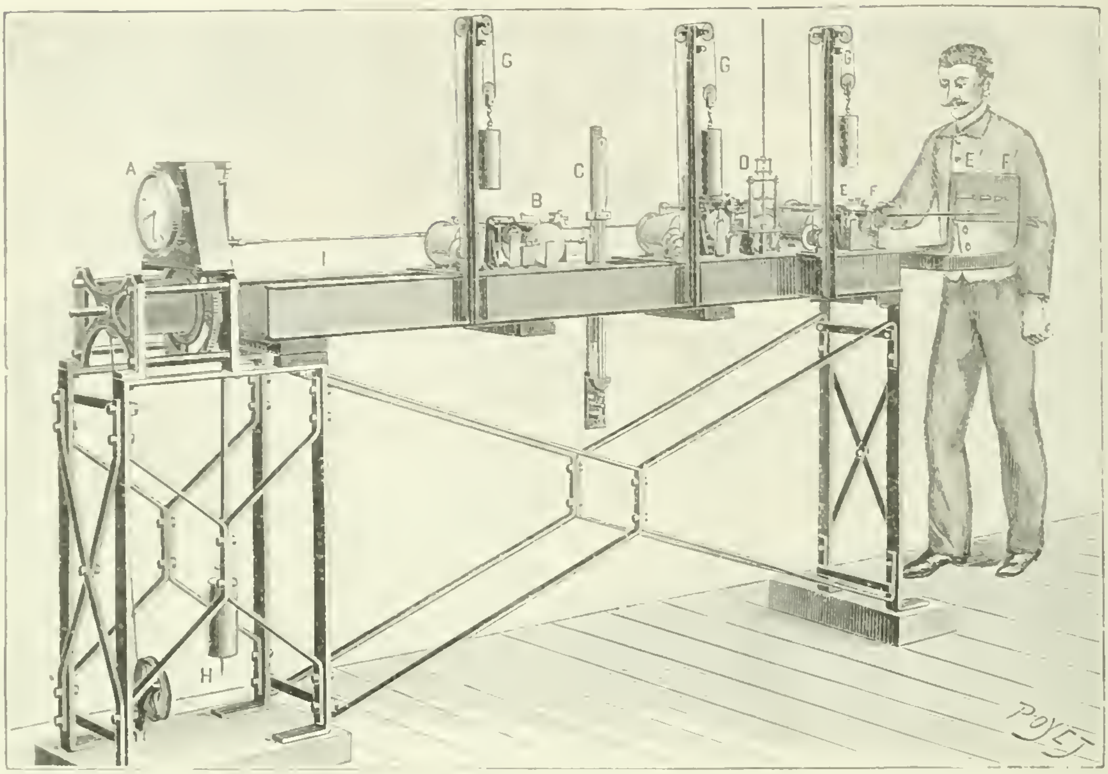

FIG. 1.—Long-period meteorograph for the Mont Blanc Observatory. A, clock to run eight months; B, barometric recording system: C, mercury barometer; D, registering anemometer and anemoscope; E, pen of thermometer; F, pen of hygrometer; E', reservoir of thermometer; F', hairs of hygrometer; G, G, G, counterpoises for ensuring the regular movement of the paper spindles; H, pendulum of clock; I, transmitter of the clock-movement to the different recording systems.

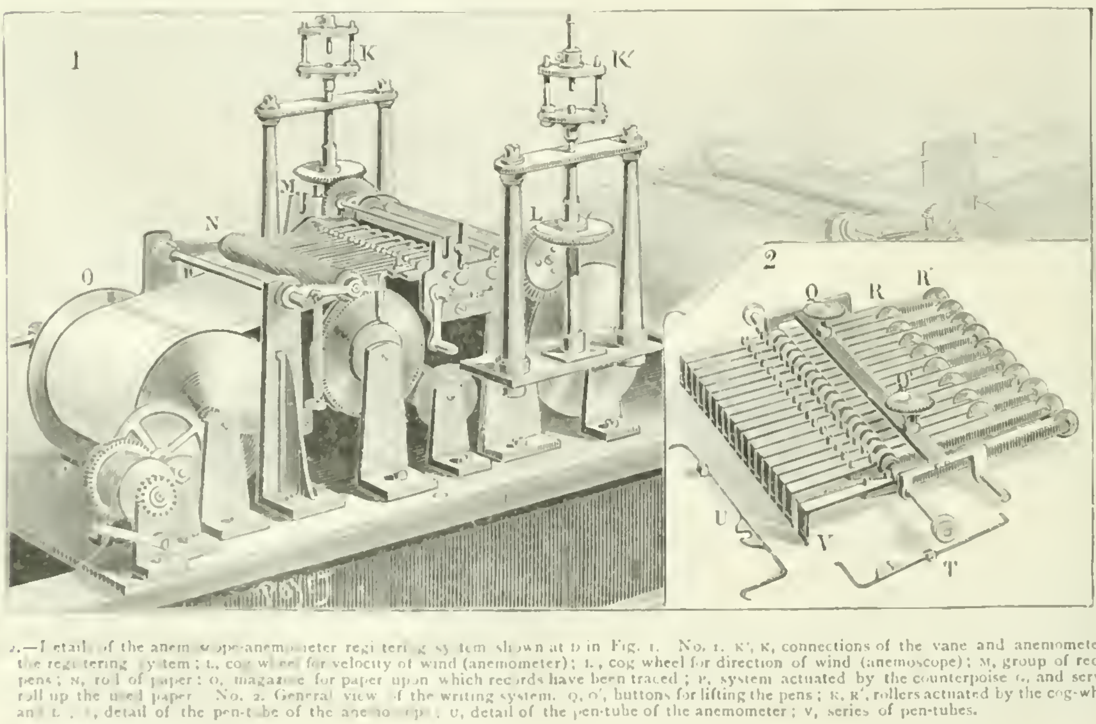

FIG. 2.—Details of the anemoscope-anemometer registering system shown at D in Fig. 1. No. 1. K', K, connections of the vane and anemometer with the registering system; L, cog wheel for velocity of wind (anemometer); L', cog wheel for direction of wind (anemoscope); M, group of recording pens; N, roll of paper; O, magazine for paper upon which records have been traced; P, system actuated by the counterpoise G, and serving to roll up the used paper. No. 2. General view of the writing system. Q, Q', buttons for lifting the pens; R, R', rollers actuated by the cog-wheels L and L'; T, detail of the pen-tube of the anemoscope; U, detail of the pen-tube of the anemometer; V, series of pen-tubes.

which is in connection with the pendulum. The shaft is completely rotated round its axis once in twenty-four hours, and this diurnal motion is communicated to the bobbins of paper belonging to the different registering instruments. The paper on these bobbins is unrolled with a different velocity for each instrument.

The instrument for registering variations of atmospheric pressure is shown at B, in Fig. 1. The marking needle records the movements of the mercury in the lower branch of a Gay-Lussac barometer having a very large cistern.

For recording variations of temperature, metallic reservoirs on the Bourdon system are employed, and for humidity a hair or Saussure's hygrometer is used. The velocity and direction of the wind are registered by a new arrangement devised by M. Richard, the principle being as follows :—A cylinder, carrying a certain number of cogs, arranged helically on its surface, is connected with a Robinson's anemometer, and acts by means of the cogs on an equal number of pens, each of which is lifted up in succession and made to mark the drum of paper so long as the cog acts upon it. For registering direction, the apparatus is provided with eight separate pens for the eight principal directions of the wind. For velocity, the cylinder carries ten cogs, which act successively on ten pens. Each pen is geared during one-tenth of a complete rotation of the cylinder, and, knowing the rate of movement of the cylinder, the velocity of the wind may be found from the length of the traces made by the different pens.

The descriptions beneath the accompanying illustrations, for which we are indebted to *La Nature*, tell the use of the different parts of the instrument. In spite of the many precautions which have been taken, Dr. Janssen recognises that the instrument is more or less tentative in character. But the question of long-period meteorographs for meterological stations at high altitudes is so important that the result of the experiment will be awaited with great interest.

NORTH AMERICAN MOTHS[1]

Many works on North American butterflies, and on some groups of moths also, have been published of late years, but the important family of the Noctuidæ has hitherto been much neglected. A great deal has been done in this direction, it is true, but the information is scattered broadcast through periodicals, and but little has been attempted to systematise it, the only existing guide being Grote's "List of North American Moths," which is limited to names of species, without even references to where they are described.

But to work at a group of insects without the aid of catalogues and monographs, is like attempting to study a language without the help of a grammar and dictionary. In the work before us, Prof. Smith has amply fulfilled the latter necessity, as far as regards the family of moths of which he treats. The Noctuidæ may be considered the most extensive family of the larger moths. We have 300 species in England, and Staudinger's last "Catalogue of the Lepidoptera of Europe, North Africa, Asia Minor, Siberia, and Labrador," published in 1871, enumerates 1040 species for those countries, and many have been added since ; and although Prof. Smith does not number the North American species, an examination of his index yields upwards of 3000 species ; and even after making the largest deductions for generic names and synonyms (perhaps too large an allowance), we may still fairly conclude that the Nearctic fauna considerably outnumbers the Palæarctic in this family, though it is not the case in the butterflies.

Prof. Smith has been accumulating materials for a monograph of the North American Noctuidæ for the last ten years. During the course of his studies, he visited London, and made a special study of the important series of type-specimens in the British Museum, which includes a large proportion of those described by Guenée, Walker, and Grote. Consequently he has been able to clear up a good deal of hitherto doubtful synonymy. He has also visited several of the more important museums on the continent, and of course the principal collections in North America had previously been examined by him ; therefore his work is not a mere compilation (though even in this case it would have been of great value), but it represents a large amount of original study.

A rather important question discussed by Prof. Smith in his preface, is that of "types." He remarks :—"Dr. Hayen holds that every specimen named by an author of a species described by himself is a type. Mr. Morrison was yet more liberal, and marked as 'type' a number of specimens of species described by Mr. Grote, having presumably compared them with the actual type. Mr. Grote's practice seems to have been to mark all specimens before him when writing his original description, as 'type,' and I think Mr. Grote is right." Our own opinion is that greater precision is necessary, and that no specimen can be considered a type which was not before an author when he drew up his description. Even so, he should always label one individual specimen, which he considers to represent his species best, as "type," and, properly speaking, there cannot be more than two such "types" of a species, male and female. The remainder of the series should be regarded not as "types," but as "co-types," and specimens which are afterwards compared and considered to agree with them, whether compared by the author of the species himself, or by some other person, should simply be labelled "compared with type." Too much precaution cannot be exerted in these matters. Among other subjects noticed in the preface, are the contents of the various collections consulted by Prof. Smith, the dates of Hübner's works (in which he hardly seems to us to be fully acquainted with the published information), and explanations respecting the manner in which he has arranged the details of his book, in quoting references and localities, &c. All the species contained in the United States National Museum at Washington are marked with an asterisk. A useful index to authors and works cited follows the preface, and the general index, which closes the volume, fills twenty-six pages of small print in double columns.

Great differences of opinion exist between Prof. Smith and other American and European entomologists respecting the classification of the Noctuidæ, and sometimes also respecting the identification of various species cited. This is unavoidable, and in no way interferes with the value of his work. In most cases, Prof. Smith indicates where the type specimens of each species are to be found, and frequently adds valuable notes on identification and variation. Transformations are omitted, owing to the late Mr. Harry Edwards having issued a complete catalogue of the early stages of North American Lepidoptera (*Bulletin* No. 35 of the National Museum).

In conclusion, we may venture to express a hope that it may not be very long before Prof. Smith's promised "Monograph of North American Noctuidæ" is ready to see the light. A catalogue is good, but a monograph is better, and we shall be very pleased to see a work of such magnitude and importance carried to a successful conclusion.

W. F. Kirby.

[1] *Bulletin* of the United States National Museum, No. 44. A Catalogue, bibliographical and synonymical, of the Species of Moths of the Lepidopterous Superfamily Noctuidæ, found in Boreal America, with critical notes by Dr. John B. Smith, Professor of Entomology in Rutger's College. (Washington, 1893.)

NOTES.

REUTER'S correspondent at Amsterdam reports that, according to a telegram received from Batavia, there has been an eruption of the volcano of Galoenggoen, near Garoet, in the Preang Regency. Several native villages are said to have been destroyed. The great eruption of this volcano in 1822 involved an enormous loss of life and property.

A SEVERE shock of earthquake is reported by the Central News correspondent at Tokio as having occurred on Monday night in the province of Akita. The centre of the disturbance was apparently the town of Sakata, which was almost entirely destroyed.

WE regret to note the death of Mr. Charles Carpmael, the Director of the Meteorological Service of Canada. He died at Hastings on Saturday. The death is also announced of General Robson Benson, whose work in connection with the development of the Botanic Gardens at Madras and Rangoon earned for him the esteem of all botanists; and of Mr. Edwin Clark, the engineer. Mr. Clark was a Fellow of the Royal Astronomical and Meteorological Societies.

WE learn from the *American Naturalist* that the Salt Lake Literary and Scientific Association has recently given sixty thousand dollars for the endowment of a chair of Geology in the University of Utah. The chair has been named the Deseret Professorship of Geology, and Dr. J. E. Talmage has been appointed to it.

A CORRESPONDENT informs us that he recently tested two samples of oxygen supplied for the use of lanternists, and found them to be mixtures of sixty-five per cent. oxygen and thirty-five per cent. nitrogen. Persons who use compressed oxygen should therefore obtain, from the dealer who supplies the gas, some kind of guarantee that it is up to a certain standard of purity.

A VERY fine auroral display was observed in New Zealand and the south-eastern parts of Australia on August 20. Mr. H. C. Russell writes to us, that at Sydney the south-eastern sky assumed a peculiar green tint at 6.35 p.m. Clouds interfered with his view of the display, and finally blotted out the auroral light and streamers at 8.33 p.m. In New Zealand, the aurora is said to have been very brilliant.

THE London and Provincial Ornithological Society will hold their ninth annual show at the Royal Aquarium, Westminster, on Tuesday, Wednesday, and Thursday, October 30, 31, and November 1. The extent of the show may be judged by the fact that over one thousand British and foreign birds will be on view.

THE following strange incident is described in the *Times* as having occurred in the reptile-house of the Zoological Society's menagerie, the scene being one of the compartments in which the boa-constrictors are confined. Two large boas occupied the chamber, one snake being nine feet and the other eight feet long. When the house was opened in the morning only one boa was found in this cage; the other had disappeared. Though the survivor was only a foot longer than the other snake, there was no reason to doubt that it had completely swallowed its companion. It was so distended that the scales were almost separated, and it was unable either to coil itself or to move. There is every reason to believe that in accomplishing this almost incredible feat the snake acted by mistake, and that it devoured its companion by what deserves to be called an accident. The larger boa was fed with a pigeon before the house was closed for the night. It swallowed the bird, and the other boa was then given a pigeon, which it had begun to swallow when the snakes were left for the night. It is believed that the larger snake then caught hold of the part of the pigeon which projected from the other's mouth, and gradually enveloped, not only the bird, but the head of the other snake. Once begun, the swallowing process would go on almost mechanically. As the swallowed snake was only one foot less in length than the swallower and of nearly equal bulk, weighing about fifty pounds, the gastric juices must have dissolved the portion which first entered the snake's stomach before the remainder was drawn into the jaws. Though still rather lethargic, the surviving boa is not injured by its meal. It coils itself up without difficulty, and its scales have the beautiful iridescent bloom peculiar to the skin of snakes when in perfect health.

THE Committee of the Bexley Cottage Hospital are to be commended for their enterprise. They have induced Mr. Hiram S. Maxim to consent to exhibit his flying machine to the public on Saturday afternoon, November 3, at Baldwin's Park, Bexley, and to give an account of its history, construction, and future. The machine will be run along its track at a high velocity, so there will be an opportunity of judging of its capabilities. Mr. Maxim's workshop will be open to visitors, and his scientific apparatus will be on view. There will also be a practical display of the Maxim automatic machine guns. This method of obtaining funds for hospital work is worth developing. We hope it will meet with the success it deserves. Perhaps the time will soon come when the public will take as much interest in a scientific invention as it does in a good picture.

TWO Russian Kalmuks from the lower Volga, one of them a Buddhist priest, have recently spent some time in Thasa, and the *Comptes-rendus* of the Paris Geographical Society expresses the hope that they may be able to make public some interesting facts about the sacred city, from which all Europeans have been rigidly excluded for the last half-century.

THE provisional programme issued by the Royal Geographical Society for the Session 1894–5 shows that the Society is responding to the more general interest now being taken by its Fellows in the serious study of geography. The rooms of the Society have been altered and greatly improved, better accommodation being provided for the large collection of maps to which the public has free access, and for the library. A large room has been added to the library for the use of Fellows who wish to carry on special study undisturbed. A new series of technical meetings is to be instituted, at which important papers may be discussed by specialists, and the investigation of the scientific aspects of geography encouraged. It has long been felt that the evening meetings did not serve this purpose, the lateness of the hour and the presence of a large general audience preventing anything like technical discussion or detailed criticism. The new afternoon meetings are intended for specialists only, and they will take place in the map-room of the Society as frequently as occasion arises.

EVENING lectures will continue to be a prominent feature of the activity of the Royal Geographical Society, and the Session will be opened on November 12 by Mr. H. H. Johnston, C.B., who will speak of the British Central Africa Protectorate, of which he is Administrator. The two following meetings will also be devoted to Africa, Mr. Walter B. Harris giving an account of his recent visit in disguise to the oasis of Tafilet in Southern Morocco, and M. Lionel Decle describing his adventurous journey from the Cape to Uganda. Papers are also promised by Mr. Basil H. Chamberlain on the Luchu Islands, Mr. O. Howarth on the Sierra Madre of Mexico, Mr. D. G. Hogarth on recent explorations in Asia Minor, Mr. G. G. Dixon on North-west British Guiana, Mr. S. Butcher on Luristan, Mr. H. Weld-Blundell on Cyrenaica, Mr. W. M.

Conway on the Alps, their limits, structure, and physiognomy, and Mr. C. Raymond Beazeley on a new Periplus of the Erythrean Sea. Mr. J. Theodore Bent, who starts immediately on a new journey from Oman to Aden across Arabia, hopes to return in time to give an account of his travels. The Christmas lectures to young people will be continued, the lecturer this year being Dr. H. R. Mill, and the subject "Holiday Geography."

WE have received a new instalment of the "Annals" (Ejegodnik) of the Russian Geographical Society, vol. iii. 1894, which is on the same high level as the preceding issues of the same series. It contains a review of astronomical, geodetical, and cartographical work done in the year 1892 by the geodetists and topographers of the Ministry of War, and of the hydrographic work done in 1891 by the officers of the Navy. The meteorological and hydrological observations made by officers of the Russian Navy are discussed by P. A. Mordovin; and also the work of the officers of the Ministry of Ways. E. E. Leist gives a review of the work done in the domain of terrestrial magnetism, magnetic anomalies, and magnetic perturbations in Russia; S. N. Nikitin sums up the progress of geological exploration in the Russian Empire; B. Y. Sreznewski deals with the progress of Russian meteorology; and N. I. Kuznetsoff gives an elaborate review of the work done in the domain of botanical geography in Russia, and partly also in West Europe. All these papers are supplied with full bibliographical indexes.

IN the same "Annals," M. Nikitin, who is undoubtedly the highest authority on the Glacial period in Russia, sums up our present knowledge as regards the supposed inter-glacial deposits in East Europe. In his well-known work on the glaciation of Russia, published in 1886, he pointed out that the theory of a double glaciation is utterly inapplicable to that country, and that, if a second glaciation really has existed in Europe, it did not exist in Russia, which must have been free of ice during the period when the ice is supposed to have invaded Europe for a second time. True, a young geologist, M. Krischtafowitsch, announced, in 1891, the discovery of inter-glacial deposits about Moscow, and his article had been quoted in West Europe as a confirmation of the double glaciation theory; but the following year, when his observations were made with greater accuracy, he hastened to recognise that he had too rashly built up his theory. M. Nikitin's opinion is, therefore, that, although the whole question cannot yet be considered as finally settled, there are no facts whatever which the theory of an inter-glacial period in East Europe might be built upon; on the contrary, the facts point to a single glaciation.

THE gradual but somewhat tardy recognition of the part played by motor elements in consciousness in the localisation of objects in space, forms an interesting chapter in the history of the progress of psychological interpretation. A valuable contribution to this subject is to be found in a paper on the localisation of sound, by Prof. Münsterberg and Mr. A. H. Pierce, in the current number of the *Psychological Review*. It is based on a careful experimental investigation, and goes far to establish Prof. Münsterberg's theory, that the assigning of direction to sounds rests upon the union of sensations of sound and motor sensations, the latter originating from actual or intended movements of the head in the direction of the sounding body. The paper, which well illustrates the value of experimental research in psychology, deserves the careful attention of all those who are interested in the psychological aspect of the problems of space.

AN investigation that furnishes a new point of view from which to consider the undoubted Arachnid affinities of that morphological puzzle, the American king-crab, *Limulus*, is described in the *Zeitschrift f. wiss. Zoologie*, vol. lviii. part 1 issued last July. The author is Dr. A. Jaworowski, of Lemberg, and he has traced out the development of the so-called "lung" in a spider, *Trochosa singoriensis*. He finds that this organ does not arise directly as such, but is formed in ontogeny by the secondary modification of a true trachea, which consists at first of a funnel-shaped external or stigmatic chamber, a common tracheal stem, and a bundle of delicate terminal tubules, penetrating some distance into the body. The tracheal tubes gradually atrophy, and on the walls of the external chamber or air-sac, which considerably enlarges, arise a number of parallel lamelliform folds, at right angles to the course of the common tracheal stem. From these structures, which in their early stages recall the appearance presented by the transverse striations of the tracheæ in insects, the respiratory lamellæ of the "lung" are derived. Development thus establishes the Tracheate origin of the Arachnida, and opposes the view that the lungs of spiders have arisen as modifications of the gill-books of a *Limulus*-like ancestor; though Dr. Jaworowski holds that the converse of this proposition—that the gill-books of *Limulus* have been evolved by the modification of Arachnid lungs—is very probably true. Simroth's view that *Limulus* is essentially a land animal, secondarily adapted to a marine existence, is thus confirmed; and Dr. Jaworowski does not hesitate, after a discussion of the nature of the Crustacean gill, to derive the whole phylum Crustacea from the Tracheate stem.

HERREN KOHLRAUSCH and Heydweiler appear to have approximated more closely to the preparation of absolutely pure water than any previous observers. In a paper on the subject, published in the current number of *Wiedemann's Annalen*, they describe the manner in which they prepared and tested the samples of pure water. Water distilled in air shows, even with the greatest precautions, an electric conductivity of $0{\cdot}7 \times 10^{-10}$ at 18°C., mercury being the unit. Distillation in a vacuum of about 0·01 mm. reduces this conductivity to $0{\cdot}25 \times 10^{-10}$, but into this value the solubility of the glass enters as a disturbing factor. A glass vessel employed for the purpose ten years ago had been constantly kept filled with water, with the result that the value for the conductivity found with what was now practically insoluble glass was as low as $0{\cdot}04 \times 10^{-10}$. This value was greatly influenced by changes of temperature, being about 0·014 at 0°, and 0·18 at 50°, but this behaviour had been predicted by the theory of dissociation. The authors now endeavoured to find the true conductivity of absolutely pure water by extrapolation, on the basis of the change of the temperature coefficient with increasing impurity, as given by the theory of dissociation. The value thus obtained for the conductivity of absolutely pure water at 18° C. was $0{\cdot}036 \times 10^{-10}$. It will be seen that the extrapolation only amounted to 10 per cent. The amount of residual impurity was estimated at a few thousandths of a milligramme per litre, which is 10,000 times less than the amount of air normally absorbed from the atmosphere. A curious phenomenon observed in the course of these measurements was the temporary increase of conductivity of the water when the current was of any considerable duration, an increase which sometimes amounted to 100 per cent. The amount of dissociated hydrogen in a cubic metre of water at 18° is calculated to be 0·08 milligrammes, at 0° only 0·036 milligrammes, and at 100° 0·85 milligrammes. Small as are these numbers, they still mean thousands of millions of atoms to the cubic mm., *i.e.* intervals between neighbouring atoms of the order of wave-lengths of light. In our conception, and even in microscopic vision, these free atoms of hydrogen would still appear to fill space continuously. That Ohm's law still holds for such a solution is not surprising.

IN a paper contributed to *L'Eclairage Electrique*, Signor L. Palmieri gives an account of the results he has obtained during the last few years in his study of the earth-currents at the Vesuvius Observatory. One of the earth-lines used terminates in a large copper plate buried in a well at the little village of Resina at the base of the mountain, and follows the direction S.W.–N.E. to the Observatory, where it is taken almost vertically down from the observing room and connected with the lightning-conductor. A shorter line has been tried in several azimuths, but has finally been permanently fixed in a N.W. direction from the Observatory. At first an ordinary astatic galvanometer with rather long magnetic needles was used, but it was found that the powerful currents which passed during thunderstorms often demagnetised the needles, or even magnetised them in the reverse direction. The ordinary form of suspended coil D'Arsonval galvanometer was also found to be subject to the objection that if the metallic suspension was sufficiently fine to allow of the small currents ordinarily obtained being recorded, then the large currents sometimes obtained fused the suspension. Finally the author, after consulting with Marianini, designed an instrument which essentially consists of a small electro-magnet the coils of which are connected to the earth-line and a magnetised needle suspended above this magnet. After more than a year of continuous observation, the author had come to the conclusion that the earth-currents were always from the lower station to the higher; but towards the end of August 1893, the currents commenced to vary in direction, and finally settled down in the opposite direction to that they had taken since 1889, when observations were first started. The change in the direction in the earth-currents occurred at a period when the volcano was more than usually active; but in January and February 1894 the volcano became much less active, and the earth-currents first decreased in intensity and then resumed their old upward direction. The activity, however, broke out again, at the central crater this time, and the earth-currents again changed their direction. In every case it has been found that when the volcano is quiescent the earth-currents ascend, but when the volcano's activity increases, the earth-currents at once change their direction and pass from the higher station to the lower. On June 7, 1891, when the lava made its first appearance, it was noticed that the needle of the astatic galvanometer at that time employed was continually in movement; and this movement was very irregular, the needle often behaving as if it had received a sudden blow.

A BRIEF summary of the analytical work required for the practical examinations in inorganic chemistry of the Science and Art Department is given in "A Laboratory Guide and Analytical Tables," by Mr. James Grant (Smith and Wood, Manchester).

THE October number of the *Proceedings* of the Physical Society of London (vol. xiii. part i.) has been published. It contains thirteen papers and six plates. The *Journal* of the Royal Microscopical Society, for October, has also just been issued.

MESSRS. WILLIAMS AND NORGATE have issued the sixtieth number of their scientific book circular, in which are catalogued new scientific publications, mostly of foreign origin, offered for sale by them. A similar catalogue has been received from Mr. J. H. Knowles, Lavender-hill, London, S.W.

THE *Electrician* Printing and Publishing Company are just issuing "Electric Lamps and Electric Lighting," by Dr. J. A. Fleming, F.R.S. The same publishers also announce, as ready shortly, "Electric Motive Power," with chapters specially dealing with the use of electricity in mines for lighting, haulage, pumping, coal-getting, &c. This latter work is by Mr. Albion T. Snell.

UNDER the title "Régularisation des Moteurs des Machines Electriques," M. P. Minel has completed a series of four volumes, which he has written for the Encyclopédie scientifique des Aide-Mémoire, on electricity and its applications to navigation. This new work has recently been published by MM. Gauthier-Villars, and also a volume on "Fortification," by Lieut.-Colonel Hennebert.

MR. ELLIOT STOCK has published a cheap edition of "A Manual of Exotic Ferns and Selaginella," by Mr. E. Sandford. The book comprises descriptions of more than one thousand species and varieties, and upwards of six hundred synonyms, as well as notes on the history, culture, and management of the plants considered. Amateur, and also professional, horticulturists will find the volume useful.

THE Geographical and Geological Commission of São Paulo, Brazil, has for some years published useful climatological data for that province. The last we have received is for the year 1892, and contains monthly and yearly means for twelve stations, and also for Rio de Janeiro, with a good general discussion, of the data for each place, by Sr. Schneider. As this State forms part of the coffee-growing region of Brazil, the publication of these summaries is of interest, both from scientific and commercial points of view.

FOUR lectures on biology, delivered by Dr. R. W. Shufeldt, before the Catholic University of America, in January 1892, have been reprinted from the *American Field*, and published in pamphlet form. The lectures deal with the history and present domain of biology; the relation of biology to geology; the value of biological study; and the growth and future influence of biology. They caused considerable stir at the time, for Dr. Shufeldt did not mince matters in presenting an account of the bearing of Catholicism to early scientific investigation. Nothing can be found in them, however, that is not sustained by the best of evidence.

DR. BÉLA HALLER has revised his numerous researches upon the morphology of Prosobranchiate molluscs, and has incorporated them in the form of a handsome quarto monograph entitled "Studien über Docoglosse und Rhipidoglosse Prosobranchier nebst Bemerkungen über die phyletischen Beziehungen der Mollusken untereinander," published by Engelmann, of Leipzig. The student of molluscan morphology will find there a lucid and admirably illustrated exposition of anatomical data, and will not fail to be stimulated, if only to opposition, by Haller's peculiar views on the phylogeny and inter-relations of the different molluscan groups.

EVERY student of physical chemistry unfamiliar with the German language will welcome a "Manual of Physico-Chemical Measurements" (Macmillan and Co.), translated by Dr. James Walker from Prof. W. Ostwald's standard work. The German edition was reviewed in these columns at the beginning of this year (NATURE, vol. xlix. p. 219), and it was then remarked that the manual was the only guide to measurements in physical chemistry suitable for service in the laboratory. The book is not intended for the beginner, but for the chemist and physicist who desires to become practically acquainted with the region common to both of them. Dr. Walker's admirable translation will doubtless considerably increase the sphere of usefulness of Prof. Ostwald's work.

A SECOND edition of the late Thomas Laslett's classical work on "Timber and Timber Trees" (Macmillan and Co.), completely revised, with numerous additions and alterations, by Prof. Marshall Ward, has just been published. The arrangement of the work has been completely altered, and the numerous advances that have been made in our knowledge of timber and its properties since 1875, when the first edition was published, have been taken into account. The work now consists of four parts. The first part deals with timber in general; in part ii. the timbers of Dicotyledonous trees are considered; part iii. deals with Coniferous timber trees; and the fourth part chiefly consists of tables showing the results of experimental investigations on the physical properties of timber. The book has been of valuable service to the shipwright and carpenter from the time it first appeared; and Prof. Ward's revision has certainly given it a new lease of life.

THE appearance of a second edition of Lord Rayleigh's "Theory of Sound" (Macmillan and Co.) reminds us that the first edition was reviewed in these columns by that eminent investigator, Hermann von Helmholtz, nearly seventeen years ago. Much additional matter has been included in the new edition, and the subject is carried to the limits of the present state of knowledge. Two new chapters have been interpolated, devoted to curved plates or shells, and to electrical vibrations. It was the author's original endeavour to produce "a connected exposition of the theory of sound, which should include the most important of the advances made in modern times by mathematicians and physicists." This object has been borne in mind in the preparation of the new edition. Lord Rayleigh naturally inclines to physical methods of investigation, but purely mathematical solutions are not entirely eschewed. The work has been recognised as a masterly exposition of a difficult subject ever since it first appeared, and the second edition maintains the high standard of the original.

AN important memoir concerning nitrogen trioxide, nitrous anhydride, N_2O_3, is communicated by Prof. Lunge and Herr Porschnew to the current issue of the *Zeitschrift für Anorganische Chemie*. It is claimed that the investigation, whose results are now published, finally disposes of all doubt as to the existence of this much discussed oxide of nitrogen. The main conclusion derived from the work is that nitrogen trioxide is a well characterised individual substance, which is readily formed under ordinary atmospheric pressure below the temperature of $-21°$ by the union of nitric oxide NO and nitrogen peroxide N_2O_4, and constitutes an indigo-blue liquid. It is stated to be perfectly stable at and below this temperature; but at a temperature slightly superior to this, even under pressure, it commences to decompose, and the dissociation is almost complete upon the conversion of the liquid into gas. Nitrous anhydride in a condition of purity thus appears to be incapable of existence in the gaseous state, while forming a comparatively stable liquid at temperatures below $-21°$. The gaseous product of dissociation, a mixture of nitric oxide and peroxide, exhibits similar chemical properties to those which might have been expected of gaseous nitrogen trioxide, hence of course the difficulty which has been experienced in deciding the question. It is pointed out, however, that the absolute incapability of existence of gaseous molecules of nitrogen trioxide is not proved, and the results of the investigation would appear to indicate that a residue of such molecules does escape dissociation upon the passage of the liquid into the gaseous state, and exists side by side with the molecules of the decomposition products. The experiments upon which these conclusions are based are mainly the following. It was first established that nitric oxide and nitrogen peroxide exhibit only the very slightest inclination to unite chemically at the ordinary temperature and at temperatures up to 100°. It was next found that at the temperature of $-21°$ the two oxides combined in practically exactly molecular proportions to form the indigo-blue liquid. The exact amount of N_2O_3 present in one of the specimens analysed is stated to have been 98·3 per cent. The well known work of Ramsay and Cundall upon this subject is, of course, quoted, and it is stated that the apparently small amount of absorption of nitric oxide by liquid nitrogen peroxide, corresponding to only 3·5 per cent. of N_2O_3, observed during that investigation, was due to the loss of weight by mechanical removal of a portion of the nitrogen peroxide in the stream of issuing nitric oxide. It was further demonstrated that the product of the action of oxygen upon nitric oxide gas behaves, particularly towards sulphuric acid, precisely like a mixture, which it probably is, of nitric oxide and nitrogen peroxide. Moreover, the vapour derived from liquid nitrogen trioxide is not stable towards oxygen, but becomes further oxidised until it is almost pure peroxide. The memoir will be found to include an admirable summary of the literature of the subject, together with the views of Prof. Lunge concerning the bearing of the main conclusions of the investigation upon the theory of the sulphuric acid manufacture.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Seymour Willoughby; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Mr. H. M. Vincent; a Tiger (*Felis tigris*) from Amoy, China, presented by Mr. Robert Bruce; a Tiger Cub (*Felis tigris*) from Burmah, presented by Mr. John Halliday; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. J. E. Symonds; two Brazillian Caracaras (*Polyborus brasiliensis*) from South America, presented by Lord Lilford; two Grey-breasted Parrakeets (*Bolborhynchus monachus*) from Monte Video, presented by the Inns of Court Hotel Company; an Egyptian Jerboa (*Dipus ægyptius*) from Egypt, a Patagonian Conure (*Conurus patagonus*) from La Plata, two Brazilian Cariamas (*Cariama cristata*) from South-east Brazil, deposited.

OUR ASTRONOMICAL COLUMN.

TRIANGULATION OF SIXTEEN STARS IN THE PLEIADES.—In addition to the great interest that has always been attached to this bright group of stars, the Pleiades, as can be gathered from the numerous myths (NATURE, vol. xlix. p. 366) which have been handed down to us, their value to the practical astronomer has been by no means small. In most astronomical measurements, observations have first to be made on stars the positions of which are accurately known, in order to determine the instrumental constants: thus, for instance, the pitch of micrometer screws, ring micrometer constants, &c. The Pleiades, as they consisted of a group of bright stars suitable for such determinations, were constantly used for these purposes, and this necessitated a previous complete knowledge of their positions and motions.

At the present day, however, the stars in the Pleiades group are rather of too bright a nature and too varied in magnitude for very accurate determinations of instrumental constants, and the tendency is now to turn to that group of stars in Perseus, which is more suitable in many respects. A recent triangulation of this region has lately been undertaken by Prof. Wilhelm Schur at Göttingen, with the large heliometer, the results of which appeared in the *Proceedings of the Royal Society of Sciences of Göttingen*. The triangulation to which we wish to refer is of sixteen stars in the Pleiades, and has been made by Dr. Leopold Ambronn at the Göttingen Observatory (*Astronomische Mittheilungen von der Königlichen Sternewarte zu Göttingen*, Bd. xxxix. 3 part).

The instrument employed, a good illustration of which is given, was the small Fraunhofer heliometer, which in earlier times was used in the two Venus Expeditions of this century. It might at first sight seem superfluous to attempt this triangulation with such a small instrument, when we are already acquainted with the results obtained from larger heliometers.

The value of this investigation lies, however, in the very minute determinations of the instrumental constants, and these would be interesting even if nothing more were attempted.

Dr. Ambronn has, however, after making these instrumental constant determinations, measured the positions of sixteen of the Pleiades stars, and compared them with the results obtained from Elkin's new computed values of Bessel's measures made with the Konigsberg heliometer. The following table is of interest, as it brings out the great accuracy of the Gottingen observations, and leads to suggestions regarding the grouping of the stars in numerous systems.

Stars.	Gottingen.—Konigsberg		Relative proper motion for 50 years in	
	R.A.	Decl	Magnitude.	Direction.
g	+0″·06	+0″·09	0·13	29·0
b	+0·20	+0·42	0·46	23·2
m	−0·66	−0·18	0·63	253·3
e	+0·49	+0·12	0·47	75·1
c	−0·52	+0·07	0·49	81·1
k	−0·01	+0·13	0·14	4·4
l	−0·09	+0·16	0·18	26·6
d	−0·35	−0·06	0·33	259·5
12	−0·60	−0·01	0·55	268·9
η	—	—	—	—
28	+0·12	+0·22	0·25	26·6
[illegible]	+1·30	−0·76	1·42	122·5
f	−0·04	−0·16	0·17	194·1
h	+0·04	−0·03	0·05	53·1
34	0·60	+0·23	0·60	67·3
40	+0·44	+0·50	0·64	38·7

Dr. Ambronn points out that the proper motions appear to show, just as those of Elkin's indicated, that the stars form not one but several systems. As will be seen from the table, *g*, *b*, *k*, *l* (and 28) appear to group themselves together, so also *e* with *c*, and the three stars *m*, *d*, 12, with one another. For a more definite opinion on this point it is suggested that the number of stars observed must be greatly increased.

The result of the triangulation shows, however, that by a suitable determination of the instrumental constants and due care in arranging the measures for reduction, small heliometers can give results, especially with regard to distances, which compare very favourably with instruments of much larger size.

The Fifth Satellite of Jupiter.—A series of micrometrical measures of the fifth satellite of Jupiter, made during the opposition of the planet in 1893, is contributed to the *Astronomical Journal*, No. 325, by Prof. E. E. Barnard. From numerous observations, Prof. Barnard is confident that the satellite is not brighter than the thirteenth magnitude. Its sidereal period appears to be 11h. 57m. 22·618s. Filar-micrometer measures of the diameters of Jupiter were made in the course of the work, the following values being obtained:—

Equatorial diameter .. ... 90,190 ± 56 miles.
Polar diameter .. . ... 84,570 ± 75 miles.

The polar compression obtained from these measures is 1/15·98. The mean of measures of east elongations of the satellite, made from September 1893 to January 1894, correspond to a distance of 111,910 miles. But on account of the eccentricity and revolution of the orbit of the satellite, the elongation distance is a varying quantity. M. Tisserand was led to conclude, a short time ago, that the major axis of the satellite's orbit must make a complete revolution in about five months. He returns to the subject in *Comptes rendus* for October 8, having used Prof. Barnard's new measures to make another determination of the eccentricity and the longitude of perijove at a given epoch. His discussion of the observations has led to the following results:—Semi-major axis, 47″·906; eccentricity, 0·0073; longitude of perijove at the epoch October 28, 1892, 14°.

THE PAST SUMMER.

An examination of the meteorological results for the six months from April to September exhibit some features of interest by way of showing how the several elements of temperature, rainfall, and sunshine combine to make up what is commonly called weather, and how, as in the case of the summer in question, the absence of sunshine can mar the season. In some summers the character of the weather varies considerably in different parts of the kingdom, but during the recent summer there was a great similarity in the conditions over the whole of the British Islands, and consequently the principal facts in the following summary, deduced from observations in the neighbourhood of London, will, to a great extent, be an index for other parts of the kingdom.

Table showing the Temperatures at Greenwich for the several Months and for the whole Summer.

	Mean.	Diff. from average.	Mean of all highest.	Diff. from average.	Mean of all lowest.	Diff. from average.	Warm days.	Cold days.
April ...	51·9	+3·8	61°·8	+4°·6	41°·9	+3°·0	26	4
May ...	51·8	−2·1	61·1	−3·1	42·5	1·2	10	21
June ..	59·8	−0·6	69·2	−1·7	50·4	+0·5	11	19
July ...	63·6	0·0	73·0	−1·0	54·1	+1·0	13	18
August..	61·4	−1·5	69·2	−3·6	53·6	+0·6	5	26
Sept. ...	55·2	−3·0	62·2	−5·1	48·1	−1·0	6	24
Summer	57·3	−0·6	66·1	−1·6	48·4	+0·4	71	112

The averages used in the above comparison are for the 50 years 1841 to 1890. A warm day is one on which the mean daily temperature is above the average, and a cold day is one on which the mean daily temperature is below the average.

It will be noticed that the mean maximum temperature is below the average, except in April; while the mean minimum temperature is in excess of the average, except in May and September. The highest day temperatures at Greenwich only reached 70° or above on 51 days, and they were distributed as follows throughout the summer:—April, 3 days; May, 2; June, 12; July, 21; August, 12; and September, 1. There were in all only 7 days with a temperature of 80° or above; they occurred as follows:—June, 3; July, 3; and August 1. For the last 50 years, 1845–1894, there have been on the average 75 days with a temperature of 70° and above, and 15 days with a temperature of 80° and above. The summers of 1860, 1879, and 1888 each had a fewer number of hot days than the summer which has just passed, while 1846, 1857, 1858, 1865, 1868, and 1893 each had double the number of hot days. Last year the mean temperature for the whole summer was more than 3° in excess of the mean for the summer this year, but the summer last year was warmer than any during the last half-century, although it was only 0°·2 warmer than in 1868.

The following table gives the rainfall and sunshine at Greenwich, and the sunshine values at Westminster, for the several months and for the whole summer:—

	Rainfall.			Hours of bright sunshine.			
	Rainy days.	Total amount.	Diff. from average of 40 years.	Greenwich.	Westminster.	Diff. from average of 10 years.	Sunless days.
		ins.	ins.				
April	14	1·45	0·21	123	122	− 2	4
May	15	1·53	0·54	137	152	− 32	2
June	11	2·02	0·03	127	155	− 19	2
July	19	3·27	+ 0·87	149	166	− 9	2
August	16	3·04	+ 0·55	114	125	− 39	4
September ...	13	1·27	− 0·98	60	83	− 29	9
Summer	88	12·58	− 0·34	710	803	− 130	23

The above figures show that rain fell with great frequency, but the amount was by no means excessive, and, with the exception of July and August, the monthly falls were below the average. A slightly different result is obtained if the comparison is made with the last 50 years, 1845 to 1894, the average total fall in summer for that period being 12·66 inches, which gives a deficiency of 0·08 inch only for the recent summer. During the whole period of 50 years, the summer falls have been deficient in 32 years, and in excess in 18 years; but the amounts in excess are much larger than the amounts in defect. The driest summer was 6·80 inches in 1870, and this was followed by 7·39 inches during the summer of last year, while the wettest summer was 22·03 inches in 1879.

The sunshine, it will be seen, was very largely deficient; and this was the principal feature of the period, the sun being screened by cloud far more than usual throughout the summer. The smaller amount of sunshine at Greenwich in comparison with Westminster is very pronounced.

The following table gives various elements in connection with the weather for the several districts of the United Kingdom, the results being for the six months, April to September, or a period of 26 weeks.

	Cold weeks.	Wet weeks.	Rainy days.	Total rainfall.	Hours of sunshine.
				ins.	
Scotland, N. ...	10	11	100	16·8	829
Scotland, E. ...	12	11	97	15·8	842
England, N.E. ..	11	11	103	13·3	856
England, E. ...	13	15	102	14·9	923
Midland Counties	14	11	89	12·5	860
England, S. ...	13	14	95	15·0	1003
Scotland, W. ...	16	11	93	15·9	946
England, N.W....	15	13	99	15·0	847
England, S.W. ...	13	11	103	18·2	1037
Ireland, N.... ...	15	13	110	15·0	814
Ireland, S.	14	13	98	18·6	859
Channel Islands...	11	15	107	18·6	1131

The frequency of rain is in excess of the average, except in parts of Scotland, and the amount of rain is in excess, except over the northern portion of the kingdom and in the Midland Counties, the total rainfall for the summer in the latter district being two inches short of the average.

The sunshine was generally deficient, although in the north of Scotland there was an excess of nearly 100 hours. The deficiency during the summer amounted to 186 hours in the Channel Islands, 141 hours in the east of England, and 119 hours in the south of England. CHAS. HARDING.

ON MODERN DEVELOPMENTS OF HARVEY'S WORK.[1]

THIS annual meeting in memory of Harvey is usually associated with feelings of pleasure and happiness, for it was intended by its immortal founder to commemorate the benefactors of the College and to encourage good fellowship amongst us.

Such commemoration of those who have benefited the College in the past, although it, necessarily, recalls many who have passed away, is, notwithstanding, on ordinary occasions pleasant instead of painful, because the feeling of loss through their death is completely overpowered by the recollection of the good they have done in their lifetime. To-day the case is very different, for the first thought that must needs occur to every one present here is that on this occasion last year our late President showed for the first time what seemed to be imperfect fulfilment of his duty to the College by being late in his attendance at the meeting. Perhaps nothing else could have shown more clearly his deep concern for the welfare of the College, and his thorough devotion of every faculty of mind and body to its interests, than the fact that no duty, no pleasure, and no press of occupation could tempt him to leave one iota of his work in the College undone. The only thing that did keep him back was the hand of Death, which, although at the last meeting he and we knew it not, was already laid upon him. Though his death was less happy than that of the great Harvey, inasmuch as he lingered on for days instead of hours after he was first struck down, yet their deaths were alike in this respect that, up to the time of the fatal attack, each was in the full possession of his faculties, each was in the enjoyment of his life. Like Radcliffe and Mead, like Halford and Baillie, and like many other distinguished Fellows of this College, the greatness of Clark is to be estimated not by the published works which he has left behind, but by the influence he exerted on his contemporaries. For the very estimation in which his professional skill was held, led to his whole time being taken up in giving advice, and prevented him from having the leisure to work out or record the results of the pathological and clinical observations which both his youthful publications and his later career showed him to be specially fitted to make. I might say very much more about him, but it has already been said much better than I could possibly do it by yourself, Mr. President, in your annual address, and in the eloquent and heart-stirring words which you addressed to the College on the occasion of your taking the presidential chair rendered vacant by the death of Sir Andrew Clark.

But while we are saddened to-day by the death of our late President, we hope to be gladdened by the presence amongst us again of one whom we all reverence not only as a former President of this College, but as one of the greatest leaders of clinical medicine in this century, Sir William Jenner. Like Harvey, Sir William Jenner is honoured by his College, by his country, by his Sovereign, and by the world at large. In times of trial and danger the lives of the Royal children were committed to the keeping of Harvey by his King; and to-day the care not only of her own life, but of that of her nearest and dearest, is committed to Sir William Jenner by his Sovereign, in the full and well-grounded assurance that in no other hands could they be more safe. The great clinician, Graves, wished to have as his epitaph "He fed fevers"; but Jenner has advanced much beyond Graves, and, by showing us how to feed the different kinds of fevers, has saved thousands of valuable lives. To-day this College is acknowledging his right to rank with Sydenham, Heberden, Bright, and Garrod, by bestowing upon him the Moxon medal for clinical research. In numbering Sir William amongst its medallists, the College honours itself as well as him, and in acknowledging the great services he has rendered, it is, on this occasion, acting as the mouthpiece of the medical profession, not only in this country, but in the world at large.

It was with the wish to keep green the memory of the benefactors of the College that this oration was instituted by Harvey, and not at all with the intention that it should be devoted to his own praise. But Harvey stands out so high above all others, that it is only natural that in the numerous orations which have been yearly given before the College of Physicians, the subject-matter should have been, to a great extent, confined to a consideration of Harvey and his works. On looking over many of these orations, I find that everything I could say about Harvey, his person, his circumstances, his character, and his works, has already been said so fully and eloquently that I could not add to it anything further, nor could I hope to express it even so well. I purpose, therefore, to consider to-day some of the modern developments of Harvey's work, more especially in relation to the treatment of diseases of the heart and circulation. There is, I think, a certain advantage in this also, inasmuch as one is apt by considering Harvey's work only as he left it, to overlook the enormous extent to which it now influences our thoughts and actions; and thus to comprehend its value very imperfectly.

As he himself says, "From a small seed springs a mighty tree; from the minute gemmule or apex of the acorn, how wide does the gnarled oak at length extend his arms, how loftily does he lift his branches to the sky, how deeply do his roots strike down into the ground!"[1]

How very minute is the gemmule from which has sprung everything that is definite in medical science, for this gemmule is no other than the idea which Harvey records in these simple words: "I began to think whether there might not be motion as it were in a circle."

Out of this idea has grown all our knowledge of the processes of human life in health and disease, of the signs and symptoms which indicate disease, of the mode of action of the drugs and appliances which we use, and the proper means of employing them in the cure of disease. In the works that have come down to us, we find that Harvey developed his idea physiologically in several directions. He discussed its application to the absorption and distribution of nourishment through the body, the mixing of blood from various parts, the maintenance and distribution of animal heat, and excretion through the kidneys. How far he developed it in the direction of pathology and therapeutics we do not know, as the results of his labours

[1] The Harveian Oration, delivered at the Royal College of Physicians, on October 18, by Dr. T. Lauder Brunton, F.R.S.

[1] "The Works of W. Harvey," Sydenham Society's Edition, p. 320.

on these subjects have, unfortunately, been lost to us by the destruction of his manuscripts during the Civil War.

We are proud to reckon Harvey as an Englishman by birth, but he is far too great to belong exclusively to any country; men of various nations and scattered all over the face of the earth acknowledge him as their teacher, and have played, or are playing, a part in developing his discovery in its various branches of physiology, pathology, pharmacology, semeiology, and therapeutics. Americans, Austrians, Danes, Dutchmen, French, Germans, Italians, Norwegians, Russians and Swedes have all shared in the work, and so numerous are they that it would be impossible for me to name them all. Stephen Hales, however, deserves special mention, for he was the first to measure the pressure of blood in the arteries, and the resistance offered to the circulation of the blood by the capillaries was investigated by Thomas Young, a Fellow of this College, who ranks with Harvey, Newton, and Darwin as one of the greatest scientific men that England has ever produced, and whose undulatory theory has been as fertile of results in physics as Harvey's idea of circulation has been in physiology and medicine.

Harvey's desire that those who had done good work should not be forgotten was founded upon his knowledge of mankind, and of the tendency there is to forget what has already been done by those who have gone before us. The opposite condition often prevails, and the past is glorified at the expense of the present. But sometimes the present is wrongly glorified at the expense of the past, and past work or past benefits are forgotten.

Good examples of this are afforded by physiological views regarding the action of the vena cava and pulmonary veins and the causation of the cardiac sounds. Harvey appears to have thought that the vena cava and pulmonary veins were simply dilated passively by the passage of blood into them; but the fact that they possess a power of independent pulsation was known to Haller,[1] and was brought prominently forward by Senac,[2] who regards the vena cava as the starting-point of the whole circulation. He says: "The vena cava is therefore the first motor cause which dilates the cavities of the heart; it fills the auricles, and extends their walls in every direction."

These observations appear to have been almost forgotten until they were again made independently a few years ago,[3] and in one of the latest and most accurate physiological treatises which now exist, the description of the cardiac cycle is nearly the same as that given by Senac. "A complete beat of the whole heart, or cardiac cycle, may be observed to take place as follows:—

"The great veins, inferior and superior venæ cavæ and pulmonary veins are seen, while full of blood, to contract in the neighbourhood of the heart; the contraction runs in a peristaltic wave toward the auricles, increasing in intensity as it goes."[4]

The pulsation of these veins, however, cannot be a constant phenomenon, or it would have been noticed by such a keen observer as Harvey.

The sounds of the heart were discovered by Harvey, or at least were known to him, for he speaks of the sound caused in the œsophagus of the horse by drinking, and says: "In the same way it is with each motion of the heart, when there is a delivery of blood from the veins to the arteries that a pulse takes place and can be heard within the chest." This observation remained, as far as we know, without any further development until the time of Laennec, who introduced the practice of auscultation; but it was a Fellow of this College, Dr. Wollaston,[5] who first discovered that the muscles during contraction give out a sound; and although many observations were made regarding cardiac murmurs by Corrigan, Bouillaud, and Piorry, it was chiefly by Fellows of this College, Dr. Clendinning, Dr. C. J. B. Williams, and Dr. Todd, that the question was finally settled, and the conclusions at which they arrived are those now accepted as correct, viz. that "the first or systolic sound is essentially caused by the sudden and forcible tightening of the muscular fibres of the ventricle when they contract; and that the second sound which accompanies the diastole of the ventricle depends solely on the reaction of the arterial columns of blood in the semilunar valves at the arterial orifices."[1]

Yet in recent discussions regarding the origin of cardiac sounds, little mention has been made of the work of this committee; and, indeed, I first learned of the value of the work from a German source, Wagner's "Handworterbuch der Physiologie."

The importance of these observations in the diagnosis of heart disease it would be hard to over-estimate. But diagnosis alone is not the aim of the physician, whose object must be to prevent, to cure, or to control disease. A knowledge of physiology may greatly help us to prevent disease, not only of the heart and vessels, but of every member of the body. The control and cure of disease may also be effected by diet and regimen, but it is undoubtedly in many cases greatly assisted by the use of drugs, and is sometimes impossible without them. Harvey knew that drugs applied externally are absorbed and act on the body,[2] so that colocynth thus applied will purge, and cantharides will excite the urine; but the action of drugs when injected into the blood appears to have been tried first by Christopher Wren, better known as the architect of St. Paul's than as a pharmacologist. According to Bishop Spratt, "He was the first author of the noble anatomical experiment of injecting liquors into the veins of animals, an experiment now vulgarly known, but long since exhibited to the meetings at Oxford, and thence carried by some Germans, and published abroad. By this operation divers creatures were immediately purged, vomited, intoxicated, killed, or revived, according to the quality of the liquor injected. Hence arose many new experiments, and chiefly that of transfusing blood, which the Society has prosecuted in sundry instances, that will probably end in extraordinary success."[3]

The method originated by Wren, of injecting drugs into the circulation, was skilfully utilised by Magendie for the purpose of localising the particular part of the body upon which the drugs exerted their action, and he thus conclusively proved that the symptoms produced by strychnine were due to its effect on the spinal cord. His experiments showed that the rate of absorption from various parts of the body varied enormously, and, through the teaching of Christison, led to the introduction into practice by Dr. Alexander Wood of that most useful aid to modern therapeutics, the hypodermic syringe.

The first quantitative experiments on the effect of drugs upon the circulation were made, to the best of my knowledge, by James Blake in 1844, in the laboratory of University College, at the suggestion of the late Prof. Sharpey, with the hæmodynamometer of Poiseulle, which had then been recently introduced.

In speaking about the work of Blake and Sharpey, who are both dead, one requires to use the greatest care not to unduly detract from the merit of one by ascribing more to the other; but those who knew Prof. Sharpey's enormous range of knowledge, his readiness to put it all at the disposal of others, and the influence he exerted upon all who came in contact with him, as well as his unselfishness in making no claim whatever to what was justly his due, will at once recognise how greatly Blake was indebted to Sharpey. More especially is this the case when we consider that, although the credit for the observations themselves belongs to Blake, yet after the impetus which Sharpey gave him had passed away, he did very little more during the course of a long life. It seems all the more necessary to commemorate Sharpey on this occasion because he has left comparatively few writings behind him, and anyone who should judge by them alone of his influence upon physiological progress in this country would grievously underestimate it. For Sharpey was above all a teacher, and his work was written not with pen and ink on paper or parchment, but was engraved upon the hearts and minds of his pupils and friends. Upon two of these, especially, has Sharpey's mantle fallen, and to Burdon Sanderson and Michael Foster we owe a revival of experimental physiology in this country, a revival of the method which Harvey not only used in making his great discovery, but also employed to demonstrate the truth of it to the rulers of this land. By their writings, by their lectures, by their original experiments, by their demonstrations, and by the pupils they have trained, Burdon

[1] Haller, "Elementa Physiologiæ," 1757, tome 1, pp. 41 and 399.
[2] Senac, "De la Structure du cœur," livre iv. ch. iii. p. 24.
[3] *Proc. Roy. Soc.* 1876, No. 172.
[4] M. Foster; "Text-book of Physiology," 6th ed. part i. ch. iv. p. 231.
[5] Wollaston, "Phil. Trans." 1810, p. 2.

[1] Report of Committee consisting of C. J. B. Williams, R. B. Todd, and John Clendinning, "Brit. Assoc. Rep. for 1836," p. 155.
[2] "The Works of William Harvey," Sydenham Society edition, p. 72.
[3] "The History of the Royal Society of London, for the Improving of Natural Knowledge," by Thos. Spratt, late Lord Bishop of Rochester.

Sanderson and Michael Foster, under the auspices of Acland and Humphrey, have diffused amongst the medical men of this country a knowledge of physiology so extensive and exact as could only be found, before their time, amongst those who had made a special study of the subject. Yet more than to them, more than to anyone else since the time of Harvey, do we owe our present knowledge of the circulation to Carl Ludwig. He it is who first enabled the pressure of blood in the arteries to record its own variations automatically, so that alterations could be noticed and measured which were too rapid or too slight to be detected by the eye. To him, also, we owe the plan of artificial circulation by which the changes in the functions of the organs and in the vessels which supply them can be observed, quite apart from the heart, lungs, or from the nervous system.

Like Sharpey, Ludwig is a great teacher, and like the great architects of the Middle Ages, who built the wonderful cathedrals which all admire, and the builder of which no man knows, Ludwig has been content to sink his own name in his anxiety for the progress of his work, and in his desire to aid his pupils. The researches which have appeared under these pupils' names have been in many instances, perhaps in most, not only suggested by Ludwig, but carried out experimentally with his own hands, and the paper which recorded the results finally written by himself. In the papers which have appeared under his pupils' names we find their obligations to the master recorded in such terms as "unter Mitwirkung." But no one, except those who have worked with him, can understand what such co-operation meant.

The graphic method introduced by Ludwig for the purpose of measuring the blood pressure, was adapted by Volkmann to the registration of the pulse in man, and the same method has been modified and rendered more easily applicable at the bedside by Marey and Chauveau, to whom we chiefly owe our knowledge of the modifications in the form of the apex beat, and of the pulse curve. It is to Ludwig and his scholars, however, that we owe the greater part of our knowledge of the mechanism of the circulation, and of the varying distribution the blood in various parts of the body.

The effect of emotion upon the heart was carefully noted by Harvey, who says: "For every affection of the mind which is attended with pain or pleasure, hope or fear is the cause of an agitation whose influence extends to the heart." [1]

Not only was Harvey well acquainted with the fact that the beats of the heart vary very much in strength and force, but he also knew that the circulation in various parts of the body may be very different at one and the same time. He says: "It is manifest that the blood in its course does not everywhere pass with the same celerity, neither with the same force in all places, and at all times, but that it varies greatly according to age, sex, temperament, habit of body, and other contingent circumstances, external as well as internal, natural or non-natural. For it does not course through intricate and obstructed passages with the same readiness that it does through straight, unimpeded and pervious channels. Neither does it run through close, hard, and crowded parts, with the same velocity as through spongy, soft, and permeable tissues. Neither does it flow and penetrate with such swiftness when the impulse (of the heart) is slow and weak, as when this is forcible and frequent, in which case the blood is driven onwards with vigour, and in large quantity."

"And what, indeed, is more deserving of attention than the fact that in almost every affection, appetite, hope, or fear, our body suffers, the countenance changes, and the blood appears to course hither and thither. In anger the eyes are fiery and the pupils contracted; in modesty the cheeks are suffused with blushes; in fear, and under a sense of infamy and of shame, the face is pale, but the ears burn as if for the evil they heard or were to hear; in lust, how quickly is the member distended with blood and erected." [2]

Harvey's great contemporary, Milton, though so violently opposed to him in politics, would certainly not remain in ignorance of Harvey's work, and he has noted the changes in the colour of the face produced by emotions. In describing the behaviour of Satan on his journey from Hell to Paradise, he says:—

> "Thus while he spake, each passion dimm'd his face,
> Thrice changed with pale—ire, envy, and despair;
> Which marr'd his borrow'd visage." [3]

[1] "The Works of William Harvey," Sydenham Society's edition, p. 70.
[2] *Ibid.*, p. 128–129
[3] "Paradise Lost," by John Milton, Book iv., p. 85

But although these facts were known to Harvey so long ago, it is only in comparatively recent years that the mechanism by which they are brought about has been investigated, and it is only within the last decade that physiologists have begun regularly to believe that the cardiac muscle has a power of rhythmic pulsation independent of its nerves, although Harvey had noted that when the heart was cut into small pieces the fragments would still continue to pulsate. We may fairly, indeed, compare the movements of the heart, as regarded by physiologists of the present day, to those of a horse which is capable of going independently, although its pace may be slowed or accelerated by the reins or spur of the rider. The power of the vagus to act as a rein to the heart, and slow its movements, or stop them altogether, was first noted by Edward and Ernest Heinrich Weber, while the effect that it sometimes has of accelerating instead of slowing, like the effect of shaking the reins of the horse, was observed by Schiff, Moleschott, and Lister.

The accelerating nerves of the heart, and the position of the nerve-centre from which they spring, were more thoroughly investigated by von Bezold,[1] while the power of the vagus to weaken as well as slow the heart was observed by Gaskell. The position of the cardiac centre, which, like the rider, regulates the movements of the heart, was located in the medulla oblongata chiefly by Ludwig and his scholars. Like the heart, the vessels also are regulated in diameter by the nervous system in accordance with the wants of the body generally; and the effect upon the vaso motor nerves which, when cut, allow them to dilate, and when stimulated cause them to contract, was discovered by Bernard, Brown-Séquard, and by our countryman, Waller; while the power of other nerves to cause immediate dilatation was discovered by Bernard, Eckhardt, and Ludwig in the submaxillary glands, penis, and peripheral vessels respectively.

The heart, when cut out of the body, still continues to beat, and the transmission of excitation from one cavity to another was experimented on by Paget, although removed completely from the influence of the central nervous system, and the vessels have a somewhat similar power of independent contractility. The alterations produced in the circulation generally and locally by the contractile power of the vessels, and the changes caused in the vessels by the central nervous system, by peripheral stimulation of the nerves, or by variations in the quality of the blood, have formed the subject of a series of researches extending over many years; and though originated, and in many cases entirely conducted, by Ludwig, have appeared to a great extent under the names of his pupils. The starting-point of these investigations was an examination of the changes in the blood as it flowed through isolated organs, with the view of ascertaining in what manner the combustion by which the animal heat is maintained was effected in the body. While keeping up the circulation of blood through the vessels of muscles severed from the body, Ludwig and Sczelkow[2] observed variations in the flow which appeared to indicate contractile power in the vessels themselves. This research was carried on under Ludwig's direction by various of his scholars in succession, Alexander Schmidt, Dogiel, Sadler, myself, Hafiz, Lepine, A. Mosso, von Frey, and Gaskell. Their observations, as well as those of Cohnheim and Gunning, have shown that the muscular fibres of the arterioles, not only in the muscles but throughout the body generally, have a power of independent and sometimes rhythmical contraction and relaxation. Their contractility is, however, controlled by the central nervous system in accordance with the wants of the body generally. For the amount of blood contained in the body is insufficient to fill the whole of the vascular system at once; and when the vessels are fully dilated, as they are after death, we find that nearly the whole of the blood of the body may be contained in the veins alone. It is, therefore, necessary that when one part of the body is receiving a larger supply of blood, another should be receiving a smaller supply; and the functions of the vaso motor centres have been well compared by Ludwig to the turncocks in a great city, who cut off the water supply from one district at the same time they turn it on to another. Thus it is that when the brain is active the feet may get cold, and Mosso has shown this in an exceedingly neat manner by placing a man on a large board delicately balanced at its centre, and demonstrating that

[1] Von Bezold "Untersuchungen uber die Innervation des Herzens," 1863. Leipzig: Engelmann.
[2] Ludwig and Sczelkow, "Henle and Pfeuffers Zeitschrift," 1863, vol. 17. p. 106 and *vide* p. 122.

whenever the man began to think, the increased supply of blood to his brain caused the head to go down and the heels to rise up. A similar condition was indicated by Mayow, who gave a different explanation. He said that the vital spirits were not able to be in the same place at once, and therefore it happens that if a man eats a heavy meal, he is apt to become drowsy, because the vital spirits descend from the brain to the stomach in order to carry on digestion; and, on the other hand, if a man thinks vigorously after dinner, the vital spirits have to leave the stomach to go to the brain, and consequently digestion is imperfectly performed. If we substitute the word blood for vital spirits, we have an exact expression of present physiological ideas.

Ubi stimulus ibi affluxus was an old doctrine and expressed a great truth. Wherever the need for increased nourishment or increased supply of oxygen exists in the healthy body, thither does the blood flow in larger quantities than usual. If the glands are active, their blood supply is greatly increased, as was shown by Bernard, and a similar occurrence takes place in the contracting muscle, as has been shown by Ludwig and his scholars. The vessels of the intestines and of the skin, with their numerous glands, have their calibre regulated by the vaso motor nerves which proceed from the centre in the medulla oblongata. This centre acts most readily upon the vessels of the intestine, and rather less readily on those of the skin. In consequence of this, when the centre is irritated, the vessels of the intestine contract and drive the blood through the skin, so that it is warmer than before, and it is only when the stimulation is very great that the vessels of both contract so that the skin receives less blood than normal, and becomes colder than before. But if the vessels of the skin and intestine are both contracted, where does the blood go? This question was put by Ludwig, and answered by the experiments which he made with Hafiz. It is evident that if the heart be stopped while the blood pressure is being measured in the artery of an animal, the pressure will fall regularly and steadily, because the blood is flowing out all the time through the arterioles and capillaries into the veins. One would naturally expect that if the arterioles were contracted by irritation of the vaso motor centres in the medulla, the fall of blood pressure would either not take place at all, or would be very much slower than before; but on trying the experiment, Ludwig and Hafiz found, to their surprise, that the blood pressure fell almost as quickly as when the vaso motor centre was left alone, and the vessels of the skin and intestine therefore remained uncontracted. In other words, the vessels which supply the muscles of the body and limbs are capable of such extension that when fully dilated they will allow the arterial blood to pour through them alone nearly as quickly as it usually does through the vessels of the skin, intestine, and muscles together. This observation, it seems to me, is one of the greatest importance, and one that has hardly received as yet the attention which it merits.

It is obvious that contraction of the cutaneous vessels, such as occurs upon exposure to cold, will drive more blood through the muscles, and as oxidation goes on more rapidly in them the result will be increased production of heat.

The experiments I have just mentioned show that the vessels of the muscles are not controlled by the vaso motor centre in the medulla oblongata in the same way as those of the intestine and skin. How far their vascular centres may be associated with those for voluntary movements, which have been so admirably localised by Ferrier in the cerebral cortex, still remains to be made out. The circulation through the muscles is indeed a complex phenomenon, and it was shown by Ludwig and Sadler to depend upon at least two factors having an antagonistic action. When a muscle is thrown into action, it mechanically compresses the blood vessels within it, and thus tends to lessen the circulation through it, but at the same time the stimulus which is sent down through the motor nerve, and which calls it into action, brings about a dilatation of the vascular walls, and thus increases the circulation through the muscle.

When the amount of blood is measured before, during, and after stimulation of its motor nerves, it is sometimes found that the flow is diminished, at others that it is increased, the alteration depending upon the comparative effect of the mechanical compression of the vessels of the muscles just mentioned, and upon the increase of their lumen by the dilatation of their walls. It invariably happens, however, that after the muscle has ceased to act, the flow of blood through the muscle is increased. This increase is quite independent of any alteration in the general pressure of blood in the arteries, and it occurs when an artificial stream of blood, under constant pressure, is sent through the muscle. The dilatation in the muscular vessels, as indicated by the increased flow of blood, and consequent change of colour in the frog's tongue, was observed by Lépine after stimulation of the peripheral ends of the hypoglossal and glossopharyngeal nerves, and the actual changes in the vessels themselves were observed microscopically by von Frey and Gaskell.

The dilatation of muscular vessels on irritation of peripheral nerves was thus brought into a line with the dilatation noticed in the vessels of the submaxillary gland by Bernard, and in the corpora cavernosa by Eckhart. It is evident that alteration in the size of such a huge vascular tract as the muscular arteries must influence, to a great extent, the blood pressure in the arteries generally, and it is equally evident that the changes induced in the condition of the blood pressure by muscular action may be of two kinds, either a rise or a fall. If the arterioles are compressed by the muscles so that the flow through them is impeded, the general blood pressure will rise. When this effect is more than counteracted by the dilatation of the arterioles themselves under nervous influence the general blood pressure will fall, for the blood will find an easy passage through the vessels from the arteries into the veins. We can thus see how readily a rise or fall in the general blood pressure may be induced by exercise of the muscles. If they contract suddenly or violently they will tend to compress the arterioles, and raise the blood pressure, while quite easy contraction will have little effect in compressing the arterioles, and these, becoming dilated, will allow the blood pressure to fall.

But there is still another factor which may tend to increase the blood pressure during severe muscular exertion, viz. a quickened pulse for stimulation of the nerve fibres extending from the muscles to the central nervous system greatly accelerates the beats of the heart. In this respect stimulation of the muscular nerves differs from that of the cutaneous and visceral nerves, inasmuch as the latter tend rather to slow than to quicken the pulse. The peculiar effect of the muscular nerves upon the heart would, indeed, appear to be a provision of nature for the purpose of maintaining an exceedingly active circulation during the active calls upon nutrition which violent exertions entail. Muscular exercise, therefore, has a special tendency to raise the blood pressure in the arterial system, and consequently to increase the resistance which the left ventricle has to overcome. Moreover, in the case of the intestinal vessels there is a special provision made for preventing their contraction from causing too great a rise of arterial pressure. This consists in the depressor nerve, which passes from the heart and tends to produce dilatation of the abdominal vessels, and thus prevent any undue pressure occurring within the heart from their excessive contraction.

In the case of the muscles, we have no such nerves. Its place seems to be taken by the dilating fibres which occur in the motor nerves. As I have already said, however, this effect of dilatation in the muscular vessels may be at first more than counteracted by mechanical compression at the commencement of exertion, and thus the blood pressure in the arteries, and the resistance which it opposes to the contraction and emptying of the ventricle, may be unduly increased.

As a general rule, the distension of any hollow muscular organ is attended with great pain. How great is the suffering when obstruction of the bowel prevents evacuation of its contents; or when a calculus, in its passage down the gall duct or ureter, forcibly distends their wall. One of the severest tortures of the Middle Ages was to distend the stomach with water, and the Emperor Tiberius could imagine no more awful punishment for those whom he hated than to make them drink wine, and, at the same time, by means of a ligature, to prevent the distended bladder from emptying itself. The heart is no exception to this rule, and distension of its cavities brings on most acute physical suffering. Its inability to empty itself is a question of relative, and not of absolute, power; for a strong heart may be unable to work only against enormously increased resistance in the peripheral arterioles, while the heart, weakened by degeneration, may be unable to empty itself in face of pressure little, if at all, above the normal.

When the contractile power of the heart is not, as it is in health, considerably in excess of the resistance opposed to it in vessels, but only nearly equal to it, a slight increase in the resistance may greatly interfere with the power of the heart to empty itself, and bring on pain varying in amount from slight uneasiness to the most intense agony in angina pectoris.

This is, indeed, what we find, for a heart whose nutrition has been weakened by disease of the arteries, and consequent imperfect supply of blood to the cardiac muscle, is unable to meet any increased resistance if this should be offered to it, and pain is at once felt. In such cases, unless they be far advanced, we find, precisely as we might expect, that walking on the level usually causes no pain, but the attempt to ascend even a slight rise, by which the muscles are brought into more active exertion, brings on pain at once. Yet here again we find, as we should expect, that if the patient is able to continue walking, the pain passes off and does not return. These phenomena would be inexplicable were it not for Ludwig's observations on circulation through the muscles, but in the light of these observations everything is made perfectly intelligible. Walking on the flat, by causing no violent exertion of the muscles, produces no mechanical constriction of the vessels, and thus does not increase the blood pressure. The greater exertion of walking up a hill has this effect, but if the patient is able to continue his exertions, the increased dilatation of the vessels—a consequence of muscular activity—allows the pressure again to fall, and relieves the pain.

As muscular exertion continues and the vessels of the muscles become dilated, the flow of blood from the arteries into the veins will tend to become much more rapid than usual. The pressure in the arterial system will consequently fall, but that in the veins will become increased, and unless a corresponding dilatation occurs in the pulmonary circulation, blood will tend to accumulate in the right side of the heart, the right ventricle will be unable to empty itself completely, shortness of breath will arise, and even death may occur. At first the right side of the heart is affected, and the apex beat disappears from the normal place and is felt in the epigastrium, but the left ventricle also becomes dilated, though whether this is simply through nervous influence tending to make it act concordantly with the right, or for some other reason, it is at present impossible to say. Severe exertion, even for a few minutes, may produce this condition in healthy persons,[1] and when the exertion is over-continued it may lead to permanent mischief. More especially is this the case in young growing boys, and it is not merely foolish, it is wicked to insist upon boys engaging in games or contests which demand a long-continued over-exertion of the heart, such as enforced races and paper-chases extending over several miles. Intermittent exertion, either of a single muscle or of a group of muscles, or of the whole body, appears to lead to better nutrition and increased strength and hypertrophy, but over-exertion, especially if it continues, leads to impaired nutrition, weakness, and atrophy. If we watch the movements of young animals, we find that they are often rapid, but fitful and irregular and varied in character, instead of being steady, regular, and uniform. They are the movements of the butterfly, and not of the bee. The varied plays of childhood, the gambols of the lamb, and the frisking of the colt, are all well adapted to increase the strength of the body without doing it any injury; but if the colt, instead of being allowed to frisk at its own free will, is put in harness, or ridden in races, the energy which ought to have gone to growth is used up by the work, its nutrition is affected, its powers diminished, and its life is shortened. The rules which have been arrived at by the breeders of horses ought to be carefully considered by the teachers of schools, and by the medical advisers who superintend the pupils.

In youth and middle age every organ of the body is adapted for doing more work than it is usually called upon to do. Every organ can, as it is usually termed, make a spurt if required; but as old age comes on this capacity disappears, the tissues become less elastic, the arteries become more rigid and less capable of dilating and allowing freer flow of blood to any part, whether it be the intestine, the skin, the brain, the muscles, or the heart itself. Mere rigidity of the arteries supplying the muscles of the heart will lessen the power of extra exertion, but if the vessels be not only rigid, but diminished in calibre, the muscles of the limbs and the heart itself will be unfit even for their ordinary work, and will tend to fail on the slightest over-exertion. This fact was noticed by Sir Benjamin Brodie, who, when speaking of patients with degenerating and contracted arteries, such as lead to senile gangrene, said: "Such patients walk a short distance very well, but when they attempt more than this, the muscles seem to be unequal to the task, and they can walk no further. The muscles are not absolutely paralysed, but in a state approaching to it. The cause of all this is sufficiently obvious. The lower limbs require sometimes a larger and sometimes a smaller supply of blood. During exercise a larger supply is wanted on account of the increased action of the muscles; but the arteries being ossified or obliterated, and thus incapable of dilatation, the increased supply cannot be obtained. This state of things is not peculiar to the lower limbs. Wherever muscular structures exist the same cause will produce the same effect. Dr. Jenner first, and Dr. Parry, of Bath, afterward, published observations which were supposed to prove that the disease which is usually called "angina pectoris depends on ossification of the coronary arteries. . . . When the coronary arteries are in this condition they may be capable of admitting a moderate supply of blood to the muscular structure of the heart; and as long as the patient makes no abnormal exertion, the circulation goes on well enough; when, however, the heart is excited to increased action, whether it be during a fit of passion, or in running, or walking upstairs, or lifting weights, then the ossified arteries being incapable of expanding so as to let in the additional quantity of blood, which, under these circumstances, is required, its action stops and syncope ensues; and I say that this exactly corresponds to the sense of weakness and want of muscular power which exists in persons who have the arteries of the legs obstructed or ossified."[1]

But the syncope and stoppage of the heart mentioned by Brodie are not the only consequences of impaired cardiac nutrition. The heart may be still able to carry on the circulation, but the patient may suffer intense pain in the process. The outside of the heart was found by Harvey to be insensible to light touches, but the inside of the heart appears to be much more sensitive either to touch or pressure.

A knowledge of the mode of circulation of blood through the muscles enables us to understand not only the pathology of angina pectoris, but the rationale of various methods of treating patients suffering from angina pectoris or other forms of heart disease. In most cases, our object is a twofold one—to increase the power of the heart, and to lessen the resistance it has to overcome. In some cases, we require also to aid the elimination of water which has so accumulated as to give rise to œdema of the cellular tissues, or dropsy of the serous cavities. In our endeavours to produce these beneficial changes in our patients, we employ regimen, diet, and drugs, and it is evident that as in one case the condition of a patient's heart may be very different indeed from that in another, the regimen which may be useful to one may be fatal to the other. We have already seen that sudden and violent exertion may raise the blood pressure, and so lead to intense cardiac pain or to stoppage of the heart and instant death; while more gentle exercises, by increasing the circulation through the muscles, may lessen the pressure and give relief to the heart.

The methods of increasing the muscular circulation may be roughly divided into three, according as the patient lies, stands, or walks. First, absolute rest in bed with massage;[2] second, graduated movements of the muscles of the limbs and body while the patient stands still; third, graduated exercises in walking and climbing.

The second of these methods has been specially worked out by the brothers Schott, of Nauheim, and the third is generally connected with the name of Oertel. It is obvious that in cases of heart disease where the failure is great and the patient is unable even to stand, much less to walk, where breathlessness is extreme and dropsy is present or is advanced, the second and third methods of treatment are inapplicable. It is in such cases that the method of absolute rest in bed, not allowing the patient to rise for any purpose whatever, hardly allowing him to feed himself or turn himself in bed, proves advantageous. The appetite is usually small, the digestion imperfect, and flatulence troublesome; and here an absolute milk diet, like that usually employed in typhoid fever, is often most serviceable, being easily taken and easily digested, while the milk sugar itself has a diuretic action, and tends to reduce dropsy. But while simple rest prevents the risk of increased arterial tension and consequent opposition to the cardiac contractions which might arise from muscular exertion, such benefits as would accrue from muscular exertion and increased circulation would be lost were it not that they can be supplied artificially by massage.

[1] Schott. Verhandl. des IX. Congresses in Med. zu Wien, 1890.

[1] "Lectures on Pathology and Surgery," by Sir Benjamin Brodie. (London, 1846, p. 360.)

[2] *Practitioner*, vol. li., p. 190.

This plan of treatment, although it has only recently been revived, was known to Harvey, who narrates the case of a man who, in consequence of an injury—of an affront which he could not revenge—was so overcome with hatred, spite, and passion that "he fell into a strange disorder, suffering from extreme compression and pain in the heart and breast, from which he only received some little relief at last when the whole of his chest was pummelled by a strong man, as the baker kneads dough."[1]

This was a very rough form of massage, but the same kneading movements which Harvey described have been elaborated into a complete system, more especially by Ling in Sweden, and made widely known in America and this country by Weir-Mitchell, and Playfair. One might naturally expect that kneading the muscles would increase the circulation through them in somewhat the same way as active exercise, but, to the best of my knowledge, no actual experiments existed to prove this, and I accordingly requested my friend and assistant, Dr. Tunnicliffe, to test the matter experimentally. The method employed was, in the main, the same as that devised by Ludwig, and employed by Sadler and Gaskell under his direction. The results were that, during the kneading of a muscle the amount of venous blood which issued from it was sometimes diminished and sometimes increased; that just after the kneading was over the flow was diminished, apparently from the blood accumulating in the muscle, and this diminution was again succeeded by a greatly increased flow exactly corresponding to that observed by Ludwig and his scholars.

The clinical results are precisely what one would expect from increased circulation in the muscles, and cases apparently hopeless sometimes recover most wonderfully under this treatment. For patients who are stronger, so that confinement to bed is unnecessary, and who yet are unable to take walking exercise, Schott's treatment is most useful, and it may be used as an adjunct to the later stages of the treatment just described, or as a sequel to it. Here the patient is made to go through various exercises of the arms, legs, and trunk with a certain amount of resistance, which is applied either by the patient himself setting in action the opposing muscles, or by an attendant who gently resists every movement made by the patient, but graduates his resistance so as not to cause the least hurry in breathing, or the least oppression of the heart. Perhaps the easiest way of employing graduated resistance is by the ergostat of Gartner, which is simply an adaptation of the labour crank of prisons, where the number of turns of a wheel can be regulated in each minute, and the resistance which is applied by a brake may be graduated to an ounce. The objection to it is the uniformity of movement and its wearisome monotony. Oertel's plan of gradually walking day by day up a steeper and steeper incline, and thus training the muscles of the heart, is well adapted for stronger persons, but when applied injudiciously, may lead, just like hasty or excessive exertion, to serious or fatal results. In Schott's method stimulation of the skin by baths is used as an adjunct, and this may tend to slow the pulse, as already mentioned. But in all these plans the essence of treatment is the derivation of blood through a new channel, that of the muscular vessels, and the results in relieving cardiac distress and pain may be described in the same words which Harvey employs in reference to diseases of the circulation: "How speedily some of these diseases that are even reputed incurable are remedied and dispelled as if by enchantment."[2]

There is yet another consequence of the circulation to which Harvey has called attention, although only very briefly, which has now become of the utmost importance, and this is the admixture of blood from various parts of the body. After describing the intestinal veins, Harvey says: "The blood returning by these veins and bringing the cruder juices along with it, on the one hand from the stomach, where they are thin, watery, and not yet perfectly chylified; on the other, thick and more earthy, as derived from the fæces, but all pouring into this splenic branch, are duly tempered by the admixture of contraries."[3]

Harvey's chemical expressions are crude, for chemistry as a science only began to exist about a century and a half after Harvey's death, yet the general idea which he expresses in the words which I have just quoted is wonderfully near the truth.

Two of the most important constituents of the blood are chloride of sodium and water. Chloride of sodium is a neutral salt, but during digestion both it and water are decomposed in the gastric glands, and hydrochloric acid is poured into the stomach, while a corresponding amount of soda is returned into the blood, whose alkalinity increases *pari passu* with the acidity of the stomach. Part of this alkali is excreted in the urine, so that the urine during digestion is often neutral or alkaline. Possibly some of it passes out through the liver in the bile, through the pancreas and intestinal glands into the intestine, where, again mixing with the acid chyle from the stomach, neutralisation takes place, so that neutral and comparatively inactive chloride of sodium is again formed from the union of active alkali and acid. But it is most probable that what occurs in the stomach occurs also in the other glands, and that it is not merely excess of alkali resulting from gastric digestion which is poured out by the liver, pancreas and intestine, but that these glands also decompose salts, pour the alkali out through the ducts, and return the acid into the blood.

We are now leaving the region of definite fact and passing into that of fancy, but the fancies are not entirely baseless, and may show in what directions we may search out and study the secrets of nature by way of experiment. For what is apparently certain in regard to the decomposition of chloride of sodium in the stomach, and probably in the case of neutral salts in the pancreas and intestine, is also probable in that important, though as yet very imperfectly known, class of bodies which are known as zymogens. Just as we have in the stomach an inactive salt, so we have also an inactive pepsinogen, which, like the salt, is split up in the gastric glands, and active pepsine is poured into the stomach. But is the pepsine the only active substance produced? Has no other body, resulting from decomposition of the pepsinogen, been poured into the blood while the pepsine passed into the stomach? Has the inactive pepsinogen not been split up into two bodies active when apart, inactive when combined? May it not be fitly compared, as I have said elsewhere, to a cup or glass, harmless while whole, but yielding sharp and even dangerous splinters when broken, although these may again be united into a harmless whole?[1]

This question at present we cannot answer, but in the pancreas there is an indication that something of the kind takes place, for Lépine has discovered that while this gland pours into the intestine a ferment which converts starch into sugar, it pours through the lymphatics into the blood another ferment which destroys sugar. Whether a similar occurrence takes place in regard to its other ferments in the pancreas, or in the glands of the intestine, we do not know, nor do we yet know whether the same process goes on in the skin, and whether the secretion of sweat, which is usually looked upon as its sole function, bears really a relationship to cutaneous activity similar to that which the secretion of bile bears to the functions of the liver. There are indications that such is the case, for when the skin is varnished, not only does the temperature of the animal rapidly sink, but congestion occurs in internal organs, and dropsy takes place in serous cavities, while in extensive burns of the skin rapid disintegration of the blood corpuscles occurs. It is obvious that if this idea be at all correct, a complete revolution will be required in the views we have been accustomed to entertain regarding the action of many medicines. In the case of purgatives and diaphoretics, for example, we have looked mainly at the secretions poured out after their administration for an explanation of their usefulness, whereas it may be that the main part of the benefit that they produce is not by the substances liberated through the secretions they cause, but by those returned from the intestine and skin into the circulating blood.

How important an effect the excessive admixture of the juices from one part of the animal body with the circulating blood might have, was shown in the most striking way by Wooldridge. He found that the juice of the thyroid gland, though it is harmless while it remains in the gland, and is probably useful when it enters the blood in small quantities in the ordinary course of daily life, yet if injected into the blood, will cause it to coagulate almost instantaneously and kill the animal as quickly as a rifle bullet. What is powerful for harm is, likewise, powerful for good in these cases, and the administration of thyroid juice in cases of myxœdema is one of the most remarkable therapeutic discoveries of modern times. Since the introduction by Corvisart of pepsine

[1] The Works of William Harvey (Sydenham Society's Edition), p. [illegible].
[2] Ibid., p. 141
[3] Ibid., p. 7

[1] *Practitioner*, vol. xxxv. August 1885.

as a remedy in dyspepsia, digestive ferments have been largely employed to assist the stomach and intestine in the performance of their functions, but very little has been done until lately in the way of modifying tissue changes in the body by the introduction of ferments derived from solid organs. For ages back savages have eaten the raw hearts and other organs of the animals which they have killed, or the enemies they have conquered, under the belief that they would thereby obtain increased vigour or courage; but the first definite attempt to cure a disease by supplying a ferment from a solid non-glandular organ of the body was, I believe, made in Harvey's own hospital by the use of raw meat in diabetes.[1] It was not, however, until Brown-Séquard recommended the use of testicular extract, that the attention of the profession became attracted to the use of extracts of solid organs. Since then extract of thyroid, extract of kidney, extract of supra renal capsule have been employed; but even yet they are only upon their trial, and the limits of their utility have not yet been definitely ascertained.

But yet another therapeutic method has been recently introduced which bids fair to be of the utmost importance, the treatment of disease by antitoxins. The discovery by Pasteur of the dependence of many diseases upon the presence of minute organisms may be ranked with that of Harvey, both in regard to the far-reaching benefits which it has conferred upon mankind, and for the simplicity of its origin. The germ of all his discoveries was the attempt to answer the apparently useless question: "Why does a crystal of tartaric acid sometimes crystallise in one form and sometimes in another?" From this germ sprung his discovery of the nature of yeast and of those microbes which originate fermentation, putrefaction, and disease. These minute organisms, far removed from man as they are in their structure and place in nature, appear in some respects to resemble him in the processes of their growth and nutrition. They seem, indeed, to have the power of splitting up inactive bodies into substances having a great physiological or chemical activity. From grape sugar, which is comparatively inert, they produce carbonic acid and alcohol, both of which have a powerful physiological action. From inert albumen they produce albumoses having a most powerful toxic action, and to the poisonous properties of these substances attention was for a while alone directed. But it would appear that at the same time they produce poisons they also form antidotes, and when cultivated without the body, and introduced into the living organism, they give rise to the production of these antidotes in still greater quantity.

The plan of protection from infective diseases, which was first employed by Jenner in small-pox, is now being extended to many other diseases, and the protective substances which are formed in the body, and their mode of action, are being carefully investigated. The introduction either of pathogenic microbes or of toxic products appears to excite in the body a process of tissue change by which antitoxins are produced, and these may be employed either for the purpose of protection or cure. By the use of antitoxins tetanus and diphtheria appear to be deprived of much of their terrible power. But it seems probable that a similar result may be obtained by the introduction of certain tissue juices into the general circulation. It was shown by Wooldridge that thyroid juice has a power of destroying anthrax poison, and it seems probable that increase of the circulation of certain organs will increase their tissue activity, will throw their juices or the products of their functional activity into the general circulation, and thus influence the invasion or progress of disease. As I have already mentioned, we are able to influence the circulation in muscles both by voluntary exertion and by passive massage, and we should expect that both of these measures would influence the constituents of the blood generally; and such, indeed, appears to be the case, for J. K. Mitchell[2] has found that after massage the number of blood corpuscles in the circulation is very considerably increased.

Had time allowed it, I had intended to discuss the modifications of the heart and vessels by the introduction of remedies into the circulation, the power of drugs to slow or strengthen, to quicken or weaken the power of the heart, to contract or relax the arterioles, to raise or lower the blood pressure, to relieve pain or to remove dropsy; but to do this would require time far exceeding that of a single lecture. Moreover, the methods and results were admirably expounded to the College by Dr. Leech in his Croonian lecture, and I have therefore thought I should be better fulfilling the wish of Harvey that the orator of the year should exhort the Fellows and Members of the College to search out the secrets of nature by way of experiment by directing their attention to fields of research which have received at present little attention, but promise results of great practical value. Lastly, I have to exhort you to continue in mutual love and affection among yourselves; and it seems to me that the best way of doing this is to direct your attention to the examples of Harvey and of our late President, whose death we deplore to-day. They were beloved by their fellows while they lived, their loss was lamented when they died, and they have left behind them an example not only of goodness, but of courage. Harvey, seated speechless in his chair, distributing rings and parting gifts to his friends while awaiting the approach of death; or Andrew Clark, steadfastly determining to continue at work and die in harness, in spite of the hæmoptysis which seemed to threaten a speedy death, afford us noble examples which ought to encourage us to follow the directions of the venerable Longfellow, who, taking the organ Harvey studied to symbolise such courage as Harvey and Clark showed, says—

"Let us then be up and doing
With a heart for any fate.
Still achieving, still pursuing,
Learn to labour and to wait."

[1] *Brit. Med. Journ.*, February 21, 1874, p. 221 *et seq.*

[2] *American Journal of Medical Science*, May 18[illegible]

SCIENTIFIC METHOD IN BOARD SCHOOLS.[1]

AT the request of my friend and former pupil, Mr. W. M. Heller, I have undertaken to say a few words by way of introduction to the course which he is about to give here to assist a number of you who are teachers in schools in the Tower Hamlets and Hackney district under the School Board for London—a course of lessons expressly intended to direct your attention to the educational value of instruction given solely with the object of inculcating *scientific* habits of mind and *scientific* ways of working; and expressly and primarily intended to assist you in giving such teaching in your schools.

Nothing could afford me greater pleasure, as I regard the introduction of such teaching into schools generally—not Board Schools merely, but all schools—as of the utmost importance; indeed, I may say, as of national importance: and I now confidently look forward to the time, at no distant date, when this will be everywhere acknowledged and acted on. Personally I regard the work that I have been able to do in this direction as of far greater value than any purely scientific work that I have accomplished. At the very outset of my career as a teacher, I was led to see how illogical, unsatisfactory and artificial were the prevailing methods of teaching, and became interested in their improvement. My appointment as one of the first professors at the Finsbury Technical College forced me to pay particular attention to the subject and gave me abundant opportunity of practically working out a scheme of my own. I was the more anxious to do this, as I soon became convinced that if any real progress were to be made in our system of technical education, it was essential in the first place to introduce improved methods of teaching into schools generally, so that students of technical subjects might commence their studies properly prepared; and subsequent experience has only confirmed this view. Indeed it is beyond question, in the opinion of many, that what we at present most want in this country are proper systems of primary and secondary education: the latter especially. Now, most students at our technical colleges, in consequence of their defective school training, not only waste much of their time in learning elementary principles with which they should have been made familiar at school, and much of our time by obliging us to give elementary lessons but what is far worse, they have acquired bad habits and convictions which are very difficult to eradicate; and their mental attitude towards their studies is usually a false one.

The first fruits of my experience were made public in 1884, at one of the Educational Conferences held at the Health Exhibition. On that occasion, and again at the British Association meeting at Aberdeen in 1885, in the course of my address as president of the Chemical Section, after somewhat sharply criticising the methods of teaching in vogue, I pointed out what I conceived to be the directions in which improvements should be effected. Others meanwhile were working in the

[1] A revised address delivered at the Berners Street Board School, Commercial Road, London, E., on October [illegible], 1894, by Prof. H. E. Armstrong, F.R.S.

same spirit, and consequently, in 1887, a number of us willingly consented to act as a committee "for the purpose of inquiring into and reporting upon the present methods of teaching chemistry." This committee was appointed at the meeting of the British Association in York, and consisted of Prof. W. R. Dunstan (secretary), Dr. J. H. Gladstone, Mr. A. G. Vernon Harcourt, Prof. H. McLeod, Prof. Meldola, Mr. Pattison Muir, Sir Henry E. Roscoe, Dr. W. J. Russell (chairman), Mr. W. A. Shenstone, Prof. Smithells, Mr. Stallard and myself. A report was presented at the Bath meeting in 1888, giving an account of replies received to a letter addressed to the head masters of schools in which elementary chemistry was taught. In 1889 and 1890 reports were presented in which were included suggestions drawn up by myself for a course of elementary instruction in physical science.

Let me at once emphasise the fact that these schemes were for a course of instruction in physical science—not in chemistry alone. The objects to be accomplished by the introduction of such lessons into schools have since been more fully dwelt on in a paper which I read at the College of Preceptors early in 1891, printed in the *Educational Times* in May of that year. After pointing out that literary and mathematical studies are not a sufficient preparation in the great majority of cases for the work of the world, as they develop introspective habits too exclusively, I then said, in future boys and girls generally must not be confined to desk studies; they must not only learn a good deal *about* things; they must also be taught how to *do* things, and to this end must learn how others before them have done things by actually repeating—not by merely reading about—what others have done. We ask, in fact, that the use of eyes and hands in unravelling the meaning of the wondrous changes which are going on around us in the world of nature shall be taught systematically in schools generally—that is to say, that the endeavour shall be made to inculcate the habits of observing accurately, of experimenting exactly, of observing and experimenting with a clearly defined and logical purpose, and of logical reasoning from observation and the results of experimental inquiry. Scientific habits and method must be universally taught. We ask to be at once admitted to equal rights with the *three R's*—it is no question of an alternative subject. This cannot be too clearly stated, and the battle must be fought out on this issue within the next few years.

Well, gentlemen and ladies, you have the honour of forming part of the advanced guard in the army which is fighting this battle (for the fight is begun in real earnest, although as yet on a small scale); nevertheless, in this case, the small beginning *must* have a great ending.

I had long sought for an opportunity of carrying the war into the camp of elementary education, and this came about four years ago when my friend Mr. Hugh Gordon was appointed one of the Science Demonstrators of the London School Board. During at least three years prior to his appointment, Mr. Gordon had been doing research work in the laboratory of which I have charge at the City and Guilds of London Institute Central Technical College, where he had also taken part in our elementary teaching, and he was already an ardent advocate of the educational policy of which I am so strong a supporter. Under the London School Board, he achieved a marvellous success, and the work that he has done as a pioneer cannot be too highly appreciated. He secured your confidence and sympathy, and interested his pupils; and working in a most unpromising field, under conditions of a most unsatisfactory and often depressing character, he has proved that to be possible, even easy (to the competent and willing teacher), which my friends in higher grade schools have often scoffed at and declared to be impossible. In future, no public school will be able to excuse itself, except on the ground of want of will to give such teaching. I have often been told that our scheme was too costly, that much special provision must be made to carry it into effect, and that it requires so much time and such an increase in the teaching staff: my friend Gordon, with your assistance alone and no other addition to the staff, by successfully teaching, I believe, in seventeen of your schools, has given all these statements the lie. But I confess that as yet there are few who could accomplish so much; few equally well fitted and prepared for the work, so imbued with the right spirit, so convinced that the cause is a great and holy one, gifted with sufficient energy and enthusiasm to overcome the difficulties. The little book he has written, in which the first part of the course of teaching he adopted is broadly outlined,[1] although containing a few slight blemishes which mar its otherwise logical character—blemishes which will be very easily removed in a second edition—appears to me to be a most important contribution to educational literature, and will render great service to our cause. But I count as his greatest achievement the introduction of a proper balance—calculated to inspire confidence and respect—into the schools, for I believe the discipline of learning to weigh carefully and exactly to be of the very highest value to a child, and one of the most effective means of leading children to be careful and exact in their work generally. I envy my friend his success, as I have in vain tried to get proper balances introduced into schools of far higher grade in place of wretched contrivances costing but three or four shillings, *which can be of no service in forming character*, although I have no wish to deny that such may be made use of in illustrating principles.

Mr. Gordon, I believe, was appointed to teach mechanics under what I will venture to call an antiquated and wooden syllabus, but he had the courage to burst the bonds imposed upon him, and from the outset determined to teach what was likely to be of real service to his pupils. I have said that he gained the confidence and sympathy of the teachers with whom he was associated and whose work he was appointed to supervise and direct; but I believe that he did more, and achieved success in a task of greater difficulty—that he actually made converts of some of her Majesty's Inspectors whose sympathies had previously lain with literary studies.

I have thought it desirable thus to sketch the history of the introduction of our British Association scheme into School Board circles. Let me now further emphasise the importance of teaching *scientific method*, which after all is recognised by very few as yet. Let me endeavour to make it clear what I mean by scientific method.: that when I speak of scientific method, I do not mean a branch of science, but something much broader and more generally useful. We may teach scientific method without teaching any branch of science; and there are many ways in which we may teach it with materials always close to hand.

I have very little belief in the efficacy of lecturing, and it is always difficult to persuade those who are not already persuaded—I would therefore refer those of you who are not yet with me to a book from which they may derive much information and inspiration. I mean Herbert Spencer's "Essay on Education," the cheap edition of which, published by Williams and Norgate, costs only one shilling and elevenpence! It is a book which every parent of intelligence desiring to educate his children properly should read; certainly every teacher should have studied it thoroughly; and no one should be allowed to become a member of a School Board who on examination was found not to have mastered its contents. But as Herbert Spencer says—and the times are not greatly changed since he wrote—although a great majority of the adult males throughout the kingdom are found to show some interest in the breeding, rearing, or training of animals of one kind or other, it rarely happens that one hears anything said about the rearing of children. I believe the subject is seldom mentioned in School Board debates. Hence it happens that Herbert Spencer's book has had a smaller circulation than many novels, and that the 1893 edition is but the 34th instead of being the 340th thousand. After very fully discussing the question "What knowledge is of most worth?" he arrives at the conclusion that science is, and eloquently advocates the claims of the order of knowledge termed scientific. The following are eminently instructive passages in his essay:—"While every one is ready to endorse the abstract proposition that instruction fitting youths for the business of life is of high importance, or even to consider it of supreme importance; yet scarcely any inquire what instruction will so fit them. It is true that reading, writing, and arithmetic are taught with an intelligent appreciation of their uses. But when we have said this we have said nearly all. While the great bulk of what else is acquired has no bearing on the industrial activities, an immensity of information that has a direct bearing on the industrial activities is entirely passed over. For, leaving out only some very small classes, what are all men employed in? They are employed in the production, preparation and distribution of commodities. And on what does efficiency in the production, preparation, and distribution of commodities depend? It depends on the use of methods fitted to the respective natures of these commodities; it depends

[1] *Cf.* NATURE, 1893, xlix. 121.

on an adequate acquaintance with their physical, chemical, and vital properties, as the case may be: that is, it depends on science. This order of knowledge, which is in great part ignored in our school courses, is the order of knowledge underlying the right performance of those processes by which civilised life is made possible. Undeniable as is this truth, there seems to be no living consciousness of it: its very familiarity makes it unregarded. . . . That which our school courses leave almost entirely out, we thus find to be that which most nearly concerns the business of life. Our industries would cease, were it not for the information which men begin to acquire, as they best may, after their education is said to be finished. And were it not for the information, from age to age accumulated and spread by unofficial means, these industries would never have existed. Had there been no teaching but such as goes on in our public schools, England would now be what it was in feudal times. That increasing acquaintance with the laws of phenomena, which has through successive ages enabled us to subjugate nature to our needs, and in these days gives the common labourer comforts which a few centuries ago kings could not purchase, is scarcely in any degree owed to the appointed means of instructing our youth. The vital knowledge—that by which we have grown as a nation to what we are, and which now underlies our whole existence, is a knowledge that has got itself taught in nooks and corners; while the ordained agencies for teaching have been mumbling little else but dead formulas."

Some improvement there has been since Herbert Spencer wrote, but chiefly in technical teaching; and there is yet no national appreciation of what constitutes true education: fashion and vested interests still largely dominate educational policy.

Another advocate of the teaching of scientific method to whom I would refer you is Charles Kingsley, the celebrated divine, but also a born naturalist possessed of the keenest powers of observation, a novelist of the first rank, and a poet. Read his life, and you will find it full of inspiration and comfort. Study his scientific lectures and essays (vol. xix. of his "Collected Works," Macmillan and Co.), and you will not only learn why "science" is of use, but will have before you a valuable model of method and style. A friend—a member of the London County Council—to whom I happened to send some of my papers, noting my frequent references to Kingsley, remarked, "How very fond you are of his writings!" Indeed I am, for they seem to me to display a truer grasp of the importance of scientific method and of its essential character than do any other works with which I am acquainted. I recommend them because they are pleasant as well as profitable reading, and because our text-books generally are worthless for the purpose I have in view. Any ordinary person of intelligence can read Herbert Spencer's and Kingsley's essays and can appreciate them, especially Kingsley's insistent application of the scientific principle of always proceeding from the known to the unknown; but few can read a text-book of science—moreover, the probable effect of most of these would be to dissuade rather than persuade.

Kingsley's great point—and Herbert Spencer's also—is that what people want to learn is not so much what is, still less what has been, but how to *do*. And the object you must set before yourselves will be to turn out boys and girls who, in proportion to their natural gifts—for, as every one knows, you cannot make a silken purse from a sow's ear—have become inquiring, observant, reasoning beings, ever thoughtful and exact and painstaking and therefore trustworthy workers. To turn out such is the whole object of our scheme, which chiefly aims at the development of intelligence and the formation of character. In your schools information must be *gained*, not imparted. After describing how the intelligent mother trains her young child, Herbert Spencer remarks:—"To *tell* a child this and to *show* it the other, is not to teach it how to observe, but to make it a mere recipient of another's observations: a proceeding which weakens rather than strengthens its powers of self-instruction—which deprives it of the pleasures resulting from successful activity—which presents this all attractive knowledge under the aspect of formal tuition. . ." You must train the children under your care to help themselves in every possible way, and give up always feeding them with a spoon. Abolish learning lessons by rote as far as possible. Devote every moment you possibly can to practical work, and having stated a problem leave it to the children if possible to find a solution. Encourage inquisitiveness, but suggest methods by which they may answer their own questions by experiment or trial or by appeal to dictionaries or simple works of reference, part of the furniture of the schoolroom, and lead them to make use of the public library even: in after life you will not be at their elbows, but books will always be available, and if they once grow accustomed to treat these as friends to whom they can appeal for help, you will have done them infinite service and will undoubtedly infuse many with the desire to continue their studies after leaving school. Under our present system school books are cast aside with infinite relief at the earliest possible moment, and the desire for amusement alone remains. Teach history, geography and much besides from the daily papers, and so prepare them to read the papers with intelligence and interest, and to prefer them to penny dreadfuls and the miserable, often indecent, illustrated rubbish with which we are nowadays so terribly afflicted. At the same time, make it clear to them that the editorial "we" is but an "I," and that assertion does not constitute proof. If such be your teaching, and it have constant reference to things natural, you will also—as Herbert Spencer points out in a very remarkable passage—without fail be giving much *religious* culture, using the word in its highest acceptation, for, as he says, "it is the refusal to study the surrounding creation that is irreligious." As I have already said, one great—indeed the great—object of our teaching is the formation of character: and if you teach your pupils to be careful, exact and observant, and they become trustworthy workers, you are giving much training of the highest excellence; and if they have enjoyed such training, what does it matter what facts they know when they leave school?

But I hear you say that the inspectors will not allow all this. Gentlemen, do not fear the inspectors—they also are advancing; they also are learning that literary methods are insufficient, that desk studies must not absorb the entire attention of the scholars; that greater latitude must be permitted to the teachers, and especially in the direction of devising more suitable methods. And a new race of inspectors is coming into existence. Mr. Gordon, I know, had difficulties with the inspectors; but when they realised that he understood his business and learnt to appreciate his work, they soon became his supporters.

And with appreciative ministers like Mr. Acland at the head of affairs, we shall move far more quickly than heretofore, and shall be able soon to entirely throw off the cast-iron bonds of control by examination and payment on results—a refined method of torture affecting both teachers and taught most disastrously. We know that a holiday spent under healthy conditions at the seaside or in the country is of the greatest service. We are becoming accustomed to take care that our houses are properly ventilated and drained, and to rest satisfied that when this is the case their inhabitants may safely be left to themselves. In like manner, in future, we shall take care that our schools are fully provided with all necessary proper appliances—in which I include teachers—and we shall see that the teachers are working in accordance with a proper system; but we shall trouble ourselves little about the taught, feeling that if they have been placed under healthy conditions they cannot fail to have benefited, however little this may be apparent on the surface. In the days to come the work of the teachers will be directly criticised; they, not their pupils, will be examined: but always by competent and sympathetic inspectors who have become acquainted with the work and its difficulties practically, and are not mere theorists, whose main function will be that of guide, philosopher and friend—not that of inquisitor.

In the course that you are about to attend under Mr. Heller—the demonstrator upon whom has fallen the mantle previously worn by Mr. Gordon, and who is equally desirous of promoting and devising rational methods of teaching—you will in the first place devote your attention to exercises in measurement, including much that is ordinarily taught under mechanics and physics, the prime object of which is to teach accuracy of observation. You will then study a series of problems, mainly chemical, which have been arranged chiefly in order to cultivate reasoning powers and to teach the research method. In fact, what we want to do is, as far as possible, to put every scholar in the position of the discoverer. The world always has and ever will advance through discovery; discoveries, however, are rarely made accidentally—indeed we all pass from ignorance to knowledge by discovery, and by discovering how to do things that we have not done before we ever increase our powers of usefulness: we all require therefore to be taught how to discover, although we may never be called on to make original discoveries or have the opportunity. But as you proceed I trust that you will realise that the method which you are learning to apply is one which can be made use of in all your work—that the course has a broad educational value far transcending its special value as an introduction to physical science.

Lastly, I should like to take this opportunity of calling attention to the very great value to girls, as well as to boys, of teaching such as you are about to give. I fear that much that girls are being taught under the guise of domestic economy is of slight value educationally or otherwise, and that they are but having imparted to them little tit-bits of information which they are as likely as not to misapply. Nothing is done by way of increasing their intelligence and forming their characters. Lessons which would lead them to be observant, thoughtful and, above all, exact—lessons in method—would be of far higher and abiding value. They would then carry out their household functions with greater ease; there would be far less waste; less unhealthiness; far more comfort. I believe the need for such training to be indeed far greater in the case of girls than in that of boys. Boys are naturally apt in many ways, and even if neglected at school, perforce develop when they go out into the world; but girls are of a different disposition, and rarely seem to spontaneously acquire the mental habits which a training in scientific method can confer, the possession of which would be of inestimable value to them. Extraordinarily little has been done as yet on their behalf, and they have been cruelly sacrificed at examinations—for which, unfortunately, they appear themselves to have an insatiable natural appetite. It is to be hoped that the new Board will give the most serious attention to this matter, and that it will take steps to secure the teaching of scientific method in all the schools under its charge, whether boys' schools or girls' schools. Unhealthy buildings have attracted much attention; but the existence of a far more serious evil—the absence of healthy teaching suited to the times—has not even been noticed.

In these remarks, I have been able but briefly to bring before you a number of questions of importance—it must rest with you to seriously study the subject. It is a subject worth hard study, which will afford infinite opportunity and infinite satisfaction to the earnest worker.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following examiners for the Natural Sciences Tripos were appointed on October 25. Physics: L. R. Wilberforce and Prof. G. F. Fitzgerald, F.R.S. Chemistry: W. J. Sell and Prof. W. Ramsay, F.R.S. Mineralogy: Prof. Lewis and H. A. Miers. Geology: P. Lake and Prof. G. A. J. Cole. Botany: Prof. F. W. Oliver, F.R.S., and W. Gardiner, F.R.S. Zoology: W. Bateson, F.R.S., and Prof. S. J. Hickson. Human Anatomy: Prof. A. Macalister, F.R.S., and Dr. H. D. Rolleston. Physiology: W. B. Hardy and Prof. E. A. Schafer, F.R.S.

Prof. Bradbury delivered his inaugural lecture, as Downing Professor, on Wednesday, October 24, before a large audience. The subject was "Pharmacology and Therapeutics."

The University Lecturer in Geography, Mr. Yule Oldham, delivered a public lecture on the evening of October 24, on "A New Discovery of America." He will give during the present and the Lent terms a course on the "History of Geographical Discovery," on Thursdays at noon in the Chemical Theatre.

An election to the Royal Geographical Society's Studentship of £100 will be held in the Lent Term. The studentship is open to members of the University who have attended the lectures on Geography.

Of the Freshmen entered this term, 137 have announced their intention to study medicine at the University.

The period of five years for which Dr. Donald Macalister was elected as the University member of the General Medical Council expires on November 13. The Vice Chancellor gives notice that an election will be held in the Senate House on Friday, November 9, from 2.30 to 3.0, at which all members of the Senate may vote. Dr. Macalister is eligible for re-appointment.

Dr. Charles Rieu, late keeper of the Oriental MSS. in the British Museum, has been elected Sir Thomas Adams Professor of Arabic in succession to Prof. Robertson Smith.

The Council of the Senate have issued a second report o special degrees (Litt.B. and Sc.B) for advanced study an research, in which they call attention to the steps in the san direction taken by the University of Oxford, the Scotti Universities, the Gresham (London) University Commissioner and the University of Harvard. They propose that, as th bearings of the subject have greatly widened since their fir report on post-graduate study, the whole question should b referred to a special Syndicate, with power to confer with oth bodies and with the several teachers concerned.

WE have received an advance copy of the report on the wor of the Examinations Department of the City and Guilds London Institute for the session 1893–94. During this sessic the number of classes registered by the Institute was 853, vi 701 in Technology and 152 in Manual Training. The tot number of students in attendance was 25,718, viz. 22,703 technology and 3015 in manual training. At the examinatio this year, 11,631 candidates presented themselves, being 1377 excess of the number examined last year. The examiners f the Institute, like those of the Department of Science and Ar find that the Honours papers are the least satisfactory. It pointed out that Honours students should be taught in speci Honours classes. To quote the report:—

"It often happens that facilities for higher or advanced i struction are not provided at the schools, and that the canc dates for Honours seeking further teaching are only able attend the ordinary class a second session. This absence higher instruction is a matter to be carefully considered by th Technical Instruction Committees of County Councils. El mentary technical instruction is of little value unless it e courages the student to seek further knowledge; and effor should be made, even where the number of students is sma either to establish advanced classes, or to enable students pursue their studies at other institutions where such advanc instruction may be obtained."

MR. HERBERT TOMLINSON, F.R.S., has been appoint Principal of the South-West London Polytechnic Institut now in course of erection in Chelsea. The institute, which w be of the same dimensions and be conducted on somewhat t same lines as the Battersea Polytechnic, will, it is hoped, finished by April next.

IT is announced that Dr. William Peterson, who for the la twelve years has been the Principal of University Colleg Dundee, has been appointed to the post of Principal of McG University, Montreal, vacated by Sir William Dawson, F.R.S more than a year ago.

SCIENTIFIC SERIALS.

American Journal of Science, October.—The standardisati of potassium permanganate in iron analysis, by Charlotte Roberts. A simple and rapid method for standardising a pe manganate solution is to determine its strength, first, by co parison with electrolytic iron, and then by immediate titrati with ferric chloride to determine the exact amount of iron each cubic centimetre of the latter solution. This being asce tained, the ferric chloride solution can be employed at any tir for the standardisation of potassium permanganate.—T detection and approximate estimation of minute quantities arsenic in copper, by F. A. Gooch and H. P. Moseley. Th is a modification of Sanger's process for wall-papers, who application is rendered difficult by the fact that the presen of copper in the Marsh generator holds back the arseni The new process is based upon the simultaneous action strong hydrochloric acid and potassium bromide upon the su of arsenic.—Wave-lengths of electricity in iron wires, by C E. St John. A Lecher wire system was used in which th discs at the end towards the induction coil were left out, so as obtain a form depending more directly upon the principle electrical resonance. The indicator used was a bolometer adapted by Rubens. It was found that the self-induction iron circuits is greater than that of similar copper circuits and very rapid electric oscillations (115 million reversals p second). The difference in self-induction varies from 3 4 to 4 per cent., and increases with decreasing diameters. The i crease in self induction produces greater damping and a shorte ing of the wave-length of 1·5 to 2 per cent. The permeabili f annealed iron wires under this rate of alternation is about 85. For oscillations of the same period, the wave-length long parallel copper wires varies directly with the diameter of he wires, the maximum difference observed being 5 per cent. with wires of 0·03915 and 0·1201 cm. diameter respectively.—The present status of high-temperature research, by Carl Barus. To clear away the anomalies now existing in high temperature ata, either the boiling point of zinc must come down from 930 o 905°, or else the melting points of gold, silver, and copper must move up 30° or 40°, or both must move towards each ther by corresponding amounts.—The recent eruption in the rater of Kilauea, by L. A. Thurston. This is a description f the subsidence of the lava lake on July 11, when its level ell 250 feet.—On solutions of metallic silver, by M. Carey Lea. The solutions previously described are all colloidal, and t the same time absolutely transparent.

Wiedemann's Annalen der Physik und Chemie, No. 10.—On ure water, by F. Kohlrausch and A. Heydweiler. (See Notes.) —Magnetic experimental investigations, by Carl Fromme. This aper deals with the self-induction and the electrostatic apacity of wire coils and their influence upon magnetic henomena. Coils with bifilar winding are free from self-nduction, and also from electrostatic capacity as long as their esistance does not exceed 1000 ohms. At 2000 ohms their apacity is already very considerable. Coils wound by Chaperon's method, *i.e.* with the direction of winding changing with each round, are perfectly free from capacity, and their elf-induction is negligible. It is therefore quite feasible to determine their resistance by the alternate current method.—Examination of the Ketteler-Helmholtz dispersion formula, by Heinrich Rubens. The electromagnetic theory of dispersion, as eveloped by Herr von Helmholtz, is in complete accordance with the results obtained in the case of fluorspar, quartz, rock-alt, sylvine, and one of the heavy Jena silicate-flint glasses. The agreement extends over the whole region of the spectrum nvestigated, comprising 5½ octaves.—Bolometric investigations, by F. Paschen. This is a reply to Herr Angström's riticism of his work on the absorption spectrum of carbonic nhydride.—On the infra-red dispersion of fluorspar, by F. Paschen. The spectrum of the fluorspar prism employed was alibrated by Langley's grating method. The best source of adiation was found to be a small piece of platinum foil coated with oxide of iron. The region of the spectrum examined xtended from 0·8840 μ to 9·4291 μ, and the corresponding refractive indices ranged from 1·42996 to 1·31612.—Change f volume during melting, by Max Toepler. The author investigated the number of cubic cm. by which a gramme of arious elements expanded or contracted during melting. The st included eleven metals and five non-metals. He found that he coefficient of expansion of the elements in the solid state, nd their change of volume during melting, show a definite reation to each other.—The depression of the freezing-point of a olvent by electrolytes, by Harry C. Jones. In the case of a olution of phosphoric acid of concentrations 0·077 and 0·146, he numbers obtained, 2·52 and 2·31, are in fair accordance with those obtained by Arrhenius, but not with those of Loomis.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 3.—The Right Hon. Lord Walsingham, F.R.S., Vice-president, in the chair.—Mr. W. F. H. Blandford exhibited specimens of a sand-flea, chigoe r nigua, received from Mr. Szigetváry, of the Imperial Maritime Customs, China, who had found them in the ears of ewer-rats trapped at Ningpo. Mr. Blandford stated that the pecieswas allied to, but not identical with, the American species, *Sarcopsylla penetrans*, L., one of the most troublesome pests n Tropical America and the West Indies to man and various omestic and wild animals, the female burrowing into the skin, sually of the feet, but also of any other accessible region. He said that the distribution of the chigoe was recorded over Tropical America and the Antilles from 30° north to 30° south, nd of late years it had established itself in Angola, Loango, nd the Congo. Colonel Swinhoe, Mr. McLachlan, Lord Walsingham, Mr. Champion, Mr. J. J. Walker, Mr. Barrett, nd others, took part in the discussion which ensued.—Mr. F. C. Adams exhibited a specimen of *Mallota eristaloides*, a species of Diptera new to Britain, taken by himself in the New Forest on July 20 last. He said that the species had been identified by Mr. Austen, of the British Museum, and that he had presented the specimen to the National Collection. Mr. Verrall made some remarks on the species and on the distribution of several allied species in the United Kingdom. Lord Walsingham, as a trustee of the British Museum, expressed his satisfaction at the presentation of the specimen to that institution.—Mr. Tutt exhibited specimens of a form of *Zygæna exulans*, well scaled, and with the nervures and forelegs of a decidedly orange colour, collected during the last week in July by Dr. Chapman in the La Grave district of the Alps, at a considerable elevation; also specimens of the same species taken by Dr. Chapman near Cogne, and others from the Grison Valley, which were less well scaled. He also exhibited Scotch specimens for comparison, and stated that he was of opinion that the latter were probably as thickly scaled as the continental ones, but that, owing to the differences in the climate of Scotland and Switzerland, collectors had fewer opportunities of getting the Scotch specimens in good condition.—Mr. P. M. Bright exhibited a remarkable series of varieties of *Arctia menthastri* from N. Scotland, also series of *Liparis monacha* (including dark varieties) and *Boarmia roboraria* from the New Forest; *Zygæna exulans*, from Braemar; *Noctua glareosa*, from Montrose and the Shetlands; *Agrotis pyrophila*, from the Isle of Portland, and Pitcaple, N.B.; red varieties of *Tæniocampa gracilis*; and a specimen of *Sterrha sacraria*, taken at light, at Mudeford, in October, 1893; also living larvæ of *Eupithecia cribrum*.—Mr. J. J. Walker exhibited a living specimen of a large species of Pulex, which he believed to be *Hystricopsylla talpæ*, Curtis, taken at Hartlip, Kent. Mr. Verrall and the chairman made some remarks on this and allied species.—Mr. K. J. Morton communicated a paper, entitled "Palæarctic Nemouræ."—Lord Walsingham read a paper, entitled "A Catalogue of the Pterophoridæ, Tortricidæ, and Tineidæ of the Madeira Islands, with Notes and Descriptions of New Species." In this paper sixty-six species of Lepidoptera belonging to these families were recorded as occurring in the Madeiras, of which thirty were noticed as peculiar to the Islands, twelve as common to the Madeiras and Canaries, of which two were not known as occurring elsewhere, and one extends its range only to North Africa. Over thirty species were added to the list, and one new genus, seven new species, and two new varieties were described. Mr. Jacoby and Mr. Bethune-Baker made some remarks on the species and their geographical distribution.—Mr. Blandford read a paper, entitled "A Supplementary Note on the Scolytidæ of Japan, with a list of Species."

PARIS.

Academy of Sciences, October 15.—M. Lœwy in the chair.—The death of M. N. Pringsheim, on October 6, 1894, was announced to the Academy, and a short account of his work given by M. Bornet.—Determination, partly experimental and partly theoretical, of the inferior contraction of a bending fluid sheet, either depressed, submerged below, or adherent, on a weir having its up-river face vertical, by M. J. Boussinesq.—Observations of Gale's comet (1894, *b*) made with the great equatorial at Bordeaux Observatory by MM. G. Rayet, L. Picart, and F. Courty. A note by M. G. Rayet. The apparent positions of the comet on twenty-seven days between May 4 and July 31 are tabulated.—On the degree of incandescence of lamps, by M. A. Crova. The conclusions are given: (1) That the quantity of light emitted by a gas-burner per litre of gas used increases with the quantity of the combustible burnt per hour, whereas the degree of incandescence slightly diminishes, up to a maximum yield which should not be exceeded; (2) that, for lamps with incandescent substances, the maximum yield corresponds to the minimum amount of the combustible which must be burnt in order to obtain the maximum degree of incandescence.—Report on the memoir by M. Stieltjes, on "Researches on Continued Fractions." After a detailed consideration of the memoir, the report proceeds to say: "This work by M. Stieltjes is one of the most remarkable memoirs on analysis which has been written in late years."—Disappearance of the southern polar spot of Mars, by M. G. Bigourdan. The spot ceased to be visible on October 13.—First observations of the pendulum in the Alps of Dauphiny. The values obtained for the constant of gravitation are given below in column g_m, for comparison the values calculated for each place at latitude ϕ from the formula $g_\phi = 9{\cdot}78124(1 + 0{\cdot}005243 \sin^2\phi)$ are appended. The values of are corrected to sea level by means of the densities of subjacent formations taken from the most recent work.

	g_0	g_1
Paris	9·81013 ...	9·81030
Valence	9·80640 ...	9·80682
Grenoble	9·80603 ...	9·80705
La Bérarde	9·80530 ...	9·80682
Marseilles	9·80539 ..	9·80536

The variation of the observed from the calculated value at La Bérarde becomes less when a correction is made for the influence of the mass of the surrounding mountains, g_0 is then 9·80575.—On the infinitesimal transformations of the trajectories of systems, by M. Paul Painlevé.—On the reduction of the structure of a group to its canonic form, by M. E. Cartan.—Experimental researches on the congelation of sulphuric acid of different degrees of concentration, by M. Raoul Pictet. Four extensive series of experiments carried out on large volumes of the acid, in different ways and with all the precautions indicated by the study of the laws of crystallisation at low temperatures, yield concurrent curves which include the cases between pure H_2O and pure H_2SO_4. This curve crosses the line of zero temperature five times (including origin with pure H_2O). On descending parts of the curve the liquid contains a larger proportion of acid than the solid, on ascending parts the inverse is the case; at the summits of the curve the titre of the liquid is the same as that of the solid. The maxima and minima do not, in general, correspond to definite hydrates.—Application of Trouton's law to the saturated alcohols of the fatty series, by M. W. Longuinine. The author finds that Trouton's constant is constant only for groups of similarly constituted substances, and varies from group to group. If M be the molecular weight, r the latent heat of vaporisation, T the absolute temperature of the boiling point, $\frac{Mr}{T} = 26{\cdot}34$ for fatty saturated alcohols. Water gives the value 25·86, ethers 21, hydrocarbons about 20. Formic and acetic acids appear to be exceptions giving the values 12·82 and 13·03. Acetic acid, however, gives 25·9 if the heat required to bring the vapour to the normal condition of $C_2H_4O_2$ be added to the latent heat. Probably formic acid is a similar case.—Action of chloride of sulphur on the copper derivatives of acetylacetone and benzoylacetone, by M. Victor Vaillant.—On estimations of glucose by cupro-alkaline liquids, by M. Fernand Gand.—On pine tar, by M. Adolphe Renard. A new hydrocarbon $C_{14}H_{22}$ is characterised; it is probably a member of the aromatic series.—Action of the sands and waters of the Sahara on cements and hydraulic limes, by M. Jules Perret.—On the homarian origin of crabs, by M. E. L. Bouvier.—On a disease of Ailanthus in the parks and promenades of Paris, by M. Louis Mangin. This disease is characterised as fungoidal, but the species of fungus causing it has not yet been determined.

NEW SOUTH WALES.

Linnean Society, August 29.—Prof. David, President, in the chair.—On the Kuditcha shoes of Central Australia, by R. Etheridge, jun. The remarkable slippers described are in vogue among certain tribes toward the centre of the continent. They are made of human hair, interlaced with emu feathers, with a cementing medium of human blood in the sole. Their variously described functions—their use by the rain-maker, by the authorised agents in obtaining blood-revenge, and to disguise tracks when wife-hunting—were summarised and discussed; and it was pointed out that it is not improbable that their use was not so much to conceal tracks as to disguise the direction in which the wearer was travelling, the heel and toe being alike.—A list of exotic trees and shrubs which have become hosts for certain Australian parasitical plants, by Fred Turner. Indigenous members of the N.O. *Loranthaceae*, more particularly *Loranthus celastroides*, Sieb., *L. pendulus*, Sieb., and *Viscum articulatum*, Burm., were shown to have taken very kindly to certain exotic plants. Twenty-seven species, belonging to a dozen natural orders, serving as hosts, had come under the author's notice in New South Wales, the *Rosaceae*, as compared with other orders, supplying the largest number.—On the formation of a "Mackerel Sky," by A. H. S. Lucas. A description of the remarkable sky of this nature seen over Sydney on April 20, 1894, was given from the notes of Mr. Russell, the Government Astronomer. The author then proceeded to compare the arrangement of the clouds with that of the ridges of sand in ripple-mark, and showed how they are formed similarly, as a result of the wave-motion of layers of the air. He considered the condensation to be produced by rarefaction of the air in the ridges of the waves with consequent fall of temperature. The condensation into cloud thus rendered manifest the position of the wave-crests. He then referred to Prof. von Bezold's paper in the February number of "Himmel und Erde," which advances somewhat similar views as to the origin and importance of wave-clouds. He concluded by suggesting that the wave-cloud, or *Undulus*, should take its place in the classification of clouds by the side of the other elemental forms, *Cirrus*, *Cumulus* and *Stratus*.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Dissections Illustrated. C. G. Brodie. Part 3 (Whittaker).—Lectures on Biology: Dr. R. W. Shufeldt (Chicago).—Chemical Handicraft (J. J. Griffin).—From the Greeks to Darwin: Dr. H. F. Osborn (Macmillan).—On Preservation of Health in India: Sir J. Fayrer (Macmillan).—Manual of Physico-Chemical Measurements: Prof. W. Ostwald, translated by Dr. J. Walker (Macmillan).—Text-Book of the Diseases of Trees: Prof. R. Hartig, translated by Dr. W. Somerville (Macmillan).—University College, Nottingham, Calendar 1894-95 (Nottingham, Sands).—Reprint of the North American Zoology: George Ord, Appendix by S. N. Rhoads (the Editor, Haddonfield, N.J.)—Peru, 2 Vols: E. W. Middendorf (Berlin, Oppenheim).—A Manual of Exotic Ferns and Selaginella: E. Sandford: cheaper edition (Stock).—University College of North Wales, Calendar 1894-95 (Manchester, Cornish).—Leçons de Chemie: H. Gautier and G. Charpy: deux edition (Paris, Gauthier-Villars).—The Great Ice-Age: Dr. James Geikie, 3rd edit. (Stanford).—Electric Light and Power: A. F. Guy (Biggs).

PAMPHLETS.—A Laboratory Guide and Analytical Tables: J. Grant (Manchester, Smith and Wood).—A Discourse on Roses and the Odour of Rose: J. C. Sawer (Brighton, Smith).—Report on Meteorological Observations in British East Africa for 1893: E. G. Ravenstein (Philip).—Brief Notes on the Physical and Chemical Properties of Soils: R. Warington (Chapman).—On the Whirling and Vibration of Shafts (Philosophical Transactions of the Royal Society of London, Vol. 185 (1894) A, pp. 279-360: S. Dunkerley (K. Paul).—On Derived Crystals in the Basaltic Andesite of Glasdrumman Port, co. Down (Scientific Transactions of the Royal Dublin Society, Vol. v. series 2: Prof. G. A. J. Cole (Williams and Norgate).—Twelfth Annual Report of the Fishery Board for Scotland for the Year 1893, Part 2.—Report on Salmon Fisheries (Edinburgh).—The Slide Rule: C. N. Pickworth (Emmott).—Geschichte der Bibliothek und Naturaliensammlung der Kaiserlichen Leopoldinisch-Carolinischen Deutschen Akademie der Naturforscher: Dr. O. Grulich (Halle).

SERIALS.—Encyklopædie der Naturwissenschaften, Dritte Abthg., 22 and 23 Lief^g, Zweite Abthg., 83-85 Lief^g, (Breslau, Trewendt).—Engineering Magazine, October (Tucker).—American Journal of Science, October (New Haven).—Record of Technical and Secondary Education, October (Macmillan).—American Meteorological Journal, October (Ginn).—Proceedings of Bristol Naturalists' Society, 1893-94 (Bristol).—American Historical Register, No. 2 (Philadelphia).—Palestine Exploration Fund, Quarterly Statement, October (London).—Quarterly Review, October (Murray).

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