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BICYCLES AND TRICYCLES.

Bicycles and Tricycles. An Elementary Treatise on their Design and Construction. With Examples and Tables. By Archibald Sharp, B.Sc., Whitworth Scholar, Associate Member of the Institution of Civil Engineers, Mitglied des vereines Deutscher ingenieure, Instructor in Engineering Design at the Central Technical College, South Kensington. With numerous Illustrations. Octavo. Pp. xviii + 536. 565 Figures. Index. (London, New York, and Bombay: Longmans, Green, and Co., 1896.)

IT is difficult to know who to congratulate most, the author of this really valuable work or the public, especially the cycle manufacturing branch of it, for whose edification and improvement it has been written.

The second paragraph of the author's preface so aptly summarises the need for such a book that, in spite of its length, it is worth quoting in full.

"The present type of rear-driving bicycle is the outcome of about ten years' practical experience. The old 'Ordinary,' with the large front driving-wheel, straight fork, and curved backbone, was a model of simplicity of construction, but with the introduction of a smaller driving-wheel, driven by gearing from the pedals, and the consequent greater complexity of the frame, there was more scope for variation of form of the machine. Accordingly, till a few years ago, a great variety of bicycles were on the market, many of them utterly wanting in scientific design. Out of these, the present day rear-driving bicycle, with diamond frame, extended wheel base, and long socket-steering head—the fittest—has survived. A better technical education on the part of bicycle manufacturers and their customers might have saved them a great amount of trouble and expense. Two or three years ago, when there seemed a chance of the dwarf front-driving bicycle coming into popular favour, the same variety in design of frame was to be seen; and even now with tandem bicycles there are many frames on the market which evince on the part of their designers utter ignorance of mechanical science. If the present work is the means of influencing makers, or purchasers, to such an extent as to make the manufacture and sale of such mechanical monstrosities in the future more difficult than it has been in the past, the author will regard his labours as having been entirely successful."

It is merely necessary for any one to go to one of the annual cycle shows and to overhear the, no doubt, honestly attempted explanation of the advantages of some hopeless device, and the apparent satisfaction with which some of these plausible follies are devoured by a section of the public, to feel that Mr. Sharp has expressed himself with too much enthusiasm. Perpetual motion is no more dead now than it ever was; in fact, in consequence of the extraordinary successes in the cycle business during the past year or so, vendors of schemes for creating power are doing a better business than ever. If fifty books as excellent as the one under review were in their hands, these people would always rise superior to the absurd limitations which mere conventional mechanicians recognise.

The real value of Mr. Sharp's book will, in the main, be felt by the manufacturers, who, in many cases, possessed of mechanical instinct, but without sound technical training, are honestly attempting to improve their produce. If any of them is able to handle elementary algebra and geometry, which is all that is asked of the reader, he will be taken in the first portion of the book through a course of instruction in which the principles, so far as they are required for cycle design, of kinematics, statics, dynamics, friction, and the stresses and strains in simple and compound structures are explained in a manner which is admirable. If he is not able to make use of the very elementary mathematical processes employed, he may yet follow much of the reasoning.

The first of the three parts into which the book is divided, is in reality itself an excellent text-book which has the unusual merit that it is not written for students or to meet a syllabus, but simply with the object of enabling any ordinary person with the usual school education to obtain a clear insight into the principles of construction and design. If there is one chapter in this part which will be valued more than others it is the one on bending, in which the theory is explained and then applied to the case of ordinary beams and tubes of various sections The numerical tables in which the sectional areas, weights per foot run, and moduli of bending resistances of solid bars and of steel tubes, should be of use to the designer.

The second part of the book, in which the well-known machines which have taken their part in the evolution of the modern cycle are described, while interesting in many ways, is of decidedly less utility than the first or last, or rather it would be so if it were not fortified by chapters on stability of cycles, steering of cycles, resistance of cycles, and gearing in general.

The third part, which is the largest, is simply one on details; but where there are such a host of details as there are in a bicycle, and each becomes the subject of an essay, the proportion assigned cannot be considered too large. For instance, seventy-two pages are devoted to the frame and to the stresses to which it is subjected Wheels, bearings, chain and other gearing, tyres, pedals, cranks, springs, saddles and brakes are all discussed at length.

Before examining this book more in detail, it may be worth while to say that Mr. Sharp is well known as an ingenious and sound mechanical engineer, so that readers of his book may be well assured that if they come across any statement which seems at variance with their ideas, or with what appears to be common sense, or even with the convictions of racing men, the statement is nevertheless one to be considered carefully.

The chief doubt which occurs to the writer of this review is whether the first 110 pages should have been written at all. This part is, after all, merely a text-book of mechanics, put together, it is true, in such a manner as to give prominence to the problems which a study of the cycle presents, but nevertheless a text-book abstract and black-boardy. If it is desirable that such a text-book should be incorporated in a work on bicycles and tricycles, then no fault is to be found with the substance of it, for it is clear, accurate, and to the point. At p. 110 the all-important question of the stiffness of tubes is reached. This is gone into at some length, both with circular and with other shaped tubes. Some attention has recently been given to the question of D-shaped tubes, which are being employed for the lower back fork of the rear-driven bicycle. The object of making these tubes of D-section

is to obtain the necessary stiffness with a narrow tube, as horizontal space is valuable at this part. Doubt has been expressed by cyclists upon the safety of D tubes when thus used. They will be glad to hear from Mr. Sharp, or to calculate for themselves if they like, as he has shown them how, that the D-tube is stiffer than a round tube of equal width and weight by rather less than 1 per cent. Mr. Sharp, however, advocates the use of tubes of rectangular section for this part of the machine, for they are roughly 33 per cent. stiffer than elliptical tubes of the same depth, breadth and weight.

In the chapter on the strength of materials, a result is given which will surprise those who do not realise the importance of depth in a beam, but who only consider tensile strength and density. Steel is so enormously strong for its weight that, with the exception possibly of some of the new alloys, it is the one material on which the designer of strong and light structures depends. Now in the case of solid beams of the same length, breadth and weight, a light material, such as wood, may be made so enormously deeper than one of steel, that the stiffness which depends upon the cube of the depth actually exceeds that of steel. For this reason a wooden cycle rim is lighter than a solid steel rim of the same width and strength. It probably is not lighter than a hollow steel rim of the same outer shape and weight, any more than a solid wooden beam would be lighter than a compound beam made of steel of the same width, weight and strength in which nearly all the material is at the upper and lower surfaces.

The concluding chapter of Part i. deals with the strength of materials. In this there are two sections of special interest to cyclists. The first relates to the "helical tubing" of the Premier Company. This is an ingenious composite tube made by rolling band steel in a helix, so that at no point has it less than two thicknesses, and then brazing all together. By this method of construction a higher grade of steel can be employed than any used in drawn tubes, and a gain of about 50 per cent obtained in tenacity. This, of course, is at the expense of ductility, so that while a frame built of helical tube will be stiffer for its weight than one of solid drawn tubing, it will, or perhaps it is better to say it should, give way suddenly to accidental stresses which would merely bend an ordinary tube.

The other interesting point is the effect of repeated small stresses of an amount which applied even many hundred times would be quite incapable of damaging a material. Certain parts of a bicycle are subject to alternate stresses in ordinary use, while others are constantly pulled in the same direction. The latter may therefore be made with a somewhat lower factor of safety than the former.

Part ii. is partly historical. This will be welcomed by readers very differently, according to their individual cycling experience. Those who have ridden since the 'seventies, or have followed the progress of the cycle, more especially in the last fifteen years, may turn over these pages with a certain melancholy interest, while those who have only recently joined the ranks of cyclists will probably be tempted by curiosity to learn something about the machines which so recently they despised. In the writer's opinion, the first fifty pages of this part is not likely to seriously interest any one for whom the really new and valuable part of the book has been written.

With Chapter xvii. the valuable portion of Part ii. begins. This is upon the stability of cycles. The author explains the bicycle balance by supposing the rider to steer unconsciously in such a curve that the centrifugal force balances the tendency to overturn. All that can be said of this is that when the rider is following a curved path he must lean over to the angle which every one knows, for this is what may be called the dynamical vertical; but small variations from this have to be counteracted just as much as small variations from the real vertical when a straight path is to be followed. Mr. Sharp speaks of the lateral oscillations that are necessary for stability as being pendular, so that a high bicycle has a slower period than a low. This, no doubt, is true in a way, but the essential difference between a hanging and an inverted pendulum are not pointed out. The former has a natural period—that is, it takes the same time to reach the vertical from any moderate inclination; but the inverse is not the case, an inverted pendulum has no natural time to fall from the vertical to any definite inclination, but only from one inclination to another, and the comparison of the periods between high and low machines can only be made when these inclinations are the same for both. The main point is that there is no natural period for the inverted pendulum, the time becoming greater as the start is made from a truer vertical, and also greater as the angle of fall becomes greater. For this reason it would seem that the more correct view is that the bicycle balance consists in merely running the wheel so as to bring the line of contact with the ground vertically under the centre of gravity, the vertical being the dynamical vertical for the particular speed and average radius of path.

There is one section in this very interesting part which is at variance with the supposed experience and almost universal belief of riders. This is upon the effect of pedal pressure upon side slip. Page 215 rather unnecessarily traces the forces upon the frame and wheel in consequence of pressure upon one pedal. Obviously no sustained pressure by the rider upon the pedal can produce a lateral force upon the tyres, however much riders may think the contrary; but is it not possible that this lateral force may exist, and to a more than perceptible extent, in consequence of the fact that it need not be sustained, that it is not one of the entirely balanced internal forces, but is unbalanced, the lateral momentum of the rider's body supplying the force which is external to the frame? This depends for its possibility upon its not being sustained, for if it were the rider would move laterally off the machine; as it is he begins to acquire a lateral velocity, which is pulled up and reversed at the next half-turn. This is the lateral equivalent of the objectionable vertical swaying of the body, which enables the rider to exert an effort on the pedal greater at the time that it is useful than that which the vertical force due to his mere weight would allow. In the middle of the stroke the vertical acceleration of the body is made a maximum, and so the position is at its lowest. At this time, therefore, a greater pressure is available; at the ends of the stroke, where pressure is less useful, less is applied, and gravity is

occupied in stopping the rise and starting a fall of the body. Thus the rider is able to store up the effect of gravity at the less useful, and employ it at the more useful periods, and so relieve his arms from the holding-down strain, which is so tiring.

After dealing with other points in connection with stability, the author comes on to steering in general, and to the difficult subject of steering and balancing upon the "Rover" type of safety without using the hands. Five pages of somewhat difficult reasoning are devoted to this point, and after the establishment of all the forces and couples which come into play, a theory is elaborated which should apply even to the case when the steering axis cuts the ground at the point of contact of the front wheel. It is often stated that riding without hands under these conditions is impossible; difficult it is certain to be, for this feat, as it used to be considered, is certainly easier when the castor action is moderately increased. It would be interesting if expert cyclists who have the means would see if they can succeed.

The writer noticed, when first practising to ride without hands, that the lateral hinging of the body about a joint in the neighbourhood of the saddle seemed to have a definite influence. This motion is evidently under the control of the rider, and so an actual variation of inclination can be forced upon the machine, the amount relatively to that in the upper part of the rider's body depending upon the moments of inertia of the two systems about their independent horizontal fore and aft axes. By this means it is certainly possible to make a rapid and temporary inclination of the frame, which, combined with the gyroscopic action of the front wheel, is all that is needed to control the steering. No doubt the forces calculated by Mr. Sharp act as he has explained, but to what extent they, or the temporary dynamical action just described, are those which are depended upon in practice, whether consciously or not, the writer is not prepared to say.

The chapter on resistance of cycles is very instructive. The conclusions are represented graphically, so that any one non-algebraically-minded can grasp the enormous importance of air resistance at high speeds. Extrapolating from these curves, it is seen that a man who can drive his machine under present conditions through the air at, say, 30 miles an hour, would, if road and machine resistance only had to be met, be able to drive at 330 miles an hour, or if he can actually go 20 miles an hour, he would be able to drive his machine 100 miles an hour. This shows the very essential part that pace-making plays in the cycle race. Whether Dr. Turner's theory on the fatigue caused by brain work in constantly determining the most suitable speed, plays any part or not, it is evident that a long machine with half a dozen riders upon it, or an autocar just in front of the racer, will make such a draught as materially to reduce the enormous resistance he would meet with if the air were still. The writer would like to propose a method to enable great speeds to be attained, which, however, is of spurious interest, since in real cycling the wind resistance must be overcome. All that is necessary is that a large box or small house with glass sides big enough to entirely surround the rider, but with a safe margin, should be dragged by steam or other power along at gradually increasing speeds until the rider shows that he is beginning to lag. Of course, there would be no floor or bottom to the box, and it should be made so that it would clear the ground by any predetermined amount. It might be safer if the house had no back.

Another suggestion offered more seriously where record-breaking without pace-making is the object, is that a day should be chosen when the barometer is very low, for a fall of an inch, if it reduced the air resistance by one-thirtieth, might mean a gain of a second in a minute, or a minute in an hour, *i.e.* if the corresponding diminution of oxygen in the rider's lungs did not compensate for the reduced resistance.

The chapter on gearing is one that cycle inventors would do well to study. It is interesting here to find the Simpson lever chain under the heading "Perpetual Motion." Mr. Sharp very clearly and forcibly points out the fallacy that renders auxiliary hand-power mechanism a practical failure.

Part iii. opens with two chapters upon the frame, which will probably be found to designers the most useful in the whole book. Graphic methods, explained in the first part, are employed to show how the stresses in a link-work frame can be calculated. It is clearly important that the design should be such in a cycle frame, that the members of the frame may be mostly in tension or compression, as they would be if they were pivoted and not brazed together. The difficulty of dealing with the actual case in practice in which they are brazed, and stresses other than tension and compression are certainly met with, is only referred to, but, perhaps wisely, the anxious engineer is not shown how to reduce these to figures.

It is a question whether too much stress has not been laid upon the necessity of straight members in a cycle frame, for in order to meet the racking and other stresses which must be met with in practice, a gauge of tube is necessarily employed, which, considering the frame as a mere girder carrying a dead weight, is quite absurdly strong, so that a moderate bending moment, due to the design, need not be feared when some distinct gain is effected in consequence.

This is more especially the case in the dropped frame which, unfortunately for themselves, ladies in this country think they prefer. Great abuse is often heaped upon the makers of machines with curved frames. Now, provided that the top and bottom members are kept apart, and the more so the better, and are effectively stayed at a few points, the bending stresses introduced by the curvature are quite moderate, and space is obtained where it is required, so that mounting and dismounting is more easy A further point is the extra steepness of the frame in front, which allows the skirt to hang more easily.

Mr. Sharp accepts the situation with regard to ladies' machines as he finds it at the present day in this country. Again, perhaps, he is wise. He assumes a drop frame to be a necessity. Now, if any person will depend upon reasoning alone, and pay no attention to the vagaries of fashion, he will see first, as is evident from Mr. Sharp's diagram, that the stresses in a so-called lady's "Safety" are greater than in one of proper design, so that in order to make it strong and stiff enough the machine has to be heavier than any that a man would ride, and is even then without that wonderful rigidity of the diamond frame.

Add to this the fact that the fair sex have not the strength or any of that recuperative power necessary in case of emergency that man possesses, and that they suffer many fold from the ever-disturbing wind resistance in consequence of the garments which fashion imposes upon them, and that because of these same garments they are in sorry plight in case of a moderate accident; with all this in the mind of a mere reasoning person, there is no wonder that he thinks of something else, the degree question at Cambridge for instance. Had the suburban ladies been given another year or so before the desire to ride a bicycle extended so far in the direction which is known from a mere social point of view as upward, it is possible that the change of attire would have spread gradually, and that now, or perhaps in a year or two, suitable costume would have been adopted as readily as the cycle jargon and slang so often met with. Ladies start with every natural disadvantage, and then they proceed to magnify them in a more effective way than their conscious ingenuity could devise.

The chapter on wheels is one which will be read with interest by riders especially. Here will be found a description of the author's tangent wheel, in which the spokes are not fastened to the hub at all! It is almost impossible to believe at first that spokes held in pairs to the hub by merely having their common centre portion wound a fraction of a turn round the hub will hold sufficiently tight to withstand all the twist that a strong rider can exert upon them. But the theory is convincing, and especially when steep-angled grooves are employed in which to lay the wire, no doubt can remain that this is the case.

Ball-bearings form the next subject, and these are treated far more thoroughly and scientifically than is usual. The actual want of absolute perfection in the ordinary bearing is pointed out, and a number of suggestions made for bearings in which the balls approach as near as possible to the state of pure rolling. The ordinary ball-bearing answers so well, in spite of the spinning and rubbing friction which accompanies the rolling, that it is hardly likely that the more elaborate bearings, in which these defects are reduced or abolished, will take their place. At the same time, a discussion of them is of educational value to designers.

Chains and chain-gearing are dealt with very thoroughly and completely. There is one omission, however, which must be noticed, and that is all reference to the results of Hans Renold, of Manchester, who found that a small difference of pitch is desirable in the driving and driven wheel. The writer of this notice picked up one of Renold's pamphlets at a cycle show some years ago, and was much struck with the arguments there used. It may be that this is all common knowledge, or that it is mistaken; but either way, one would like to have had Mr. Sharp's views upon the subject.

Mr. Sharp explains the correct method to setting out chain wheels for long-link and for block chains; he is not afraid of criticising one of the chief companies.

"In Humber pattern chain-wheels the teeth are often quite straight (Fig. 451). This tooth form is radically wrong."

On page 417, Mr. Sharp points out a defect in a usual pattern of chain which the practical man would hardly expect. Here the plates of the chain are cut away on the side next the chain-wheel, so that the line joining the rivets is not in the middle of the portion that is left. If the plates were cut away on the other side as well, so as to leave less metal, they would be stronger still. In the next page there is a suggestion which seems valuable, namely, to make the side plates of metal which has been stretched beyond its elastic limit, and which therefore has an increased rigidity. As these links can never be subjected to compression, the objection to this procedure, which is met with in other cases—as, for instance, in Southard's twisted cranks—does not apply.

The bicycle chain is a more marvellous piece of mechanism than is generally supposed. The pins have to bear a force which is far greater than is prudent in ordinary structures, while the bearing surface of the blocks on the rivets have in use occasionally to bear more than twice the amount given by Prof. Unwin as the maximum value for bearings on which the load is intermittent and the speed slow.

The discussion on the variation of relative speed in the driving and driven wheel is curious rather than important.

One result of the rules given by Mr. Sharp for shaping the teeth of sprocket wheels is that even in elliptical wheels the teeth will have the same form as in circular wheels of any size, so that the same cutters can be employed for all wheels if adapted to the tooth face, and not made simply to plough out the space between two teeth at one cut.

The practical reader would like to know whether the tooth forms recommended work well in practice, for there is undoubtedly much prejudice in favour of the patterns of our standard makers, whether condemned by Mr. Sharp or not.

Toothed-gear wheels are treated at length. The theory is, of course, common knowledge, but it is very well put, and the results of a paper on circular-wheel teeth, published by the author in the *Proceedings* of the Institution of Civil Engineers, are given also. Toothed-wheel gears follow. The mechanical reader who is not already acquainted with these, will be surprised at the ingenuity and perfection which are embodied in this class of work.

There is much remaining unnoticed, but the length to which this review has reached is such that many interesting points cannot be even mentioned.

"Bicycles and Tricycles," by Sharp, has taken its place as the one standard book which ought to be found wherever cyclists do congregate, and which no one designing or inventing any detail connected with a bicycle should fail to possess.

C. V. BOYS.

THE GEOLOGY OF THE BRITISH ISLES.

Geological Map of the British Isles. Originally compiled by Sir Archibald Geikie, LL.D. Revised and extended by Alexander Johnstone, F.G.S. (Edinburgh and London: W. and A. K. Johnston, 1896.)

Mineralogical Geology: a Synopsis for the Use of Students. To accompany W. and A. K. Johnston's Geological Map of the British Isles. By Alexander Johnstone, F.G.S. (Same publishers as above, 1897.)

THE first of these works is by a long way the best and most convenient geological map of the British Isles, both for lecturers and students; and this new and greatly

revised edition has added considerably to its utility. It is, indeed, not likely to have a serious rival until the completion of the index-maps of the Geological Survey; and these will still be on too large a scale for the purposes of a comprehensive view. On the present map, fourteen miles go to an inch; and we are glad to see that a scale of kilometres is added. The colouring is clear and bold; and a number of small-type notes along the coast call attention to local details, as is customary in British maps of an educational character.

A series of well-chosen longitudinal sections occupies the blank spaces in the surrounding seas. It would be an advantage, in the next edition, to be informed as to the length of each section in miles, since some are naturally of a much more general character than others. In one, moreover, the term "Neocomian" is used, though it does not occur in the Table of Systems which forms the index. In another, owing, probably, to the small scale, there is a striking unconformity between the London Clay and the Bagshot Beds of the London basin. Teachers will be glad to have the Erriboll section, as an example of the northern thrust-planes; and the whole series will prove of constant service.

In the index, we note with pleasure the use of "Stonesfield Flag"—an "s" is probably omitted—for the well-known but misleading "Stonesfield Slate." In the Pre-cambrian group, the Caledonian Schists, the Hebridean, and the Dalradian, are separately coloured; and it is here that the map is in course of time likely to undergo modification. It has had the advantage of following Sir A. Geikie's recent edition of his map of Scotland, and is naturally a great improvement on other available wall-maps, in which all the schists east of the Torridonian border are classed and coloured as Ordovician. Ireland receives similar treatment; but here again some reminder is required of the prudent and cautious language with which the term "Dalradian" was introduced to geologists by its author. The Ordovician areas of eastern Ireland are also likely to become broken up, through the discovery, now announced, of several Silurian districts in their midst.

In South Wales we have a doubtful boundary, a dotted line, drawn between Silurian and Ordovician; and in many other of the older areas the map draws attention to recent observations. Even the Lenham Beds receive proper recognition along the scarp of the North Downs.

In trying to separate the Old Red Sandstone of southern Ireland into an upper and a lower division, Mr. Johnstone has naturally fallen into the common pitfall. As a matter of fact, the Dingle promontory and the region south of Omagh are the only safe areas where the Lower Old Red Sandstone can be marked out. Prof. Hull drew a provisional line across the centre of the county of Cork, which Mr. Johnstone properly puts aside, as being merely a suggestion. But he carries his Lower Old Red Sandstone along the south of the Blackwater, and colours the same rocks, where they emerge on the north side of the synclinal, as Upper Old Red Sandstone. The logical thing seems to be to use one tint at present for the main Irish Old Red Sandstone, and to split it into two minor tints for the benefit of the Dingle and Tyrone areas.

A few misprints require revision in the notes along the coast, such as "roches montonées," "Permiam," and "Greenstones" for the town Greystones. There are two references to Eocene plant-beds at Portree, but none at Ardtun, although the unimportant tachylyte at the latter point is mentioned. When we find, however, Radiolarian cherts and the Dover coal among the recent additions to our information on the map, we are not inclined to point out small omissions. We may rather end, as we began, by recommending schools, teachers, and public institutions to place this clear and conscientious work, without delay, by the side of any older general map which they may happen at present to depend on.

The earlier edition of Sir A. Geikie's map was accompanied by a concise handbook dealing with the geological structure of the British Isles. Some such book is obviously desirable, and the new map has provided an excellent opportunity. The progress of our views regarding the relations of certain strata could have been pointed out, and the meaning of such terms as "Dalradian," "Ordovician," &c., could have been made clear. There was ample room for a picturesque and yet accurate description of the features recorded in the map itself, prominence being given to those aspects of the country that would strike the ordinary traveller.

In what sense, however, Mr. Johnstone's tabular treatment of elementary mineralogy "accompanies" the map of the British Isles is indeed hard to discover. The author has given excellent and judicious prominence to the localities in which the several minerals occur in the British Isles; and a series of plates of British fossils occurs as an appendix, repeated, if we mistake not, from the borders of the original map. The revision of the names on these plates still remains to be done; we have "Fenestalla," "Rhynconella" more than once, "incrasata," "Cyrene," and divers similar slips. One Eocene mammal is even labelled "Palæo magnum." Our old friend, the seated Pterodactyl, still appears with his five digits on the hand. However, it may be justly urged that these illustrations have nothing to do with the book under review, which is an introduction to the study of minerals. As a book of reference for well-taught students, it may have its value; and we suspect that it has been compiled from notes already found useful by the author in his own courses of instruction. But it suffers from somewhat imperfect proof-reading, as in the case of the formulæ of the felspars on page 7; the mica formulæ also surely require revision. Where, moreover, are "Pary's Mine," "Magee Island," "Penmaen Maur," "Corinthia," and a few others?

We confess to feeling afraid of a small work so full of facts and figures; but its compilation must have involved serious work. The subject is plunged into abruptly, as when we are told in a foot-note on page 11 that "a growing together of two or more crystals constitutes a macle or twin." It is satisfactory to find a fuller treatment of twin-crystals on page 45; but the beginner is then informed that "when chemically and physically similar crystals at an early phase of their existence unite at inversely dissimilar parts to form a compound crystalline body, the product is called a twin macle, or hemitrope. . . . The plane of junction (*plane of composition*) is throughout the *twinning plane* in young

forms." This makes us truly wish for a teacher at our elbow. The difference between young and old twins is new to us; the Carlsbad twins, by the above statement, were clearly never young.

Altogether, this book must be compared with our smaller treatises on mineralogy, and must be judged accordingly. As a reference-book for British localities of minerals and rocks it will undoubtedly be useful.

G. A. J. C.

OUR BOOK SHELF.

A Ride through Western Asia. By Clive Bigham. With illustrations. Pp. 276. (London: Macmillan and Co., Ltd., 1897.)

MR. BIGHAM gives a simple, straightforward and modest account of a journey of the "record-breaking" order. In a year and a month he travelled, mainly on horseback, from Constantinople through Asia Minor, Persia and Central Asia, reaching as far as Kashgar, thence returning *viâ* Siberia and Russia. The small size of the book is welcome, and indeed remarkable, as it shows that the author cherishes no undue opinion of his somewhat remarkable journey. It is to be regretted, however, that his duties as a correspondent at the seat of war deprived the proof-sheets of his personal revision, and that many slips, chiefly in place-names, have thus eluded observation. Mr. Bigham was possessed of the best qualities of an explorer determined to go through a given programme; but he does not mention the special object for his expedition, nor does he tell much which had not previously been placed on record. The object presumably was merely pleasure, and the points of original importance refer to matters of undoubted interest, but so intimately involving political questions as to be unsuited for special reference here.

Numerous quotations are given from Mandeville, Marco Polo, the Vulgate and other authorities, and the author assumes as matters of common acceptance several theories, anthropological and otherwise, which are either exploded, or are now looked upon with great suspicion by competent authorities. Perhaps the most interesting part of the journey was the trip from Teheran through Kashan, Ispahan, Shiraz, and across the Bakhtiari country to Dizful, down the Karun River, up the Tigris, and back to Teheran by Kermanshah and Hamadan. It is a pity that fuller details of the Bakhtiari country were not given. The same may also be said of the journey from Kashgar to Semipalatinsk, across the Tian-shan, so early in the year as the month of May. There was too much travelling compressed into the thirteen months to allow of the careful collection of local information, which might be of scientific value; but the book is attractively written with plenty of action, maps well suited to bring out the routes, and good illustrations.

Elements of Theoretical Physics. By Dr. C. Christiansen, Professor of Physics in the University of Copenhagen. Translated by W. F. Magie, Ph.D., Professor of Physics in Princeton University. Pp. xii + 339. (London: Macmillan and Co., Ltd., 1897.)

WHILE the small edition of Thomson and Tait's "Natural Philosophy" professed to supply the essential details of this reasoning, devoid of mathematical notation, the present treatise appears to perform the converse operation, of providing the student of Physics with the mathematical argument and equations he is likely to encounter, devoid of any appeals to experiment or numerical illustration. The book is therefore a very handy manual of reference for formulas, and the mathematical treatment is very elegant and condensed, not running to unnecessary luxuriance. As it is stated at the outset that the C.G.S. system alone is employed, there is no need for any specification of the units employed; although we think it would tend to clearness to mention them occasionally; and this can be done, on the Hospitalier System, in a very condensed form, thereby training the student not to shirk this most important detail of his practical work; thus, for instance, the number $1{\cdot}695 \times 10^{12}$, representing the modulus of elasticity on p. 81, is given in dynes/cm^2.

The subjects treated in the chapters are—General Theory of Motion, Theory of Elasticity, Equilibrium of Fluids, Motion of Fluids, Internal Friction, Capillarity, Electrostatics, Magnetism, Electro-Magnetism, Induction, Electrical Oscillations, Light, Thermodynamics, and Conduction of Heat. These subjects are all polished off in 333 pages; and as most of them are discussed ordinarily in separate treatises, each of, say, 300 pages to itself, the treatment in this work is necessarily very condensed, and the author cannot permit himself any following out of details, or Calculus dodging.

This will make the book a difficult one for a beginner to use, except as a handbook of reference, to be used in conjunction with a series of Lectures; and it was probably in that way that the treatise assumed its present shape.

G.

In Garden, Orchard and Spinney. By Phil Robinson. Pp. iv + 287. (London: Isbister and Co., Ltd., 1897.)

The Woodland Life. By Edward Thomas. Pp. viii + 234. (Edinburgh and London: Blackwood and Sons, 1897.)

THE critic to whom these volumes were entrusted read a good part of them with a growing sense of perplexity not unmixed with enjoyment. When he attempted to write down what he had found in them, he could for a long time do nothing but gnaw his pen. At last it occurred to him that almost any reader of NATURE would have found himself in a like difficulty, and that the best plan would be to speak of the books from his and their point of view. We, the readers of NATURE, are accustomed to read for information, and we judge of books mainly by the quantity and quality of the matter which they contain. Now the two books before us may be shortly said to contain no information at all; to give information is no part of their plan. They are akin to the sonnet, the symphony, and the landscape painting, and make their appeal to sympathies of which the mere naturalist is quite devoid. Even the dull soul of the mere naturalist is, however, faintly stirred now and then, as he reads these pages, wondering all the time what he can find to say about them. Mr. Phil Robinson throws in many a pleasant phrase, many an apt quotation, and there is plenty of movement in his descriptions. Mr. Thomas' touch is not so light, but among his abundant epithets are not a few which show real familiarity with the natural objects, especially the birds, which catch his eye. Though these books make no pretence of being founded on inquiry, nor of adding to knowledge in any way, it is quite possible that a competent judge of literary form would give them a good place as prose poems.

L. C. M.

Social Transformations of the Victorian Age. By T. H. S. Escott. Pp. viii + 450. (London: Seeley and Co., Ltd., 1897.)

THIS book calls for but a brief reference in these columns. It consists of a series of sketches of social and legislative changes which have taken place during the Victorian era, and points to some of the causes of these transformations. Education receives a fair share of attention, but the transforming influences of science occupy only a single chapter of sixteen pages.

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.*]

Colour Photography.

I HAVE had a good many inquiries addressed to me about the Dansac-Chassagne process of colour photography, described in NATURE, February 4, 1897, and as I was to a large extent responsible for having drawn public attention in this country to the process, I am naturally anxious that those who feel an interest in the subject should have, at all events, such information about it as I can supply without a breach of the confidence with which I have been favoured.

First let me say that the information I can publish does not include any details as to the materials employed, or the method of their manufacture. The process is to be worked as a secret one, and the statements made to me as to the method of preparing the liquids used were confidential. This of course greatly affects the scientific interest of the question, but commercial considerations in this, as in many like cases, overpower scientific interest.

It is only quite lately that I have been able to make any fuller examination of the process, and such rough tests as I have made are very incomplete. They are, however, complete enough for me to say that, while they do not justify the claims originally put forward as to the completely automatic nature of the process, I yet cannot account for the results produced without admitting that the selective action claimed does to some extent exist; that the colouring matters applied to the photographic print have a certain tendency to attach themselves to those portions of the print which would be of a similar colour had the image been reproduced in natural colours, and also that the colouring matters, when applied in succession, do so combine or react on each other as to reproduce, approximately, the tones or tints of the original.

There are some other inaccuracies in the first description given to me, which I should like to correct. It does not appear to me that a special negative, or a special print, is any advantage. It certainly is not necessary. The process can be applied to any ordinary print on albumenised paper, or to any positive on an ordinary gelatine plate. It does not appear to work successfully with some, at all events, of the more modern printing-out papers. Nor is it a fact that during the process of treatment the positive has to be exposed to bright light.

This it will be said is different from the process as it was first described. Precisely. It is because of that difference, and because I was responsible for the publication of the first description, that I now ask you to allow me to inform your readers as to the real value of the process so far as I can estimate it at present.

The above conclusions are based on my own attempts, and some rather more successful) by my friend Mr. Herbert Jackson. Judging from the work of the skilled operators, whom I have watched in M. Chassagne's studio, I can only say that in their hands the process is certainly not entirely automatic. The operator requires to know generally what the colours should be, and the results largely depend on his judgment and skill in applying the colour in the right places.

But the practical outcome is that anybody, after a little instruction, can produce, with very great rapidity, coloured pictures which, as evidenced by the specimens shown in public, are of considerable merit. The result is obtained by first applying the liquids over the whole picture, and then working up the different parts of the picture by applying them locally. About the truth of this there can be no manner of doubt. Hundreds of persons in Paris have seen it done, and have admired the results. The difficulty is to satisfy oneself as to how far the process is purely mechanical, and how far it is a matter of skill. A certain amount of skill is required, but, admitting this, it appears to me that taking it at its lowest value, the process does provide a means of colouring photographs—and with approximate correctness—that has not previously been available.

Whatever may be the practical or commercial value of the process, it will prove of very great theoretical interest, if as an outcome it should be conclusively proved that any monochrome photograph has even the smallest power of colour selection, depending on the tints of the original; as this once established, some of our current photographic notions would be revolutionised.

HENRY TRUEMAN WOOD.

Telegraphy without Wires, and Thunder-storms.

I HAVE recently made experiments on telegraphy without wires, and during the last few days, which have been very hot, I have experienced certain phenomena which somewhat interfere with the reception of signals. The receiver used by me is constructed thus: a piece of goose-quill one inch long is stopped at each end with cork, two ordinary pins pierce each cork, their points being about $\frac{1}{8}$-inch apart; the intermediate space is filled with finely-powdered nickel; (experiments on the relative sensitiveness of receivers made with quill and glass show that those made with quill are more sensitive than those made with glass.) The receiver is attached to an acoustic resonator carrying an electrically driven tuning-fork (500 double vibrations per second). The receiver is placed in contact with the foot of the fork, where it is attached to the resonator. The receiver forms part of a circuit including a dead-beat galvanometer, a single dry cell, and a resistance of 1500 ohms. One terminal of the receiver is earthed, and the other is attached to a thick copper wire, 30 feet long, fixed to a post. The vibrating fork effectually maintains the high resistance of the receiver, except when it is affected by a spark at a distance. The galvanometer is then instantly deflected, but at once returns to a nearly zero position. While I was watching the spot of light of the galvanometer, I noticed that it was deflected when the transmitter was not in action; after some time distant thunder was heard; in some cases the time between seeing a deflection and hearing thunder was 25 seconds, a time corresponding to about 5 miles; by degrees the storm, though at some distance, caused the spot of light to be deflected up to 25 times per minute.

From what I noticed it is evident that signalling would be somewhat seriously interfered with by a thunder-storm even at a considerable distance.

I have used the tuning-fork method of shaking the receiver since last February, and have never seen it fail in its action. Another method which gives good results is to mount the receiver on a small projection cemented to the disc of a telephone, in the circuit of which an electrically driven tuning-fork and a battery are included.

June 26. FREDERICK J. JERVIS-SMITH.

Distant Cannonade.

IN answer to your note upon the distances at which Saturday's salute was heard (NATURE, July 1, p. 204), I have to say that I heard what I suppose was the salute here in Chelsea. I took it at first for distant thunder, and went to look at the sky and barometers.

The newspaper reports showed, since that, that the thunderstorm was much later; and I did not hear sounds of it at all. The sound reminded me rather of a *feu de joie* than of a salute, which is accounted for by the fact that the squadrons saluted in succession.

There is nothing unusual in the hearing of artillery at such a distance, about sixty statute miles. The Bombay time guns and salutes are often heard at the northern Mahim, a known distance of over fifty statute miles. They are, or were in my day, very modest affairs—old-fashioned twenty-four or thirty-two-pounder guns, loaded with four or five pounds of coarse black powder, not all of which was burnt. I was working at warning guns in that country myself for some years, and had to attend to such matters, but have no notes here from which I can give exact figures.

The target practice of the forts and turret-ships at Bombay was very easily distinguishable from mere salutes and time guns; not merely as a louder sound, but by being *felt* in the chest when those could only be heard. Probably some of your naval readers can tell us something of the guns and charges used at Spithead on June 26. It may be presumed that they were of more power than the old-fashioned artillery that I have mentioned; but still it is probable that they were the smallest guns of the fleet, and the saluting charges much less than those for service. The sound produced by modern powders, too, is probably very different in quality from that of the old black powder with which the late Prof. Tyndall made his experiments.

The subject is of very considerable importance, and any information that our "up-to-date" gunners can give us will be welcomed by all connected with the sea.

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

Rotifers Commensal with Caddis-worms.

IT may be of interest to record the fact that, like *Gammarus pulex* and *Asellus aquaticus*, the larva of *Phryganea grandis* is a host for the commensal rotifer, *Callidina parasitica*. On one specimen, taken near Potter Heigham Bridge, I found between fifty and sixty of these commensals. As is the case with the commensals of *Gammarus* and *Asellus*, those of the caddis-worm gradually disappear when the hosts are kept in an aquarium. *Rotifer tardus* was also found among the materials of the larval case. HENRY SCHERREN.

The Lost Books of Euclid.

WILL you or any of your numerous readers kindly let me know, through the medium of your journal, if the lost books of Euclid (Books vii., viii., ix. and x.) have been found and published in English; if so, the name of the editor and that of the publishing house.

I may say, in reference to this inquiry, that an Indian Prince, who is at present in this country for the Jubilee celebration, possesses a complete copy of Euclid in Sanskrit—no book or books missing. A. K. GHOSE.

6 Forest Road, Kew, June 8.

[WE are indebted to Mr. H. M. Taylor for the following information:—

The first English translation of the Elements, published at London in 1570, had the title (16 Books):—

"The Elements of Geometrie of the most ancient Philosopher Euclide of Megara, Faithfully (now first) translated into the Englishe toung by H. Billingsley, City of London. Whereunto are annexed certain Scholias, Annotations and Inventions of the best Mathematicians both of time past and in this our age."

The English edition of the first printed Greek text, published at Basel, contained all the extant works attributed to Euclid. This was published in 1703, at Oxford, by Dr. David Gregory, and was entitled "Εὐκλείδου τὰ σωζομένα."

See Encl. Brit., ninth edition, for further information.—EDITOR.]

ARCHAIC MAYA INSCRIPTIONS.

THERE can be no surer sign of the smallness of the number of persons in this country who take an interest in the progress of our knowledge of American archæology, than the fact that not many years ago the editor of this journal asked me to review my own work on the subject, a request which, as far as courtesy would allow, I succeeded in avoiding by effecting a compromise which resulted in the publication of a few general notes on the ancient civilisation of Central America (NATURE, April 28, 1892). The far more grateful task has now been entrusted to me of calling the attention of the readers of this journal to an essay on the Archaic Maya Inscriptions, by Mr. J. T. Goodman, of California, which has been published as an appendix to the archæological section of the "Biologia Centrali Americana."

It is to the liberality and sympathetic kindness of Mr. F. du Cane Godman and Mr. Osbert Salvin that my work on Central American antiquities is being published in its present sumptuous form. Their names, indeed, figure on the title-page as editors; but the old-fashioned and much abused title of patrons would be more appropriate in expressing an ideal relationship in which they have confined their editorial duties to giving the kindliest and most valuable advice, whilst leaving me an absolutely free hand in the selection of material, and relieving me of all expense of printing and publication, and the reproduction of photographs, plans and drawings, which already extend over 175 double quarto plates.

It is again to this same liberality that my friend Mr. Goodman's interesting essay owes its publication; and were he here I know how heartily he would join me, and I think I may add so would every other student of American archæology, in a grateful acknowledgment of the deep debt of gratitude we owe to the editors of the "Biologia." To Mr. Goodman, as to myself, has been accorded an unrestricted freedom in the expression of his views; and after fully acknowledging the assistance he has received on this side of the water, there are passages in the preface to his essay which may be taken to express a natural disappointment that the value of his work was not recognised, and its publication ensured in the land which he loves so well.

Such attempts as have previously been made to interpret American hieroglyphic inscriptions have been mainly directed towards the interpretation of the three or four Maya manuscripts or codices which alone have escaped destruction. Although Mr. Goodman has not failed to devote the most careful attention to that branch of the subject, giving years of study to the codices as well as to the Yucatec and Cachiquel Calendar systems, it is to the interpretation of what he terms the "Archaic system," that is to say, the system of notation employed in the carved inscriptions found amongst the ruins of Palenque, Copan, Quirigua, Menché and Tikal—an almost untrodden field of research—that the present essay is devoted.

It will doubtless be disappointing to the general reader to learn that the greater part of the carved Maya inscriptions deal only with dates and the computation of intervals of time; but this is a fact which has gradually been forcing itself on the minds of students.

As Mr. Goodman says:—

"It may appear absurd, at first thought, that temples, monuments and altars should be covered with elaborately carved inscriptions that record nothing but dates and other forms of time reckoning. But a little reflection should convince one that such inscriptions, under certain conditions, would not be preposterous, but the wisest and most useful of records. A calendar is an indispensable requisite of civilisation. The very attempt to construct one is the first step towards evolution from savagery, and a completed calendar of any kind is proof that the transition has been accomplished."

The work of constructing a satisfactory calendar system from the chaotic fragments of information which have come down to us, has been a work necessitating the most extraordinary patience and insight. Not only must such a system stand the test of application to the inscriptions which are already known, but it must be prepared to stand the further tests to which it will be continually submitted as hitherto undiscovered inscriptions are brought to light.

Of the methods employed by Mr. Goodman in the preparation of his calendar a slight sketch is given us, and he tells us how it was to the writings of Diego di Landa (A.D. 1566), the Bishop of Yucatan and arch-destroyer of Maya records, that he had finally to return as his only trustworthy guide.

It is impossible in a short notice even to touch on the numerous points which had to be considered in the preparation of the calendar tables which accompany Mr. Goodman's essay. The main factor is the concurrent use of two systems based, one on a year of 360 days, and the other on a year of 365 days.

The Chronological Calendar deals with the former system, the divisions of time being

20 days	1 Chuen.
18 Chuens	1 Ahau (360 days).
20 Ahaus	1 Katun.
20 Katuns	1 Cycle.

13 Cycles = 1 Great Cycle.

It is somewhat unfortunate that the Ahau, or period of 360 days, bears the same name as one of the twenty days of the Maya month, and in the same manner that the Chuen, or twenty-day period, is made to bear the name of another day of the month.

The Annual Calendar is divided into eighteen named

months, each of twenty named days, and one short month named Uayeb, of five days.

This Calendar repeats itself at the end of fifty-two years.

I called attention, some years ago, to the fact that the greater number of the carved inscriptions commenced with easily recognised series of glyphs with numerals or faces attached to them, which I called the Initial Series. Mr. Goodman now shows that the Initial Series expresses a date thus :—

1 2 3 4 5 6 7 8

(1) The Great Cycle sign. (2) The Cycle. (3) The Katun. (4) The Ahau. (5) The Chuen. (6) The Day. (7) The named day. (8) The named month.

As has been long known, each bar counts as five, and each dot as a unit. (The roundish marks *under* the glyphs are not part of the numerical series.)

The signs in front of the Ahau, Chuen and Day signs denote a "full count" of those periods. The date thus reads :—

54th	Great Cycle.
9th	Cycle.
15th	Katun.
"Full count"	Ahaus.
"Full count"	Chuens.
"Full count"	Days.
4 Ahau (day).	13 Yax (month).

A reference to Mr. Goodman's chronological Calendar shows that the 15th Katun of the 9th Cycle of the 54th Great Cycle commences with the day 4 Ahau, the 13th day of the month Yax, the date which is here given in the inscription. The combination 4 Ahau 13 Yax can only occur once in a period of fifty-two years.

One of Mr. Goodman's discoveries is the system on which the Mayas numbered the different series of time divisions. For instance, the twenty Ahaus are not numbered 1, 2, 3, &c., up to 20, but they were numbered 20, 1, 2, 3, &c., to 19.

If we should nowadays wish to use a similar notation, we should probably number the series 0, 1, 2, &c., 19 ; but it seems as though the Mayas, having no sign for 0, wrote the sign for 20 or a "full count" of Ahaus in the first place.

The 18 Chuens are in like manner numbered 18, 1, 2, 3, &c., to 17 ; the same sign being used for a "full count" of Chuens as is used for a "full count" of Ahaus.

As a "full count" of days (twenty) is a Chuen, a "full count" of Chuens (eighteen) is an Ahau, and a "full count" of Ahaus (twenty) is a Katun. The foregoing inscription may be read thus :—

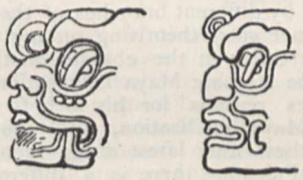
The 15th Katun of the 9th Cycle with no odd Ahaus, Chuens, or days added, begins with 4 Ahau 13 Yax.

Had the date been one including a specified number of Ahaus, Chuens, or Days, we should have had to make use of the Annual Calendar. Without giving examples and tables it is not easy to explain the method employed, which in practice is very simple, and almost invariably gives a satisfactory result ; so that we can now locate in the Maya Calendar almost all the initial dates inscribed on the monuments, and many of those expressed in the body of the inscriptions.

In the first chapters of the essay Mr. Goodman discusses each of the time periods used in the dates and computations, and identifies the glyphs by which they are expressed in the carved inscriptions.

Next follows a chapter on the "Burner Period" (260 days) and the "Bissextile Count," and then a series of chapters on the signs employed to express numbers, in addition to the well-known dot and bar system. The most interesting of these chapters is that devoted to the "Face Numerals," in which it is shown that the face so frequently met with in the inscriptions in connection with Cycle, Katun, and other signs for time periods, are in reality numerals, and the whole series of numeric faces from 1 to 20 is determined in some cases with certainty, and in others with a fair degree of probability.

The "face sign" for 10 is a death's-head, and it is interesting to note that some of the faces representing numbers from 10 to 20 are repetitions of the faces representing numbers from 1 to 10, with the addition of a death's-head jaw, or some other similar combination of 10 and the lesser numeral. Thus 6 is expressed by a grotesque face with a hafted stone axe in the eye.



And 16 is expressed thus—

the death's-head jaw replacing the more natural form of a jaw.

With the remaining chapters of this essay it is impossible to deal within the limits of this article ; although the student may not always be able to agree with the conclusions arrived at, he will find an abundance of helpful suggestions. A table of signs is given which denote "the beginning" ; numerous "directive" signs are distinguished, such as those indicating a reckoning "from the beginning of a cycle" "from the preceding date," &c., as well as "declarative" signs, such as "the beginning of a Katun," &c.

Then follow "Exercises in Decipherment" and "A Review of the Inscriptions"—that is, of those inscriptions of which drawings have already been published in the "Biologia Centrali Americana," and some others now in course of publication.

The essay is accompanied by a "working chart" in which the equivalent of each of the different time periods is given in days, and by a "Perpetual Chronological

Calendar"; also by a complete "Annual Calendar" for each of the fifty-two years of the Calendar round, and a complete "Chronological Calendar" for three great cycles. In these three great cycles all the dates as yet found in the inscriptions can be located; and, according to Mr. Goodman's theory of a Grand Era of seventy-three great cycles, these three great cycles are numbered the 53rd, 54th and 55th.

No doubt the first objection raised to the scheme will be the improbability of the Mayas having had a chronological system extending over 374,400 years, the number of years composing a Grand Era. And the objection will have all the more force, in that no such time period is mentioned by Landa or any other authority. Mr. Goodman says the Grand Era is a necessity to round off the various time periods on which the Mayas rested their computations. It does not appear to me that this would of itself necessitate a phenomenal antiquity for Maya civilisation, for the Mayas, like every other race, must have been confronted by the question, "When did time begin?" We ourselves have avoided the difficulty by taking a certain point of time, and reckoning forwards from it and backwards until we are lost in the mists of antiquity; but it must be remembered that it is only in the last few years that the date 4004 B.C. has disappeared as a marginal note from the first chapter of Genesis. Is it, therefore, impossible to believe that a people may have reckoned backwards to an imaginary beginning of time, fixed by a purely arithmetical calculation as the point when all the complicated time periods with which they were in the habit of reckoning could have started fair? How those time periods became so complicated, and needed such a vast stretch of time to work themselves out, is another matter—possibly it may have originated from the combination of various methods of reckoning time employed by different branches of the race. However, I must not start theorising on my own account, but refer the reader to the chapter on the "Era and Duration of the Archaic Maya Civilisation," where Mr. Goodman gives reasons for his belief in the great antiquity of Maya civilisation, and shows that between the earliest and latest dates recorded on the sculptures at Palenque there is a difference of 7082 years.

I am so fully aware of my own incompetence to deal with such an abstruse subject as the construction of Calendar systems, that I shall not venture on any critical review of Mr. Goodman's methods or conclusions; but I am glad to have an opportunity of saying that my acquaintance with Mr. Goodman and with his partner in his investigations, Dr. Gustav Eisen, commenced with a correspondence about the drawings of the inscriptions published in the "Biologia Centrali Americana"; and when I was afterwards able again to compare these drawings with the original sculptures, I found that the alterations of form suggested to me with regard to certain obscure and weather-worn minerals and glyphs had nearly always to be confirmed as correct. Then, as Mr. Goodman's methods became more familiar to me, I found myself constantly making use of the results at which he had arrived without any opportunity of acknowledging the source of my information. I was therefore urgent with him to publish the results of his researches, although he lingered fondly over his work, by no means considering it as yet complete.

Since commencing this article a photograph of a carved inscription, lately discovered on the banks of the Rio Usumacinta, has been forwarded to me from Yucatan by Mr. T. Maler. This inscription contains forty-eight glyphs. With the use of Mr. Goodman's tables I am able to locate (in the Maya Calendar) the date expressed in the inscription, and to follow five distinct reckonings to other dates—the reckoning made with the tables giving in every case the same result as that which is expressed in the inscription—and can thus ascertain with certainty the meaning of twenty-two out of the forty-eight glyphs contained in the inscription.

ALFRED P. MAUDSLAY.

TWENTY YEARS OF INDIAN METEOROLOGY.

SOME years ago, when the Indian Meteorological Service was started, under the directorship of the late Mr. H. F. Blanford, F.R.S., he predicted that the Indian area would yield results second to none in importance in clearing up the mysteries which surround the working of atmospherical conditions. At that time the "Indian Meteorological Memoirs," designed to embody compilations and discussions of data in the spare time of the hard-worked officials of the service, were only just starting.

Six portly volumes of these Memoirs have now been completed since 1876; and, to judge from the character of their contents, and the evident growth of certainty and breadth of view with augmenting experience and improving data, Mr. Blanford's prediction is being fulfilled even more satisfactorily than he could have anticipated.

In 1883 a series of articles, by Mr. Archibald, appeared in NATURE, in which vol. i., containing the first twelve Memoirs, were reviewed at some length. Since that date five more volumes have appeared, containing papers by the late Mr. H. F. Blanford, F.R.S., Mr. Hill, of Allahabad, Mr. Frederick Chambers, Mr. John Eliot, F.R.S. (the present head of the department), Mr. Dallas, and Mr. Archibald. In some of these papers the phenomena dealt with, such as hot winds and special storms, are of purely local incidence. In others, conditions outside the Indian area and their variations over a long course of years are discussed. We shall in the present article direct our attention principally to the light thrown upon the latter in the more recent Memoirs. Before doing this, however, allusion must be made to a very important series of papers, which form a large proportion of these volumes, in which the normal diurnal elements are discussed at twenty-five observatories scattered over the entire Indian area.

The adequate presentation of such normals is of vital importance to the efficient work of the Meteorological Department. To estimate an anomaly or abnormal, we must manifestly be able to refer to a correct normal. One of the points early foreseen by Mr. Blanford, and continually insisted upon by his successor, Mr. Eliot, has been the accurate determination of normals for as many stations as possible over the Indian area. At these twenty-five selected observatories, not merely have the normal means been determined, but the diurnal variations in temperature, pressure, wind, cloud, &c., have been worked out most exhaustively with the guiding aid of the harmonic formula, and the critical epochs determined with no stint of labour by the aid of the analytical process known as Jelinek's method of approximation. The series began with Sibsagar, by Mr. Blanford, on June 16, 1882, and was completed by a special monograph on Calcutta, by Mr. Douglas Archibald, in the present year. The area represented by these observatories extends in longitude from Aden to Dhubri in Assam, and in latitude from Leh in Thibet to Trichinopoly in Southern India. Many valuable points in connection with diurnal variations have been determined and discussed; and if ever the vexed problem of the cause of the daily variation in atmospheric pressure is completely solved, it will only be by the aid of this valuable series of papers.

In the Calcutta Memoir, which has only just reached us, the discussion embraces the temperature, pressure, and humidity observations, registered autographically

during the thirteen years 1881–1893, not merely with regard to the diurnal, but also the monthly and annual variations, together with a comparison of results at the other stations. This is probably one of the first complete discussions ever made of autographic records.

By adding on these thirteen years to the previous period of eye observations, a period is obtained sufficiently long to exhibit any secular periodicity, such as that in the mean sunspot period.

In the case of tropical air temperature, the existence of such a period is so well known that it has been frequently pointed out by Blanford, Eliot, and Hill in these Memoirs.

In the case of barometric pressure, as Mr. Blanford pointed out some years ago in his memorable discussion of the barometric see-saw between Siberia and Indo-Malaysia in the sunspot period, there is a small periodic variation of the barometric pressure of such a character that over India the pressure is above the normal in years about the minimum epoch of sunspots, and below it near those of maximum.

Calcutta, as Mr. Archibald states, is too near the axis of the see-saw (which is probably a little to the north of the Himalaya) to show a very marked variation; but the following figures for the mean cycle show that it has an existence, and must be reckoned with as a factor in the prevalent character of the weather in different years :—

Mean Annual Barometric Pressure anomaly at Calcutta (Alipore) in the eleven-year sunspot cycle from 1853 to 1893.

	Years of cycle.	Mean anomaly of annual barometric pressure unsmoothed. Inches.	
(1)	1853	− ·0067	
(2)	1854	+ ·0007	
(3)	Two cycles intervene.	+ ·0132	Min. sunspot.
(4)		+ ·0077	
(5)		− ·0012	
(6)		+ ·0042	
(7)		− ·0032	
(8)	1893	− ·0067	Max. sunspot.
(9)		− ·0100	
(10)		− ·0060	
(11)		− ·0013	

These minute variations of pressure might appear too small to be associated with air movements and conditions of any considerable magnitude. It must, however, be remembered, especially by English meteorologists, that the barometric oscillation, corresponding to any given air-motion, is a direct function of the deflecting force of the earth's rotation, and therefore of the latitude. Consequently, a variation which would represent an insignificant disturbance in latitude 50° might be attended with serious consequences in India.

Thus the only marked feature of the great Madras drought and famine of 1876-77 was a slight excess of pressure over the whole area of drought, which nowhere exceeded ·04″ or ·05″ in amount.

The abnormal pressure conditions which enabled the Indian weather department to foretell accurately the last serious drought in India—that of 1891 in Rajputana—were small in amount, depending on variations and anomalies not exceeding ·05″, which is little more than one-third of the amount of the regular diurnal change between 10 a.m. and 4 p.m.

The range of pressure for the mean cycle for Calcutta in the present case is ·02″, and since the extreme range of annual means is only ·06″, it may be fairly presumed that the cyclical variation bears a sensible ratio to the variations which cause effective changes in the character of the years and seasons. When we further recollect the well-recognised fact that in Northern India the sunspot variations affect the summer and winter oppositely as regards rainfall, no doubts need be entertained that the state of the solar surface coincides with variations which are just as real, and probably no less practically important in their results, than those introduced by the diurnal and seasonal position of the sun in the sky.

It is indeed impossible to live in the tropics without being sensible of the reality of the sunspot influences. In years about the minimum spot epoch the mean annual temperature of the air is from one to two degrees higher, the range is increased, the wind force greater, and the rainfall less and more irregularly distributed than about the maximum epoch. Moreover, though the total sunspot effects are only a part of what occurs and are often masked by certain larger variations, whose origin is probably terrestrial and reactionary rather than solar and direct, the relation is recognised officially as a factor of practical importance, and allowed for in drawing up the forecasts of the summer and winter monsoons.

The whole subject of secular changes has received a decided impetus of late from the Memoir, Vol. vi. Part 2, on "Certain Oscillatory Changes of Pressure of Long and Short Period," by Mr. John Eliot, F.R.S. In this Memoir attention is drawn to a remarkable series of long-period waves of pressure over the Indian area, which vary from six months to two years in duration. The period investigated extends from 1875 to 1894.

These waves are believed to be of the nature of advances or checks in the general oscillatory system of air flow across the equator, which represents the so-called south-west and north-east monsoon winds of the Indian area.

As Mr. Eliot observes: "In part they are probably determined by seasonal conditions in Southern and Central Asia, and in part assist in determining the seasonal conditions in India, and perhaps also in Central Asia."

The extreme range of these fluctuations, measured by monthly abnormals over the whole period, amounts to about 0·118″, or about the same as the diurnal pressure range at sea-level in tropical India.

In discussing these waves, Mr. Eliot exhibits a similar series of oppositely phased oscillations in what are termed the vertical pressure anomalies between pairs of stations situated at considerable elevations in the Himalaya and on the adjacent plains.

These vertical anomalies (which are simply the variation at the hill stations *minus* the variation at the plain stations) are now so successfully employed in the preparation of the forecasts of the winter rains of Northern India, that they demand a little special reference.

In a country like India, where climatic changes far outweigh ephemeral weather changes, it is found that 95 per cent. of the irregular ephemeral changes of pressure are less in amount than the normal diurnal pressure range, the air movements are slow, massive, and regular in contrast with those of higher latitudes, and due quite as much to vertical as horizontal changes. It is therefore to be expected that the density or pressure of the lower mass of air between the hill stations at 7000 feet and sea-level, will often show variations of an entirely opposite character to that of the air above. In other words, abnormally high pressure below argues abnormally low pressure above, and *vice versâ*. As a matter of experience, this is found to be almost invariably the rule. When the pressure at the upper levels is lower than usual, the vertical anomalies would be *negative*, and when higher they would be *positive*. Mr. Eliot finds, moreover, that the vertical anomaly waves between stations such as Leh and Lahore, Murree and Peshawar, correspond all through to the long-period waves at the stations on the plains, but are exactly reversed in phase.

This shows either that the variation of flux is entirely confined to the lower atmosphere, or else that the vertical up and down flow remains temporarily uncom-

pensated at the higher levels. In any case, the conclusion is irresistible that the pressure variations are due to *flow* and not to a mere tidal rise and fall of the entire atmosphere.

A further proof that these so-called waves are connected with the seasonal transfers of air between Asia and the Indian Ocean, is the remarkable fact that the pressure variations at Mauritius are exactly contrary to those on the Indian plains, and *in general* similar to those of the vertical anomalies. In other words, the lower atmosphere over the Southern Indian Ocean and the higher Indian air strata are analogous termini of the harmonic oscillations in the general convective interflow over the monsoon and trade-wind area of Southern Asia and the Indian Ocean.

The chief critical epochs of both the vertical anomaly and general pressure anomaly curves observed over the plains, occur in March and November. These are, therefore, the months when the character of the ensuing season may be partially forecasted from an inspection of the pressure curves.

Experience has shown, as Mr. Eliot says, that "the primary maximum values of these oscillations [*i.e.* of the pressures on the plains] occur at the end of cold weather periods, characterised by abundant or excessive precipitation in Upper India and the Western Himalayas, and that the primary minimum values occur near or at the end of south-west monsoon periods during which the rainfall has been more abundant than usual."

If we remember that the cold weather rains occur in a stratum which mostly lies above the upper stations, and that the general variations above and below are almost invariably opposite in character, the empirical rule simply embodies the rational fact that the maximum rainfall occurs in connection with the minimum pressure of the containing air-stratum. Also since the vertical anomaly and plain pressure curves are inverse to each other, the rule may be put thus.

A descending vertical anomaly curve commencing about November, and a descending plain pressure anomaly curve commencing about March, indicate respectively the probability of heavy winter and summer rainfalls. Ascending curves commencing about the same epochs indicate the reverse seasonal conditions.

In the empirical form, these relations are now being successfully employed by the Indian Meteorological Department in its system of seasonal forecasts.

The marked tendency to a semi-annual or multiple semi-annual variation in the general pressure anomalies is curiously analogous to a similar period in cirrus bands noticed by Weber, in solar and lunar halos by Tromholdt, in the aurora Polaris, and in the spots and prominences on the sun.

What causes the equally marked differences which characterise the incidence of these barometric movements and their attendant conditions in different years, is still a mystery. Like most meteorological phenomena, they are probably a resultant of several components, solar, terrestrial, direct, and reactionary.

In any case, it is evident that the general outcome of these Indian meteorological researches, so far as relates to the question of long-period and universal weather changes, is decidedly encouraging, since it is plain that the majority of the anomalies in the Indian area are resoluble into harmonic periodic elements, leaving only a small residual to be labelled non-periodic and unpredictable. The moral, therefore, is not merely to extend terrestrial observation and the discussion of data over wide areas on broad, rational methods, but to endeavour to discover the precise way in which solar changes produce analogous long and short changes in terrestrial weather, especially where, as in India, these relations form such a dominant proportion of the total.

Since the above was written Mr. Eliot's interesting article on "Periodic Variations of Rainfall in India" has appeared.

Referring as it does particularly to the remarkable wave of rain and drought which has occurred during the past five years, it chiefly emphasises the remark made above, that the yearly anomalies in the general meteorological conditions are the resultant of several components—local, general, terrestrial, solar, direct, and reactionary. From the evidence adduced therein regarding the Indian Ocean area, and a general survey of conditions which have obtained in other parts of the world, it appears that this large oscillation has been of world-wide incidence. That it represents something in addition to the ordinary variations in the oscillatory flow of the trade-monsoon currents across the equator in the Indian Ocean. That it is therefore due to some abnormal extra-terrestrial—probably solar—influence, which must be referred to the solar physicists for its solution.

At the same time, its occurrence in no way invalidates the preceding conclusions deduced from a study of the ordinary yearly variations, or weakens the value of Mr. Eliot's vertical anomaly rule, as an empirical criterion of general monsoon characteristics.

MR. NEY ELIAS.

THE name of Mr. Ney Elias, whose death we briefly announced on June 17 (p. 159), is perhaps less familiar to the readers of travel and geography of to-day than it was to similar students of a quarter of a century since. In 1873 the Council of the Royal Geographical Society awarded him the Founders Medal for the successful accomplishment of a most remarkable journey through Western Mongolia. This was a district that no European had traversed since the days of Marco Polo, and notwithstanding the numerous difficulties which Mr. Elias overcame, and the personal danger in which he often stood, he was able to execute unaided a survey of the whole country travelled. The distance travelled was more than 2000 miles, starting from Kalgan, across the desert of Gobi, thence westerly to the Chinese frontier town Kwei-hua, and onward in a north-westerly direction to the Khangai range. The fanatical Mahommedan Mongol tribes, who were at war with the Chinese garrisons, prevented him journeying further to the south, to Kuldja, which was his proposed destination. The murderous devastation occasioned by this insurrection, and the impossibility of securing adequate assistance, compelled him to cross the Russian frontier and seek shelter at the town of Büsk. This journey, which he accomplished in about six months, was not his first experience in China. In 1871 he set out, with a single Chinese servant, to cross the entire continent of Asia, and a few years earlier had penetrated far into the interior with the view of discovering the causes that had forced the Lower Yellow River to forsake its bed and seek a new outlet to the sea. According to Chinese history, this river flowing through the great eastern plain of the country has had a very restless and eventful career. Nine times, within Chinese records, this river has varied its course, and sought a fresh estuary. The positions of the various mouths are scattered up and down the coast, covering, on the whole, five degrees of latitude. The date of the most recent of these fitful excursions is somewhat uncertain, but Mr. Elias concluded, from the observations which he made in 1867, that the change of bed was due to continuous flooding of the country in 1851-2-3, by which various barriers were broken down and changes of level produced. Mr. Elias was subsequently employed in India, and sent to Yunnan and Ladak; also undertaking a mission to Chinese Turkestan. Mr. Elias was a skilled observer in many branches of physics, and in the course of his travels enriched science by many observations. At

Bhamo, Sawuddy, and at Mandalay he carried on magnetic investigations and determined the variation. His longitudes are generally derived both by the method of lunar distances and by occultations. His skill as an observer is shown by the small differences that separate the results obtained by either method. At Mandalay, for example, the two values are separated by only a little more than a minute of arc. At Leh, actinometric observations engaged his attention; and if the series are not so long as those of Lieut. Hennessey and Mr. Cole, made at a station further south, they still possess great interest owing to the fact that the observations refer to a station so difficult of access. He rendered yeoman's service in the work of demarcating the frontier line between Burmah and the Shan States, and after a life of great adventure and of much service to science, he settled down as Consul-General at Meshed. For this most important post, and the management of the tangled web of diplomatic service, arising from its close connection with the Persian, the Russian, and the Afghan Governments, to say nothing of the restless Kirghiz tribes, he had admirably prepared himself. In 1885 he traversed the difficult Pamir country, and visited those districts on the banks of the Oxus, where may be met tribes of the most diverse races, and whose interests are as varied as the climates under which they dwell.

NOTES.

PROF. VIRCHOW, of Berlin, has been elected a Foreign Associate of the French Academy, in the place of the late M. Tchebicheff.

A CONFERENCE on the subject of the renewal of Antarctic exploration was held in the rooms of the Royal Geographical Society on Monday last, under the presidency of Sir Clements Markham. Themain object of the conference was to induce the Australasian Premiers to bring the matter before their Governments, with a view to inducing them to contribute towards a British expedition under the auspices of the Royal Geographical Society. The conference was attended by, among others, the Duke of Argyll, the Marquis of Lothian, Sir Joseph Hooker, Admiral Sir George Nares, Admiral Sir Erasmus Ommanney, Admiral Sir W. J. L. Wharton, Sir John Kirk, Sir George Taubman Goldie, Prof. Rücker, and the Agents-General of Victoria, New Zealand and New South Wales. The Australasian Premiers were unable to be present. Speeches in favour of the object before the meeting were delivered by the chairman, the Duke of Argyll, Sir Joseph Hooker, Prof. Rücker, and the Agents-General. The chairman announced that the Council of the Royal Geographical Society were prepared to contribute any sum up to 5000*l.* to the amount which the colonial Governments might subscribe to the undertaking, and he expressed the hope that the matter might be pushed to a successful issue next year.

THE Institution of Naval Architects has, in honour of the Queen's Diamond Jubilee, organised an International Congress of Naval Architects and Marine Engineers, which was inaugurated by a conversazione on Monday evening. The congress itself was formally opened at the Imperial Institute on Tuesday by the Prince of Wales, who gave a short speech. On his departure, the chair was taken by the Earl of Hopetoun, the President of the Institution. After the President had delivered his address, papers were read by M. L. E. Bertin, on "Hardened Armour-plates and Broken Projectiles"; by Mr. C. E. Ellis, on "Non-inflammable Wood"; by Sir A. J. Durston and Mr. J. T. Milton, on "The History and Progress of Marine Engineering"; by M. P. Sigaudy, on "Water Tube Boilers." The session will conclude at Newcastle on July 15.

WE regret to announce the death, at the age of eighty-four, of Prof. J. J. Smith Steenstrup, of Copenhagen. After having acted as Lecturer on Mineralogy at Soröe, he was appointed, in 1845, Professor of Zoology and Director of the Zoological Museum at Copenhagen, retiring from his professorial activity in 1885. Prof. Steenstrup was the author of a number of scientific publications, several of which have been translated from the Danish into foreign languages.

AMONG other deaths we notice those of Dr. Alfred Stocquart, Chief Demonstrator of Anatomy in the University of Brussels, and Secretary of the Anatomo-Pathological Society, aged forty-one, of septic poisoning, contracted in making a post-mortem examination; and Dr. B. E. Cotting, for fifty-five years Curator of the Lowell Institute, Boston, Mass.

ACCORDING to a Reuter telegram of July 1 from Madrid, a dispatch from Manila gives some details of the eruption of the volcano Mayon. The village of Libong was completely destroyed, and 120 of the inhabitants were killed. The eruption was accompanied by a violent shock of earthquake.

THE Board of Regents of the University of the State of California have accepted the offer of Mr. C. F. Crocker, to defray all the expenses of an expedition to India to view the approaching eclipse of the sun. The expedition will remain in India from October next till June 1898.

INTENSE heat has prevailed for several days in Kansas and Arkansas, followed, on June 24, by destructive cyclones in Kansas and Missouri, and heavy storms in other States. During the storm at Hopkinsville, Kentucky, on the morning of the date mentioned, two earthquake shocks were felt. The vibrations were from west to east.

THE silver medal of the Zoological Society of London has been conferred by the Council on Mr. Alexander Whyte, who has lately retired from the post of Naturalist to the Administration of British Central Africa. Mr. Whyte accompanied Sir Harry Johnston when he first went out to Nyasaland in 1891, and has had the charge of the botanic garden at Zomba since that date, and performed other duties entrusted to him with zeal and fidelity. Under Sir Harry Johnston's instructions Mr. Whyte has made and sent to England from time to time large and most valuable collections in every branch of natural history. These have been transmitted to the British Museum through the Zoological Society of London, and have formed the subject of numerous communications by various experts to the scientific meetings of that Society. The fauna of Nyasaland, previously quite unknown, has thus become better understood than that of almost any other part of tropical Africa.

SIR MARTIN CONWAY and Mr. E. J. Garwood left London last week for Spitzbergen, their object being to continue the exploration of the interior of the main island begun by them last year. They are to be landed at King's Bay, whence they hope to make sledge expeditions over the northern ice sheet. They intend afterwards to revisit Horn Sound, and complete the scientific exploration of the southern peninsula.

DR. N. A. BUSCH, assistant-director of the Botanic Garden at Dorpat, has been commissioned by the Russian Geographical Society to undertake a botanical investigation of the Province of Kuban in the Caucasus, an almost unexplored territory. An assistant at the same Botanic Garden is also investigating the flora of the Government of Ssaratow.

A KEEPER in the service of the Zoological Society of London left London by the *Arundel Castle* on Saturday last, under arrangements sanctioned by the Colonial Office, to bring home

from Bechuanaland a young male giraffe, presented to the Queen on the occasion of her Diamond Jubilee by Chief Bethoen. The giraffe was captured three years ago, when quite young, in the Khalahari desert, and is now at Garanaka, ten miles north-east of Kanye, whither the keeper, on arrival at Cape Town, will proceed to receive it.

ANOTHER motor-cycle race is being organised in France. The date is fixed for August 22, and the course traversed will be from Paris to Cabourg, a distance of 215 kilometres.

A BIOLOGICAL station, containing aquaria, laboratories, rooms for collections and library, is in course of erection near Sebastopol, on the Black Sea. It is expected that the building will be opened for scientific work during the present year.

A LARGELY attended meeting, presided over by the Marquis of Tweeddale, was held on Friday afternoon last in the Botanical Theatre of University College, Gower Street, to inaugurate the personal memorial to the late Sir John Pender. The chairman handed over the sum of 5000*l.* to the College authorities to endow the electrical laboratory at University College, and announced that a portion of the amount subscribed had been expended on a bust of Sir John Pender, and that the balance would be given to the Glasgow University and the West of Scotland Technical College. Lord Kelvin, in a brief speech, said that it gave him great pleasure to have the opportunity of expressing his hearty concurrence with the resolutions of the Pender Memorial Committee as to the mode in which the fund collected should be distributed. He wished to speak of his own knowledge of what Sir John Pender had done. He remembered the first experiment that was made to lay a cable across the Atlantic. The scheme was supported by the then Mr. Pender, who in 1858 was one of the first directors of the company which was started to carry out the work. It was well within his recollection that all the directors resigned one after the other when the temporary success which attended the laying of the cable was followed so soon by failure. It was certainly a most discouraging result, but Mr. Pender was not to be disheartened. He was the only one to have the will and the power to keep the undertaking afloat, and from 1858 to 1864 he kept it afloat. The success which ultimately attended his efforts they all knew, and our colonies, he was glad to say, were now brought within speaking distance of the mother country.

A MONUMENT to the memory of Daguerre has been erected by public subscription at Bry-sur-Marne, and the inauguration ceremony was performed on Sunday, June 27. The memorial takes the form of a bronze bust placed on a stone pedestal, and is the work of Madame Bloch. At the close of the ceremony wreaths were placed upon Daguerre's grave.

THE outline programme of the Cardiff meeting of the Iron and Steel Institute, which is to take place from August 3 to 6, has now been issued. In it will be found full information as to each day's engagements. The following papers have been offered for reading: (1) "On Passive Iron," by J. S. de Benneville; (2) "On the Diffusion of Sulphides through Steel," by E. D. Campbell; (3) "On the Manufacture of Tin Plates," by George B. Hammond; (4) "On a Spectroscopic Analysis of Iron Ores," by Prof. W. N. Hartley, F.R.S., and Hugh Ramage; (5) "On Improvements in Shipping Appliances in the Bristol Channel," by Sir W. T. Lewis, Bart.; (6) "On the Iron Industry of Hungary," by D. A. Louis; (7) "On a Thermo-Chemical Study of the Refining of Iron," by Prof. Honoré Ponthière; (8) "On Carbon and Iron," by E. H. Saniter; (9) "On some Mechanical Appliances at Penarth Docks," by T. Hurry Riches; (10) "On the Application of Travelling Belts to the Shipment of Coal," by Thomas Wrightson.

THE *Times* Paris correspondent reports that at last Monday's sitting of the Academy of Sciences a paper by M. Tatin and Dr. Richet, on steam aerodromes, was read. The experiments of the authors are being carried on in emulation of those of Prof. Langley, the Secretary of the Smithsonian Institution, in Potomac Bay, near Washington. The French experiments have been made at Carquenez, near Toulon. The aerodrome weighed about 70 lb., or two and a half times as much as the American. The power of the engine was about the same—a little more than one-horse power. The French machine had two screws instead of one—one in front and the other behind. The maximum velocity obtained by MM. Tatin and Richet was greater, namely, 18 metres per second instead of 10, but the length of their run was 140 metres instead of more than a kilometre. The duration of the experiment was only a few seconds, instead of more than two minutes.

THAT science is being well fostered in our colonies can be gathered by a perusal of the *Transactions* of the Astronomical and Physical Society of Toronto, the seventh annual volume of which we have before us. This volume contains several interesting papers communicated by the active and corresponding members of the Society; and the numerous meetings seem always to have been well attended. The President's address delivered in January last, given in the volume, sums up the aim of the Society.

ATTENTION is called, in the *Engineer*, to a simple appliance intended as a substitute for the present crude method of fog-signalling on railways. The appliance is the invention of Mr. Pratt, of Bristol, and has recently undergone in a satisfactory manner a series of experimental tests on the West Lancashire Railway at Southport. The object of the invention is, in times of thick or foggy weather, when the ordinary danger signal would be invisible to the driver, to set automatically in operation the engine whistle, on passing the point where the ordinary fog detonator would be exploded. This is effected by a knife-cutter placed in the 6-foot way—and which is raised when the danger signal is put on—cutting through a brittle metal bar carried on the engine, the cutting through of which operates the lever acting upon the whistle, and which continues to sound until turned off by the driver, when the whole apparatus is automatically placed in position for operation when the engine again approaches a danger signal. The apparatus on the engine, which can be readily attached in any suitable position, consists simply of a pair of iron rods, between which slide, on half-rings, a series of the brittle metal bars referred to. When the bottom one is cut through it is thrown off, and brings down a lever rod attached to the engine whistle, which is at once set in operation; whilst the bar immediately above falls into its place, so that so long as the couple of rods between which these bars slide are kept supplied, the apparatus is always in readiness for signalling to the driver. The only real objection raised to the apparatus by the railway officials present was that it would be absolutely indispensable that every engine travelling over a line should be fitted with the appliance, and as over most main lines different railway companies have travelling powers, this would no doubt be a difficulty in the way of its adoption.

THE collection of Penguins in the Zoological Society's Gardens has received some valuable accessions in the shape of two examples of the little Blue Penguin of New Zealand (*Eudyptula minor*), and two specimens of the King Penguin from the Antarctic Seas, neither of which species are often seen alive in captivity. The former birds will be found in the Fish-house, where they are fed along with the other diving-birds, while the King Penguins have been located in an enclosure near

the Seal-pond, where they present a very attractive appearance with their sedate gesture and strangely contrasted colours. There are here also five examples of the Black-footed Penguin of the Cape to bear them company, but the King Penguins keep quite aloof from their smaller brethren.

IT is well known that the bison or buffalo (*Bison americanus*) is practically extinct in the United States as a wild animal, being now only to be found there in certain "parks" where it is carefully protected. But it is not generally so well known that there is still one district in the Dominion of Canada where the bison, or the variety of it called the "Wood-Bison," is still to be met with in its native wilds. The locality in question, which is perhaps one of the least accessible on the earth's surface, lies near Fort Chipewyan to the south of Great Slave Lake. It was visited in 1894 by Mr. Caspar Whitney, who has recently published an account of his unsuccessful hunt after this animal in his work entitled "On Snow-Shoes to the Barren Grounds." Before this interesting relict is quite exterminated, it is very desirable that a specimen of the Wood-Bison should be obtained for our Natural History Museum in South Kensington, where there is at present no specimen of this little-known mammal. It is probably only a local form of *Bison americanus*, but should certainly be represented in the National Collection.

A VERY compact and neat little camera has recently been put upon the market under the name of the "Photoscope," and is being made by Messrs. Ross and Co., of New Bond Street. This instrument is exactly like a binocular glass, and, in fact, it may be used as one when the fittings pertaining to the photographic attachment are removed. To use this for photographic purposes, one half of the binocular acts as a finder, and the other as the camera, the thicker ends of the binocular being placed up to the eyes, and pointed at the object to be photographed. The camera is arranged for carrying films, so that thirty or forty exposures may be made rapidly if required. The focussing is done after the manner of all binocular glasses, and the largest size picture capable of being taken by the instrument is 2 inches by 2 inches.

THE *Engineer*, commenting on a monograph by Mr. N. N. Banerjee, written under the auspices of the Bengal Government, says:—"The number of professional dyers in India is fast diminishing. Aniline dyes and cheap European goods are killing their trade. They are being compelled to turn their attention to new handicrafts, just as French competition and the vagaries of fashion caused the ribbon-makers of Coventry to seek a new livelihood in the manufacture of bicycles. Aniline dyes have made every man his own dyer. Formerly, the complicated processes by which indigenous dyes were prepared made the dyer a specialist. Now-a-days, anybody can dissolve the chemical powders sent out from Europe and colour his own clothes. The aniline dyes are more brilliant, and, to the native, they have the superlative merit of cheapness. They are not so fast, and they lack the delicacy of colour which, judging by the specimens annexed to the monograph, distinguish the Indian dyes. But their very gaudiness makes them more popular, and so the fate of the native dyer is sealed. Silk dyeing, cotton dyeing, and carpet dyeing are all declining. The fault, it should be added, is to some extent due to the conservatism of the native dyers themselves. They persistently adhere to their crude methods of preparing their dyes, and show a lamentable lack of ingenuity in preparing new designs."

THE *Weekly Weather Report* of June 26, shows that for the first half of this year the rainfall has exceeded the mean value in all districts, except in the north and west of Scotland. The greatest excess is in the south-west of England, where it amounts to 5 inches. This result is in some measure due to the occurrence of several heavy thunder-storms. During the week in question, some very high temperatures were recorded: Greenwich registered 90·2° in the shade, and 144·2° in the sun's rays, on the 24th, the day of the violent storm in Essex; while on the continent still greater heat was experienced, the shade temperature reaching 99° at Lisbon and Madrid, and 108° at Biskra (Algeria), in the early part of the week.

THE report of the Director of the Hongkong Observatory for the year 1896 states that the investigations of typhoons have been continued, and are now complete since the time of starting the Observatory in 1884. An important discussion of the anemometrical records obtained from the top of the Victoria Peak is being carried on, and will no doubt throw additional light upon the movements of the wind at elevated stations, which will be useful for storm-warning purposes. We notice that the weather forecasts during the year have been very successful, a result which is probably due to the receipt of three-hourly telegraphic reports, day and night, from Gap Rock Lighthouse, about thirty miles to the south of the colony. The examination of ships' logs has been continued with much activity; the observations for each month are tabulated in 10° squares, for the purpose of constructing trustworthy pilot charts of the Eastern seas. The number of observations so entered exceeds 131 thousand.

IN a note in NATURE for May 20, we called attention to Prof. Augusto Righi's investigations on electro-optics. Since then, we have received three further papers bearing on kindred theories from the same author. In one of these (*Atti dei Lincei*, vi. 10), Prof. Righi investigates the principal indices of refraction of selenite for electro-magnetic waves. In order to obtain a sufficiently large prism for his observations, the author had to make one of a number of small crystals cemented together with their axes parallel. In another paper, communicated to the Academy of Bologna (Bologna, Tipografia Gamberini, 1897), Prof. Righi deals with the orientation of a disc of selenite in a uniform electric field, and confirms Maxwell's theory according to which the three optical axes are coincident in direction with the three principal dielectric constants. A second communication to the Bologna Academy treats of secondary waves of dielectrics, and includes mathematical investigations for the effects of a dielectric sphere or cylinder.

WE have received a pamphlet entitled "An account of an investigation, by the late Joseph Baxendell, F.R.S., as to the short period cyclical changes in the magnetic condition of the earth, and in the distribution of temperature on its surface," by Joseph Baxendell, who read it recently before the Liverpool Astronomical Society. The author, from considerations arising out of an investigation of the irregularities which take place in the changes of some of the variable stars, was led to think that it was highly probable that the light of the sun, and also its magnetic and heating powers, might be subject to variations of a more complicated nature than had hitherto been supposed, and that changes indicated by the greater or less frequency of solar spots, others of a minor character and occurring in shorter periods, might also take place. A discussion of an immense amount of magnetical and thermometrical observations led the author to deduce the periods of variation, and conclude that (1) a ring of nebulous matter exists differing in density or constitution in different parts, or several masses of such matter forming a discontinuous ring, circulating round the sun in a plane nearly coincident with the plane of the ecliptic, and at a mean distance from the sun of about one-sixth of the radius of the earth's orbit. (2) The attractive force of the sun on the matter of this ring is alternately increased and diminished by the operation of the forces which produce the solar spots, being greatest at the times of minimum solar spot frequency, and least when the spots are most numerous. (3) The attractive force being variable, the

dimensions of the ring and its period of revolution round the sun will also vary, their maximum and minimum values occurring respectively at the times of maximum and minimum solar spot frequency. We may mention in this brief note that Leverrier was led to attribute a certain unexplained excess in the motion of Mercury's perihelion to the action of a disturbing body, a ring of small bodies, circulating round the sun within the orbit of this planet. It is stated in the paper that the eminent man of science, Dr. J. P. Joule, F.R.S., considered this hypothesis of Baxendell's very favourably, likening this supposed vibratory nebulous ring to a pendulum.

AN exhaustive memoir on the plague bacillus has appeared in the *Centralblatt für Bakteriologie*, and is from the pen of Dr. Rudolf Abel. In some respects this microbe resembles the cholera bacillus as regards its possible mode of distribution, and like it is apparently transmissible through water. Wilm states that he has discovered the plague bacillus in no less than three wells upon which suspicion had fallen. This investigator has also examined the vitality of the bacillus in various descriptions of water, and found it living for twenty days in distilled water. In well-water it survived sixteen days' immersion, and in sea-water six days. But these experiments were not quite satisfactory, inasmuch as considerable quantities of culture material were introduced into the waters along with the bacillus. Dr. Abel used distilled water and sterile, and also non-sterile, tap-water, and found that the plague bacilli in all cases were still living at the end of twenty days. In these investigations less culture material was added to the waters in question; but still it would have been undoubtedly better if the method had been adopted of first diluting the material of infection in water, so that the culture material was not *directly* introduced into the experimental waters. The plague bacillus is easily grown, and is very hardy, although in no instance have spore forms been discovered. Sunshine appears to be its most powerful natural enemy, for Dr. Abel found that one hour's insolation, when finely spread out in broth on cover-glasses, destroyed it. Kitasato in Hong Kong exposed bubonic pus on cover-glasses to sunshine, and found that the bacilli were killed in from three to four hours; similar results were obtained with pure cultures by Wilm. The bacillus is also sensitive to desiccation. Numerous investigations have been carried out by Dr. Abel on the action of disinfectants on the bacillus; and the memoir contains a mass of valuable information, gathered from various sources, on the character of this important micro-organism.

THE Secretary of Agriculture in the United States is arranging with recently-appointed ministers and consuls for an investigation of and report of agricultural conditions and work in the countries to which they are sent. Prof. Plumb, of Purdue University, Indiana, has been commissioned to report on the condition of dairying in certain countries he proposes to visit. Other specialists will go to Australasia and to Mexico, and the latter will collect specimens and data of what may be desirable from the semi-arid regions. Advantage will be taken of the visit of an expert to Central Asia, and tree seeds from there are expected. Prof. Hanson, of the Agricultural College of South Dakota, who is coming to Europe, will be sent on to Asia to bring back seeds of trees and legumes. Especial attention will be given to the search for vegetation of high and dry altitudes which may be introduced into America with success in similar altitudes.

THE June number of the *Mathematical Gazette*, published under the auspices of the Mathematical Association (formerly the Association for the Improvement of Geometrical Teaching), contains interesting papers on the projection of the sphere, by Prof. Alfred Lodge and by Mr. P. J. Heawood. Among the miscellaneous matter, teachers would do well to read Mr. R. F. Muirhead's brief note calling attention to certain flaws in the ordinary text-book treatment of uniform acceleration in dynamics.

AMONG the publications which have recently reached us attention may be directed to the *Photogram* for July, which contains several articles of interest. Dr. R. W. Shufeldt, in a short communication on the "Photography of Birds' Nests," pleads for good photographs of the nests of all birds that are nest-builders. His article is illustrated by a photograph of the nest of the cat-bird (*Galeoscoptes carolinensis*). Other articles in the same number are "Photography and Art," by C. E. Benham, and "The Restoration of Faded Prints," by A. Villain. In the latter two methods of restoration are described, and particulars given of a process by which greater permanence to photographic prints may be secured.—The *Irish Naturalist* has, as its leading contribution, "Some Observations by English Naturalists on the Fauna of Rathlin Island and Ballycastle District." The authors are R. Standen, Lionel E. Adams, G. W. Chester and J. Ray Hardy, who treat respectively of general observations, land and fresh-water mollusca of the Ballycastle District, the marine mollusca of Rathlin Island, and the Coleoptera of Rathlin Island.—The *Observatory* for July contains as frontispiece a striking photograph of the late Mr. E. J. Stone, F.R.S. In the July number of the *Strand Magazine* is the first of a series of articles by Grant Allen, entitled "Glimpses of Nature." The present instalment bears the attractive title of "The Cows that Ants Milk," and is well illustrated by F. Enock.—Another publication, the first part of which has just been issued, deserves mention. It is an album of pictures entitled "All about Animals," and contains well-executed reproductions of twenty of Gambier Bolton's well-known photographs.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*, var.) from Appantoo, Coomassie, presented by Dr. Thomas Pigg; an Orang-outang (*Simia satyrus*) from Borneo, presented by Dr. H. Dohrn; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. James Callingham; a Common Squirrel (*Sciurus vulgaris*), British, presented by Lady Acland Hood; two Palm Squirrels (*Sciurus palmarum*) from India, presented by Mr. C. Ingram; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. M. A. Murray; a Common Seal (*Phoca vitulina*), British, presented by Mr. Wethenhogg; two Babirussas (*Babirussa alfurus*, ♂ ♀) from Celebes, presented by H.G. the Duke of Bedford; two White-crested Jay Thrushes (*Garrulax leucolophus*) from the Himalayas, presented by Mr. B. H. Jones; a Red-crested Cardinal (*Paroaria cucullata*) from South America, presented by Miss E. M. Kenyon Welch; a Blackbird (*Turdus merula*, var.), British, presented by Mr. A. Lawford Jones; eight Spotted Geckos (*Pachydactylus maculatus*), twenty-four Hispid Lizards (*Agama hispida*), thirteen Rough-scaled Lizards (*Zonurus cordylus*), two Delalande's Lizards (*Nucras delalandii*), two Three-streaked Skinks (*Mabina trivittatus*), two Aurora Snakes (*Lamprophis aurora*), two Infernal Snakes (*Boodon infernalis*), a Lineated Snake (*Boodon lineatus*), a Smooth-bellied Snake (*Homalosoma lutrix*), two Rough-keeled Snakes (*Dasypeltis scabra*), eleven Rufescent Snakes (*Leptodira holambœia*), eight Crossed Snakes (*Psammophis crucifer*), five Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), a Yellow Cobra (*Naia flava*) from Port Elizabeth, Cape Colony, presented by Mr. J. E. Matcham; a Salvadori's Cassowary (*Casuarius salvadori*) from New Guinea, two Gentoo Penguins (*Pygosceles tæniatus*) from the Falkland Islands, an Indian Dial Bird (*Copsychus saularis*) from India, a Banded Ichneumon (*Crossarchus fasciatus*) from Africa, deposited; a Tayra (*Galictis barbara*) from South America; two Black Cuckoos (*Eudynamis orientalis*), three Ruddy Finches (*Carpodacus erythrinus*) from India, purchased.

OUR ASTRONOMICAL COLUMN.

WEINEK'S LUNAR ENLARGEMENTS.—Selenographers will be glad to hear that Prof. Weinek proposes to publish a Lunar Photographic Atlas, which will contain an accurate and artistic representation of the whole visible surface of the moon. The materials that will form the basis and bulk of this atlas have been mainly derived from the series of negatives of the Lick Observatory, which have been enlarged twenty-four times. The maps will be printed by the phototype process direct from Prof. Weinek's enlarged glass diapositives, and will be constantly under his supervision and control during their reproduction by the Art Photographical Institute of Carl Bellmann in Prague. The proposed scale of the atlas will be 4 metres to the diameter of the moon; there will be in all 200 maps 26 × 31 cm., and each sheet will give the selenographical latitude and longitude for the centre of the picture, and also the selenographical longitude of the terminator for the latitude 0°. This will greatly facilitate the arrangement of the sheets according to the relative positions of the lunar objects they portray. The publication of such an atlas as this, which requires a great deal of outlay, cannot be undertaken unless a considerable number of subscribers are forthcoming. Prof. Weinek appeals in the first instance to all the observatories of the world to become subscribers for the ten issues, each to contain twenty lunar landscapes. There should be no difficulty in obtaining a sufficient number of applicants, as such a useful and epoch-making publication in selenography should be in the possession of every observatory.

MARTIAN MARKINGS.—In the current number of *Knowledge*, M. Antoniadi brings together in an interesting summary all the more important observations made from the year 1864 of that well-known marking on the surface of Mars, namely, Syrtis Major. The discussion shows that, on the whole, decided changes have taken place in the form of this marking, and that its expansion has invaded the regions occupied by Mœris Lacus and Lilaga. Two new canals have also been recorded during the last few years in this region. The diagramatic sketch, showing the gradual changes recorded during the last thirty-three years, brings out very clearly the reason of the disappearance of the lake as such mentioned above. M. Antoniadi remarks, as regards the displacements of "seas" and "lakes," that "absurd and imaginary as they might seem to the ordinary reader, they are simply familiar occurrences to the areographer. Evidently the surface of Mars has some fixed areographical markings; but the stability of the lesser details and of the polygonians of the canal system is so frail, that at times the changes assume a fantastic, grotesque, and almost ridiculous character."

LEAKAGE FROM ELECTRIFIED METAL PLATES AND POINTS PLACED ABOVE AND BELOW UNINSULATED FLAMES.[1]

§ 1. IN § 10 of our paper "On Electrical Properties of Fumes proceeding from Flames and Burning Charcoal," communicated to this Society on April 5, results of observations on the leakage between two parallel metal plates with an initial difference of electric potential of 6·2 volts between them, when the fumes from flames and burnings were allowed to pass between them and round them, were given. The first part (§§ 1-4) of the present short paper gives results of observations on the leakage between two copper plates 1 centimetre apart, when one of them is kept at a constant high positive or negative potential; and the other, after being metallically connected with the electrometer-sheath, is disconnected, and left to receive electricity through fumes between the two.

The method of observation (see Fig. 1) was as follows. Two copper plates were fixed in a block of paraffin at the top of a round funnel 86 centimetres long and 15·6 centimetres internal diameter. A spirit-lamp or a Bunsen burner, the only two flames used in these experiments, was placed at the bottom of the funnel, 96 centimetres below the two copper plates. One terminal of a voltaic battery was connected to one plate, and the other terminal was connected to the sheath of a Kelvin quadrant electrometer. The other copper plate was connected to one of the pair of quadrants of the electrometer in such a way that by pulling a silk cord with a hinged platinum wire at its end, this copper plate and this pair of quadrants could be insulated from the sheath of the electrometer and the rest of the apparatus. On doing so with no flame at the bottom of the funnel, no deflection from metallic zero was observed, even when the other plate was kept at the potential of 94 volts by the voltaic battery; this being the highest we have as yet tried. When the plate was kept at potentials of 2, 4 . . . 10 volts, the deflection from metallic zero in three minutes was observed; but for higher potentials, merely the times of attaining to 300 scale divisions from metallic zero were observed.

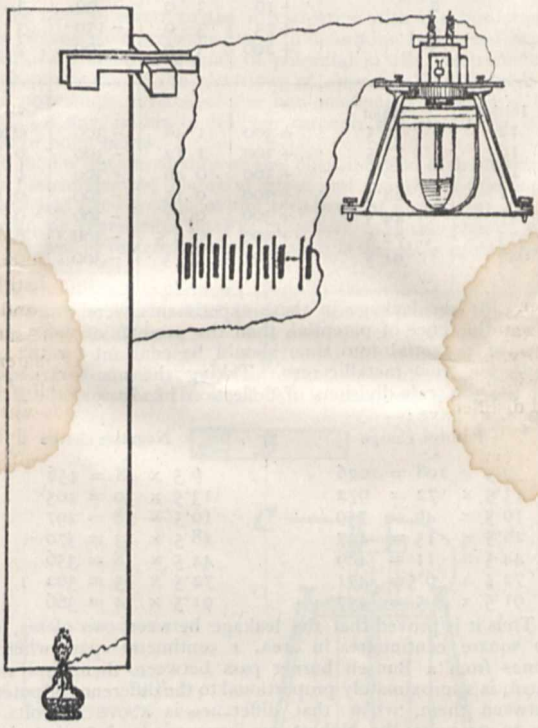


FIG. 1.

§ 2. The results obtained are summarised in the following table. In every case for potentials below 90 volts there was greater leakage when the uninsulated plate was connected to the negative terminal of the battery.

Spirit Flame.

Sensitiveness of electrometer = 60·7 scale divisions per volt. Hence 300 scale divisions corresponds approximately to 5 volts.

Difference of potential		+to plate, −to sheath		−to plate, +to sheath	
Volts		Deflection	Time	Deflection	Time
		Divisions	Min. Sec.	Divisions	Min. Sec.
2		+ 35	3 0	− 80	3 0
4		+ 92	3 0	−133	3 0
8		+205	3 0	−265	3 0
10		+240	3 0	−311	1 15
Initial	Mean				
12	9·5	+300	0 53	−300	0 38
18	15·5	+300	0 25	−300	0 16
44·5	42·0	+300	0 4·5	−300	0 4
89	86·5	+300	0 2·5	−300	0 2·5

[1] Paper communicated to the Royal Society, Edinburgh, on July 5, by Lord Kelvin, G.C.V.O., F.R.S., and Magnus Maclean, D.Sc.

Bunsen Flame.

Sensitiveness of electrometer = 60·7 scale divisions per volt.

Difference of potential		+to plate, −to sheath		−to plate, +to sheath	
Volts		Deflection	Time	Deflection	Time
		Divisions	Min. Sec.	Divisions	Min. Sec.
2		+10	3 0	−99	3 0
4		+73	3 0	−159	3 0
8		+200	3 0	−300	2 20
Initial	Mean				
12	9·5	+300	1 48	−300	0 48
16	13·5	+300	1 12	−300	0 30
19	16·5	+300	0 46	−300	0 18
31	28·5	+300	0 15	−300	0 13
47	44·5	+300	0 11	−300	0 8
75	72·5	+300	0 6·5	−300	0 5
94	91·5	+300	0 5	−300	0 4

§ 3. If the leakage in these experiments were proportional to the difference of potential, then the product of mean difference of potential into time should be constant for the same deflection from metallic zero. Taking the numbers obtained for the 300 scale divisions of deflection in virtue of the Bunsen flame, we have :—

Positive charge		Negative charge	
	s.		s.
9·5 ×	108 = 1026	9·5 ×	48 = 456
13·5 ×	72 = 972	13·5 ×	30 = 405
16·5 ×	46 = 759	16·5 ×	18 = 297
28·5 ×	15 = 427	28·5 ×	13 = 370
44·5 ×	11 = 489	44·5 ×	8 = 356
72·5 ×	6·5 = 471	72·5 ×	5 = 362
91·5 ×	5 = 457	91·5 ×	4 = 366

Thus it is proved that the leakage between two plates, each 10 square centimetres in area, 1 centimetre apart when the fumes from a Bunsen burner pass between them and round them, is approximately proportional to the difference of potential between them, when that difference is above 20 volts and up to 94 volts, the highest we have tried; but that, below 20, it diminishes with diminishing voltages more than according to simple proportion.

§ 4. To determine the currents which we had in our arrangement, we took a movable plate of a small air condenser charged to a known potential, and applied it to the insulated terminal of the quadrant electrometer. In this way we found that a quantity equal to 0·15 electrostatic unit, gave a deflection of 300 scale divisions. Hence in the experiments with the Bunsen flame and with a potential of +94 volts kept on the uninsulated copper plate, the current to the insulated copper plate opposite to it, when 300 scale divisions was reached in 5 seconds, was—

$$\frac{0{\cdot}15}{3\times10^{9}}\times\tfrac{1}{5}=10^{-11}\text{ ampere.}$$

$$=\frac{1}{100000}\text{ mikro-ampere.}$$

§ 5. One of us about the year 1865, when occupied in experimenting with the latest form of portable electrometer, found that if it was held with the top of its insulated wire (which was about 33 centimetres long) a few inches below a gas-burner, a charge of electricity, whether positive or negative, given to this wire was very rapidly lost. The disinsulating power of flames and of hot fumes from flames was well known at that time, but it was surprising to find that cold air flowing up towards the flame did somehow acquire the property of carrying away electricity from a piece of electrified metal immersed in the cold air.[1] Circumstances prevented further observations on this very interesting result at that time, but the experiment was repeated with a portable electrometer in December of 1896, and we were made quite sure of the result by searching tests. During April and May of the present year observations were again made by means of (1) a multicellular electrometer reading up to 240 volts, and (2) a vertical electrostatic voltmeter (Fig. 3, p. 235) reading up to 12,000 volts. A steel wire 43 centimetres long was fixed to the insulated terminal of the multicellular electrometer, with its needle-point vertically below an ordinary gas-burner, as shown in Fig. 2.

§ 6. By means of a small carrier metal plate (a Coulomb's proof plane) a positive or negative charge was given to this wire and the quadrants of the multicellular till the reading on the scale was 240 volts. The leakage was then observed (*a*) with gas not lit, (*b*) with gas lit at different vertical distances above the point of the wire. We found that there was rapid leakage when the flame was one centimetre above the wire; and the times of leakage from 240 volts to about 100 volts increased as the flame was raised to greater distances above the point; or, otherwise, the rate of fall of potential in one minute from 240 volts diminished as the distance of the flame above the point was increased. When the vertical distance of the flame above the point was 15 centimetres, or more, the time of leakage from 240 volts was practically the same as if the flame was not lit at all. A plate of metal, glass, paraffin, or mica, put between the point and the flame, diminished the rate of leakage. The leakage from 200 volts during the first minute is given in the following table, for different distances of the flame, with no intervening plate.

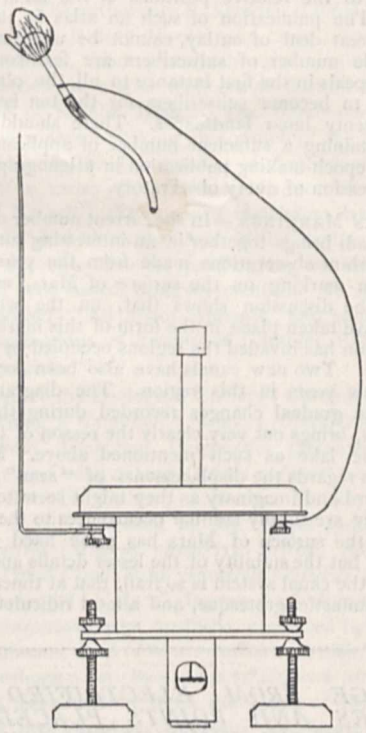


FIG. 2.

Distance of flame above point	Leakage during one minute	Remarks
Centimetre	Volts	
1·0	200 to 60 = 140	
1·5	200 to 92 = 108	
3·0	200 to 179 = 21	
6·0	200 to 196 = 4	
	200 to 197 = 3	No gas lit, but wire on the electrometer as in the other tests.*

* We sometimes found the multicellular electrometer to insulate so well that in five minutes there was no readable leakage from 240 volts.

[1] We have recently (June 1897) found the following statement, in Worthington's communication to the British Association (1889 Report, pp. 225, 227) "On the Discharge of Electrification by Flames"; . . . "the observation seems to have been made by Priestley, that the discharge takes place *with apparently equal rapidity*, if the rod be held at the side of, or even below, the flame at the distance of, say, five centimetres" The four words which we have italicised are clearly erroneous, as we find *enormously greater leakage* five centimetres above a flame than five centimetres below it: but it is very interesting to learn that Priestley had found any leakage at all through air five centimetres below a flame.

§ 7. Similar experiments were made with higher voltages measured by the vertical electrostatic voltmeter, and we found that when the flame was three or four centimetres above the point, there was very rapid discharge; but when the flame was 60 centimetres or more above the point, the leakage from 3500 volts was practically the same as if the flame was not lit.

In place of the metal point, a round disc of zinc, 8 centimetres in diameter, was fixed, as shown in Fig. 3, to the end of another steel wire of the same length; and leakage from it to the flame above it, observed. For the same distance between the flame and either the point or the metal disc, the rate of leakage through the same difference of potential, was *less for the point than for the disc.* Thus with the flame 25 centimetres above the point the time of drop from 3000 volts to 2000 volts was 1 min. 53 secs., and with the flame the same distance above the horizontal plane of the disc the time of drop from 3000 volts to 2000 volts was 1 min. 14 secs. *This is a very important result.*

§ 8. Experiments were next made to find if, and if so, how much, the leakage is diminished by putting non-conducting plates of glass, paraffin, mica, between the point or disc and the flame. At a corner of each plate was pasted a little square of tinfoil, so

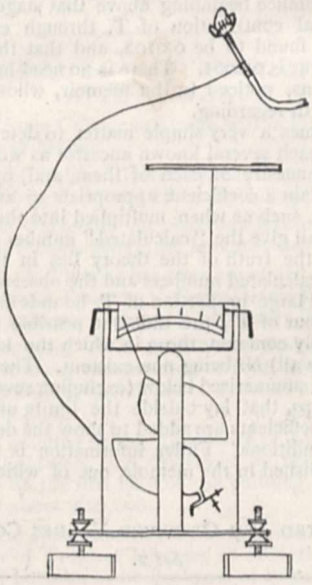


FIG. 3.

as to prevent any electrification of the non-conducting substance by handling. These pieces of tinfoil were always kept metallically connected with the sheath of the electrometer. Each plate was fixed with its under surface 1 cm. above the steel point. In preliminary experiments (of which a continuation is deferred until the insulation of the electrometer is made practically perfect by coating its vulcanite insulators with paraffin) the following numbers were obtained:—

I. *Glass Plate* 18 *cms. by* 19 *cms. by* 0·3 *cm.*

Distance of flame above point	Time of fall from 3000 to 2000 volts		Remarks
Cms.	Min.	Sec.	
—	5	30	Insulation test, with no flame.
12	2	5	Flame lit: no intervening plate.
,,	4	7	,, ,, glass plate between.

II. *Mica Sheet* 18 *cms. by* 9 *cms. by* 0·1 *cm.*

—	6	46	Insulation test, with no flame.
12	1	56	Flame lit: no intervening plate.
,,	3	50	,, ,, mica sheet between.

III. *Paraffin Plate* 11 *cms. by* 11 *cms. and* 0·75 *cm. thick.*

—	6	40	No flame. Insulation test.
12	1	53	Flame lit: no intervening plate.
,,	2	20	,, ,, paraffin plate between.

We hope to return to the investigation with the insulation of the electrometer perfected; and to determine by special experiment, how much of the fall of potential in the electrometer in each case is due to the electricity of opposite kind induced on the uppermost surface of the non-conducting plate, and how much, if any, is due to leakage through the air to the metal disc or point below.

§ 9. To test the quality of the electrification of both sides of the non-conducting plates of glass and paraffin, a thin copper sheet was fixed to one of the terminals of a quadrant electrometer, as represented in Fig. 4, where A is the plan of plate C attached to the electrometer, and B is the plate of paraffin or glass under test.

In the primary experiment (Fig. 3) the non-conducting plate was fixed in a horizontal position one centimetre above the electrified metal (point or disc), and eleven centimetres below the flame. A charge was given to the metal, to raise its potential to about 3500 volts. After some minutes, generally till the potential of the metal fell to 2000 volts, the non-con-

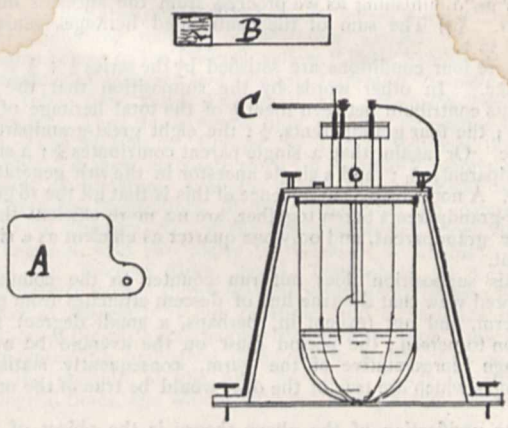


FIG. 4.

ducting plate was removed and placed, as shown in Fig. 4, above the metal plate C attached to the quadrant electrometer, and the deflection was observed. For a thin piece of glass (0·3 cm. thick) the whole effect of the two sides was negative when the electrified metal point or disc had been charged positively and *vice versâ*. But on putting two plates of glass above the electrified metal, we found the top plate to be oppositely charged and the under plate to be charged similarly to the point or disc, but not so highly. We found corresponding results with a plate of paraffin 0·75 cm. thick, and with two plates of paraffin 0·5 cm. and 0·75 cm. thick. When a plate of paraffin 3·25 cms. thick was used, we always found the top face charged oppositely to the charge of the metal, whether disc or needle-point, and the under face charged similarly to the metal below. Thus the apparent total charge of the two faces of a thin non-conducting plate is due to the fact that the face of the plate away from the electrified metal is more highly charged oppositely than the face next the metal is charged similarly.

A NEW LAW OF HEREDITY.

THE truth of a law of heredity proposed by Mr. Francis Galton, has been verified in particular instances, in a memoir[1] read by him before the Royal Society on June 3.

He first put forward the law, with hesitation, in his book "Natural Inheritance" (Macmillan and Co., 1889), page 134, because it was founded at that time almost wholly upon *à priori* grounds. Now, being found to hold good in a large group of

[1] "The average Contribution of each several Ancestor to the total Heritage of the Offspring," by Francis Galton, D.C.L., Sc.D., F.R.S.

cases, there is strong reason for its acceptance, as applicable generally to all qualities in all the higher (bisexual) animals. When it is applied to individual cases, minor corrections should of course be made in respect to sexual limitations, prepotencies of particular ancestors, and the like.

The law shows the proportion of the heritage that is contributed on the average by each parent, grandparent, great-grandparent, and so on. There *must* be an *average* contribution, drawn from each ancestral place *independently* of all the rest, because cases are familiar to observers in which a peculiarity found in some single ancestor has appeared in one or more of the offspring; the present law expresses its amount.

The general considerations upon which the law was originally founded, are four in number but not equally cogent; there is only one solution that satisfies them all. (1) The consequence of limitation in space on *particulate* germinal matter, which necessitates the loss of one-half of the total germinal material contributed by the two parents. This is confirmed by the commonly (though not universally) accepted fact of observation in the life-history of the germ. (2) The remark already made, that any ancestor however remote *may* contribute his peculiarity independently of the rest. (3) The contribution of the two parents to the child, being analogous to that of the 4 grandparents to the 2 parents, of the 8 great-grandparents to the 4 grandparents, and so on, make it probable that the latent links of the chain of ancestral contributions form a geometric series of terms, diminishing as we proceed from the ancestor downwards. (4) The sum of the contributed heritages must be equal to 1.

These four conditions are satisfied by the series $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16}$ + &c. In other words by the supposition that the two parents contribute between them $\frac{1}{2}$ of the total heritage of the child; the four grandparents, $\frac{1}{4}$; the eight great-grandparents, $\frac{1}{8}$, &c. Or again, that a single parent contributes $\frac{1}{4}$; a single grandparent, $\frac{1}{16}$; and a single ancestor in the nth generation, $1/2^{2n}$. A noteworthy consequence of this is that all the 16 great-great-grandparents taken together, are no more efficient than a single grandparent, and only one quarter as efficient as a single parent.

This supposition does not run counter to the commonly accepted view that the true line of descent stretches from germ to germ, and not (except in, perhaps, a small degree) from person to person; the person must on the average be a fair average representative of the germ, consequently statistical averages which are true of the one, would be true of the other, also.

The verification of the above theory is the object of Mr. Galton's memoir. Appropriate materials for the purpose were at last found in the registered colours of the pedigree stock of Basset hounds. This stock was started some twenty years ago by Sir Everett Millais, who purchased on the continent 93 selected hounds for the purpose, and has subsequently interbred their most valuable descendants. A Basset Club has long been established, which publishes an occasional stud-book (the latest was in 1896) containing the registered name, parentage, date of birth, and breeder of each hound. The colours are not printed in it, but they are always entered on the form sent by the breeders to the Club, and Sir E. Millais kindly had them copied for his use. Now there are two, and only two, recognised varieties of these colours: the one technically known as *lemon and white* (the word "lemon" standing for any shade between yellow and reddish-brown), and the other known as *tricolour*, from its containing black as well. So there are only two alternative conditions to be considered: "with black" and "without black"; or "Tricolour," and "Non-tricolour"—say for brevity, T. or N. It is asserted that intermediate and doubtful cases between T. and N. hardly exist.

The result is a collection (1) of 817 hounds of registered colours, T. or N., descended from parents whose colours are also known. (2) Of these, in 567 cases, the colours of all four grandparents are known; again (3) of these, in 188 cases, the colours of all eight great-grandparents are known. These three sets form the material that is tabulated and discussed, and supplies the requisite means for comparing calculated results with observed ones.

There are numerous points dealt with in the memoir, and explained away, to which there is not space to speak of here; one only need be mentioned, namely the question whether either the sire or the dam is so prepotent in transmitting colour, as to make it necessary to treat the sexes apart. It proves that the dam is prepotent over the sire in this respect, but only in the proportion of 6 to 5; also that the neglect of sex made no sensible difference in a test case. Consequently all ancestral places in the same generation are treated as of equal average efficiency. In short, if n be the order of any given generation (counting $n = 1$ for parents, $= 2$ for grandparents, &c.), there are 2^n ancestral places in the nth order, and these contribute between them $1/2^n$ of the total heritage; consequently each ancestral place contributes $1/2^{2n}$ of it. If the same hound fills more than one ancestral place, he has to be rated separately for each of them.

The contributions from the unknown ancestry are reckoned as follows. It was found that 79 per cent. of the parents of T. hounds are T. also, and that 56 per cent of the parents of N. hounds are T.; consequently the unknown grandparents, great-grandparents, &c., of the T. hounds would have probably $(\cdot79)^2$, $(\cdot79)^3$, &c., of T., and those of the N. hounds would have $(\cdot56)^2$, $(\cdot56)^3$, &c., of T. A simple calculation shows that the sum of the T. contributions to the offspring of the unknown ancestry of each T. grandparent would be 0·0408, and that of each N. grandparent would be 0·0243; these values are used in discussing the set (2). In set (3) the great-grandparents are known, ignorance beginning above that stage; in this case, the pre-ancestral contribution of T. through each T. great-grandparent, is found to be 0·0102, and that through each N. great-grandparent is 0·0061. There is no need here to allude to minor corrections, noticed in the memoir, whose effect is too small to be worth regarding.

It thus becomes a very simple matter to determine the contribution from each several known ancestor as well as that from the unknown ancestry of each of them, and, by adding these together, to obtain a coefficient appropriate to any given group of similar cases, such as when multiplied into the total number of offspring, shall give the "calculated" number that are T.

The test of the truth of the theory lies in the accordance between these calculated numbers and the observed number.

Owing to the large proportion of T. hounds and to selective breeding in favour of T., the different possible matings are by no means equally common, those in which the known ancestry are all (or nearly all) N. being non-existent. The results for such as occurred, are summarised below (excluding seven cases, falling into three groups, that lay outside the limits of the Table for set 3). The coefficients are added to show the degree of variety in the test conditions. Fuller information is to be found in the Tables published in the memoir, out of which these figures are extracted.

CALCULATED AND OBSERVED VALUES COMPARED.

Set 2.

Coefficient...	·91	·83	·76	·68	·66	·58	·51	·43	·26	·18	—	Total
T. calculated	108	99	21	8	24	92	30	3	5	1	—	391
T. observed	106	101	24	8	20	79	36	4	7	2	—	387

Set 3.

Coefficient...	·96	·94	·92	·90	·87	·85	·83	·81	·81	·79	·77	
T. calculated	2	24	13	14	16	18	13	5	2	3	2	(continued)
T. observed	2	25	14	15	17	19	14	6	2	2	3	

Set 3 (continued).

Coefficient...	·75	·69	·67	·65	·64	·62	·60	·58	·56	·54	·52	Total
T. calculated	2	1	1	6	1	17	8	18	5	2	7	180
T. observed	2	1	0	5	1	16	12	8	9	1	7	181

Comparing the totals of each of the two sets, we see that the calculated results are practically identical with the observed ones, 391 with 387; 180 with 181; grand total, 571 with 568. There is therefore no *constant* error, the errors in individual

cases balancing one another. When we examine the several groups, 32 in number, which contribute towards the above totals, a remarkable amount of agreement is shown throughout between calculation and observation, such as would raise the art of breeding to a science of considerable precision. The most notable exception is in the sixth column of set 2, where the numbers are 92 and 79, but, as is shown in the memoir, the observed values run there so irregularly with their neighbours, that they cannot be accepted as true representatives. The causes of heterogeneity undoubtedly include the disturbing effects of close interbreeding, because particular hounds of good shape that have also considerable prepotency, are largely bred from.

The author mentions that he had made experiments with the coefficients, altering them slightly and recalculating, and that he found in every case a notable diminution in the accordance between calculation and observation; the test that the law has successfully undergone thus appears to be even more severe and searching than might have been anticipated.

It is hardly necessary to insist on the value to breeders of a trustworthy law of heredity. Vast sums are spent annually in rearing pedigree stock of the most varied kinds, such as horses, cattle, sheep, pigs, dogs, and other animals, besides flowers and fruits. Certainly no popular view at all resembles that which is put forward and justified in Mr. Galton's memoir, which is epitomised here so far as space admits.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Maine State College at Orono will in future be known as the University of Maine.

MR. MUIR, of Halifax University, has been appointed to the chair of Psychology in Mount Holyoke College.

THE Victoria University on Saturday last conferred on Sir George Gabriel Stokes, Bart., the honorary degree of D.Sc.

THE Rev. D. J. Thomas has been appointed Principal of the Home and Colonial Training College, Gray's Inn Road, and of the Highbury Training College for Secondary Teachers.

THE establishment of a fresh-water biological station at Hemlock Lake, under the direction of Prof. Charles W. Dodge, has been sanctioned by the Board of Trustees of the University of Rochester, U.S.A.

THE library building of the University of Iowa was on June 19 struck by lightning, and destroyed by fire. The physical laboratory was on the first floor of the building. The total loss is estimated at about £20,000.

AMONG recent appointments may be mentioned:—Dr. Brault, to be Professor of Tropical Diseases at Algiers; Prof. W. Th. Engelmann, of Utrecht, to be Professor of Physiology at Berlin, in place of the late Prof. du Bois-Reymond.

THE following resignations are announced:—Dr. James Woodrow from the presidency of South Carolina College; President Craighead and Profs. Tompkins and Wright from Clemson College; Dr. W. H. Hervey from the presidency of the Teachers' College, New York.

ACCORDING to *Science*, Prof. Edward L. Nichols, the President of the New York State Science Teachers' Association, has appointed a committee of nine to consider and report at the next annual meeting of the Association on the following topics:—"Science as an Entrance Requirement to Colleges," "Science Teaching in the Secondary Schools," "Nature Study in Primary Schools."

THE June issue of the *London Technical Education Gazette* contains particulars of various courses of science lectures which are to be given in the autumn and winter of this year at University and King's Colleges, and at the Battersea and South-West London Polytechnics. Many of the courses are quite free of charge, and as only a limited number of persons can be accommodated at some of them, early application is desirable.

UNDER the auspices of the American Society for the Extension of University Teaching, a summer meeting is being held at the University of Pennsylvania from July 6 to 30. *Science* announces that two lectures on "Mediæval Science" will be given by Prof. W. F. Magie, and lectures on "Forestry" and "Museums" will be delivered by Prof. J. T. Rothrock and Prof. W. P. Wilson respectively. In Psychology courses of lectures are announced by Prof. L. Witmer, Prof. J. M. Baldwin and Prof. E. B. Titchener. Conferences on the teaching of geography will be led by Profs. W. M. Davis and R. E. Dodge.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, June.—Hail-storm at Seaford, Sussex, May 30, 1897. It can be very rarely proved that a shower of hailstones as large as a hen's egg has fallen over a considerable area in England, but from letters received from various observers this is shown to have been the case during thunderstorms which occurred over the east of England on that day between the Isle of Wight and Lincoln. At Seaford several hailstones were picked up measuring 4½ inches round, and at Maidstone the stones were as large as walnuts; the noise there was so great that the services in nearly all the churches were interrupted.—Heavy rain at Port Elizabeth, Cape Colony, May 5, 1897. The amount measured between 8 a.m. and 1.30 p.m. was over 5 inches, and in three days 7·29 inches were measured.

Bulletin de la Société des Naturalistes de Moscou, 1896, No. 2.—New tertiary mammals found in Russia, by Mme. Marie Pavloff, with one plate (in French). The most important find is that of a bone which was identified as the lower end of the third metacarpus of *Anchitherium aurelianense*, Cuvier; thus being the first *Anchitherium* rest found in Russia. It comes from the neighbourhood of Nikolaieff, where it was found in a layer containing remains of *Mastodon borsoni*. The other remains belong to the Pliocene yellow "Balta Sands," and are: *Rhinoceros Schleiermacheri* (Kaup), *Capreolus cusanus* (Crois. and Job., *teste* Boyd Dawkins), and *Mastodon turicensis* (Schintz). They throw a new light on that interesting formation.—The reptiles of Europe, by Dr. J. Bedriaga, Part ii. *Urodela*. A most elaborate work (in German), containing full indexes of literature, synoptic tables for determination, and full detailed descriptions of the species (to be continued).—On the structure, &c., of the Nematocysts of Cœlenterata, by N. Iwanzoff, with two plates (in German, concluded).—Polar Land and Tropical Flora, by H. Trautschold (in German). Deichmüller having shown that the invariability of the rotation-period of the earth is not probable, and a variation in the position of the earth-axis having been proved, Prof. Trautschold enumerates the geological data, which render very probable that the position of the axis has been slowly displaced in geological times, and which could not be explained otherwise.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 13.—"Further Note on the Influence of a Magnetic Field on Radiation Frequency." By Prof. Oliver Lodge, F.R.S., assisted by Mr. Benjamin Davies.

Referring to a former communication of mine, on the subject of Zeeman's discovery, printed on page 513 of the *Proceedings* of the Royal Society for February 11 this year, vol. lx. No. 367, I wish to add an observation to those previously recorded, as I have recently acquired a concave Rowland grating (3½ × 1½-inch ruled surface, 14,438 lines to inch, being the one used by Mr. George Higgs), of which the spectra of the first and third orders on one side are very satisfactory.

It is said on page 513, "If the focussing is sharp enough to show a narrow, dark reversal line down the middle of each sodium line, that dark line completely disappears when the magnet is excited." With the greater optical power now available the dark reversal line is often by no means narrow, and though in some positions of the flame it does still tend to disappear or become less manifest when the flame is subjected to a concentrated magnetic field, the reason of its partial disappearance is that it is partially reversed again—*i.e.* that a third bright line, as it were, makes its appearance in the midst of the dark line, giving a triple appearance to each sodium line.

The following is a summary of the different appearances that may be seen according to the state of the flame and the strength of the field:—

At low temperature, and with the flame forward in the field, when each sodium line is sharp and single, magnetism widens it,

and with a little more power doubles it, causing a distinct dark line down its middle. The same effect occurs with lithium and thallium lines.

At higher temperature, and with the flame partially behind the field, when each sodium line appears as a broad hazy-edged double, magnetisation greatly widens the doubling, pushing asunder the bright components very markedly; stronger magnetisation reverses the middle of the widened dark band, giving a triple appearance; stronger magnetisation still reverses the middle once more, giving a quadruple appearance to the line. In every case a nicol, suitably placed, cuts off all the magnetic effect and restores the original appearance of the line.

The same thing is seen when salts of lithium or of thallium are introduced into the flame; and the components of the doubled red lines are more widely separated than the components of the doubled green lines, the effect being proportional to wave-length. The most interesting line to try was the red cadmium line, since this has been proved to be of specially simple constitution by Michelson. We have recently been able to get the cadmium spectrum well developed by means of a sort of spark arc between the magnet poles, maintained by an induction coil excited by an alternating machine, and we find that the magnetic doubling of the chief lines occurs in precisely the same way with the spark spectrum as with the flame spectrum, and that the red cadmium line behaves in the same way as the others. The magnetic effect is better seen from a direction perpendicular to the line of force when a nicol is interposed in the path of the light, but rotation of the nicol, through 90°, cuts it entirely off, accurately so where a small spark is the source of light.

June 17.—"Kathode Rays and some Analogous Rays." By Silvanus P. Thompson, F.R.S.

(1) The size of the kathodic shadow of an object depends upon its own electric state, as already found by Crookes (*Phil. Trans.*, 1879, Part ii. p. 648). If it is negatively electrified the shadow expands. If it is positively electrified the shadow contracts. The position, as well as the size of a kathodic shadow, may be affected electrostatically; the rays which cast the shadow being repelled from a neighbouring body if the latter is negatively electrified. In some cases the contraction of the shadow of a narrow object that is made positively electrical (anodic) may go so far that the luminous margins approach and even overlap, giving the appearance of a bright or negative shadow in place of a dark one. The enlargement of a shadow when the object is made kathodic, and the diminution of the shadow when the object is made anodic, both depend upon the degree of exhaustion of the tube; and both are augmented up to a certain point by raising the degree of exhaustion. The enlargement when the object is made kathodic vastly surpasses the diminution when the object is made anodic. Kathode rays are capable of being deflected electrostatically; being apparently strongly repelled from a neighbouring kathodic surface, and less strongly attracted towards a neighbouring anode. Two kathode beams from two small disc kathodes can cross through or penetrate one another without interfering with another.

(2) Objects protected by a non-conducting layer of glass do not at moderately low exhaustions, when made kathodic, repel or deflect kathode rays, and their shadow does not enlarge. But at a certain minimum exhaustion they suddenly exert an electrostatic deflection. Naked objects made kathodic deflect the kathode rays at all exhaustions.

(3) Kathode rays cannot be concentrated by reflection either from a non-conducting or a conducting surface, nor by passage through a metal tube which is itself negatively electrified.

(4) When kathode rays strike upon an internal metal target or anti-kathode there are emitted from the latter (both at exhaustions lower than suffice to produce Röntgen rays, and at exhaustions at which those rays are also produced) some internal rays resembling ordinary kathode rays in the following respects:—They produce a similar luminescence of the glass; they cast shadows of objects; they are susceptible of deflection both magnetically and electrostatically. But they produce no Röntgen rays where they fall upon the glass surface. They do not follow either the law of specular reflection, nor that of diffuse reflection, but are emitted from the anti-kathode surface apparently according to a similarly anomalous distribution to Röntgen rays, *i.e.* with nearly equal intensity, at all angles up to 90° with the normal. It is proposed to call these rays *para-kathodic* rays in contradistinction to the ordinary or *ortho-kathodic* rays. From the similarity of their distribution with that of the Röntgen rays it is inferred that the physical processes concerned in their production are identical. These para-kathodic rays are emitted from the anti-kathode both when the latter is made an anode, and when it is neutral or even made kathodic. From an anti-kathode there may proceed at one and the same time, and in one and the same direction para-kathodic rays and Röntgen rays, which, meeting an interposed object, may cast simultaneously two shadows—a para-kathodic shadow on the glass, and a Röntgen shadow on an external screen of barium platinocyanide. The former shadow can be deflected by a magnet, the latter cannot. The former shadow expands if the object is made kathodic; the latter does not.

(5) If thin metal screens are used to sift the kathode rays the luminescent phenomena change. The rays of least penetrating power appear to be most susceptible to magnetic and electrostatic forces. The various constituents of a heterogeneous kathode beam are emitted in various proportions at different degrees of exhaustion. In the kathode rays emitted at higher degrees of exhaustion there is a greater proportion of the less-deflectable rays. The least-deflectable rays are those which most readily penetrate through a perforated screen when that screen is itself negatively electrified.

When ordinary kathode rays fall upon a perforated screen which is itself made kathodic, or are attempted to be passed through a negatively electrified tube, there emerge beyond the screen or tube some rays, here termed *dia-kathodic* rays, which differ from the ortho-kathodic, and also from the para-kathodic rays. These dia-kathodic rays are not themselves directly deflected by a magnet. They show themselves as a pale blue cone or streak. Where they fall on the glass they do not excite the ordinary fluorescence of the glass. The dia-kathodic rays excite, however, a different or second kind of fluorescence; the tint in the case of soda-glass being a dark orange. Intervening objects in the beam or cone of dia-kathodic rays cast shadows. The orange fluorescence evoked on soda-glass by the dia-kathodic rays shows in the spectroscope the D lines of sodium only. The shadows cast by dia-kathodic rays are not deflected by the magnet, nor do they change their size when the object is electrified.

"Fifth Report to the Royal Society Water Research Committee." By H. Marshall Ward, F.R.S., Professor of Botany in the University of Cambridge. Presented to the President and Council, December 10, 1896.

The following conclusions show the principal points resulting from three years' study of the Bacterial Flora of the Thames:—

(1) Very many forms occur in the Thames, some of which are pathogenic under certain conditions.

(2) The "species" of the descriptive hand-books—principally medical—are frequently not species at all, in the botanical sense, but varieties, or growth-forms, the distinctive characters of which are not constant. These so-called species need revision and grouping around types, which may turn out to be the true species.

(3) The characters derived from the behaviour of colonies are not sufficient for the determination of species, and how far they may be employed in conjunction with other characters will only be elucidated by advances in our knowledge of the way the colonies are built up by the growing bacteria on the given media.

(4) The effects of definite changes in the environment on the media are of great importance, but have hardly been noticed as yet. Plate-colonies on gelatine, for instance, develop quite differently, according to the condition of the gelatine; so that a feeble and slow-growing bacterium produces colonies quite unlike those developed by the same species when vigorous and quickly growing, not only owing to its peculiarities of growth as a feeble form, but also because the gelatine has altered during the intervening period.

(5) The effect of changes of the environment on the growing organism itself is recognised as important.

(6) With especial reference to the Thames bacteria, the past history of the organism isolated from the river implies causes of variation. The river water is a poor nutritive medium, and the organism is exposed to great changes of temperature, light, movement, &c., during its sojourn therein. Consequently the time it has been in the river affects the behaviour of the organism when isolated, just as we know that a bacterium is affected by the previous conditions of its culture in other media. Hence two colonies on a plate may look very different, and yet belong to the same species, one being developed from a cell

that had been many days or weeks in the water, the other from one that had only been there a few hours. It may need weeks or months of cultivation under constant conditions to establish the identity of the two.

Linnean Society, May 24.—Anniversary Meeting, Dr. A. Günther, F.R.S., President, in the chair.—The report of the Librarian having been read, the President opened the chief business of the meeting, when the Fellows present proceeded to ballot for the President, Officers, and Council for the ensuing year. Scrutineers having been appointed, and the votes counted, the result was declared to be as follows:—President, Dr. Albert Günther, F.R.S.; Treasurer, Mr. Frank Crisp; Secretaries, Mr. B. Daydon Jackson and Prof. G. B. Howes. The President then delivered the annual presidential address, which, on the motion of Mr. C. B. Clarke, seconded by Prof. Stewart, it was resolved should be printed and circulated. The gold medal of the Society was formally awarded to Dr. J. G. Agardh, Emeritus Professor of Botany in the University of Lund, and, in consequence of his inability to receive it in person, was delivered on his behalf to his Excellency the Minister for Sweden and Norway, who made a suitable acknowledgment.

June 3.—Dr. A. Günther, F.R.S., President, in the chair.—Prof. G. B. Howes exhibited specimens of the remarkable Crustacean *Anaspides tasmaniæ*, from the Hartz Lake, Huon district, Tasmania, which he had received from Mr. G. M. Thomson, its discoverer (see *Trans. Linn. Soc.*, Zool. [2] vol. vi. p. 287), together with a letter stating that the animal is now known from three localities. He directed attention to a recent monograph by Calman (*Trans. R. Soc. Edinb.*, vol. xxxviii. p. 787), in which the conclusion was drawn that the "Pod Shrimps" of the genera *Acanthotelson*, *Gampsonyx*, and *Palæocaris*, in respect to characters in which they are anomalous, agree with *Anaspides*, and that the four genera are probably to be referred to an ancient group of primitive Malacostraca. He remarked that he was disposed to agree with Calman's determination of the morphological value of the "first thoracic segment" of Thomson, and that he could confirm his statement that the peduncle of the flagellum of the antenna was but two-jointed.—The Rev. T. R. Stebbing, F.R.S., threw doubts upon the association claimed by Calman for *Acanthotelson*, and remarked that some Amphipods are known to agree with *Anaspides* in the possession of double epipodial lamellæ. The "ocellus" of Calman did not appear to him to occupy the position of an ocellus, and he thought it might possibly be a luminous organ.—Dr. G. D. Haviland, F.L.S., gave the substance of a paper on *Termites*, illustrated by lantern-slides, showing some of the more characteristic and remarkable forms of nests made by these insects, as well as figures of the insects themselves. A discussion followed, in which Mr. Saville Kent, the Rev. T. R. Stebbing, and the Rev. F. C. Smith took part; Mr. Kent exhibiting another series of lantern-slides illustrating the nests of Australian species.—Prof. T. Rupert Jones, F.R.S., communicated a paper by himself and Mr. F. Chapman on the genus *Ramulina*, forming the second part of a paper of which the former portion, on the tubulose and fistulose Polymorphinæ, has been already published (*Linn. Soc. Journ.*, Zool. xxv. p. 496).—The Secretary communicated a paper, by Mr. E. C. Horrell, on the number of sterigmata and spores in *Agaricus campestris*.

June 17.—Dr. A. Günther, F.R.S., President, in the chair.—Dr. D. H. Scott, F.R.S., exhibited original preparations by Prof. Ikeno and Dr. Hirase, of Tokio, Japan, illustrating their discovery of spermatozoids in two Gymnospermous Phanerogams, namely, *Ginkgo biloba* and *Cycas revoluta* (*cf.* Bot. Centralblatt, Bd. lxix. Nos. 1–2, 1897, and Annals of Botany, June, 1897). The slides showed the spermatozoids while still in the pollen-tube, before the commencement of active movement. In the case of *Ginkgo* one section showed the two male generative cells, closely contiguous and enclosed in the pollen-tube. The general structure resembles that in many other conifers at the same stage, *e.g. Juniperus virginiana* and *Pinus silvestris* (Strasburger, Hist. Beiträge, iv. pl. 2). In *Ginkgo*, however, each generative cell showed a distinct spiral coil, situated in each cell, on the side remote from its neighbour. Another preparation of *Ginkgo* showed a series of sections across the micropyle, passing through a pollen-tube and its generative cells, the plane of section being in this case approximately parallel to the surface of contact of these two cells, through which four of the sections passed. In the two terminal sections of this series the spiral coil was clearly shown, consisting of about three windings. The spiral is connected with the nucleus of the cell, but whether it is itself of nuclear or cytoplasmic origin is not certain. In the preparation from *Cycas revoluta*, several pairs of generative cells were shown; in some cases the pollen-tube enclosing them was intact. The spiral coils in some of the generative cells were surprisingly clear, consisting of about four windings. A distinct striation was visible in connection with the coil, probably indicating the presence of the numerous cilia described by the Japanese discoverers. The facts admit of no other interpretation than that given by these authors, namely that in both *Ginkgo* and *Cycas* each generative cell gives rise to a spiral spermatozoid; the latter by its own movements (actually observed by Dr. Hirase in the case of *Ginkgo*) no doubt travels from the end of the pollen-tube to the female cell. In a discussion which followed on this highly important subject, Dr. W. T. Thiselton Dyer, C.M.G., Mr. W. Carruthers, F.R.S., Prof. E. Ray Lankester, F.R.S., Prof. Howes, F.R.S., and the President took part.—Mr. T. B. Blow exhibited and described a curious case of protective mimicry in *Asparagus albus*, which drew forth criticism by Mr. H. Groves and the President.—Mr. J. E. Harting exhibited and made remarks upon specimens of *Nestor productus* and *Nestor norfolcensis*, from the Derby Museum, Liverpool, lent for exhibition by Dr. H. O. Forbes. The specimen of *Nestor norfolcensis* was of especial interest, from the remark of Count Salvadori (Brit. Mus. Cat. Parrots, xx. p. 10) that this bird is now extinct and is only known from Latham's description (Gen. Hist. Birds, 1822, ii. p. 171), and from the description and figure of the head published by von Pelzeln (Sitzb. k. Akad. Wiss., 1860, xli. p. 322) from a drawing by Ferdinand Bauer, who had visited Norfolk Island where the bird was found. With regard to *Nestor productus*, it appeared (1) that the species underwent a change of plumage analogous to that of the Crossbills: (2) that the description given by Latham applied to a more adult bird than that now shown; (3) that the result of a comparison of the two skins exhibited and the dimensions of the wings, tarsi, and feet, rendered it doubtful whether the two forms were specifically distinct, the slight variations observable in the colouration being such as might reasonably be attributed to age or sex.—Mr. Miller Christy read a paper on *Primula elatior*, Jacq., in Britain. He remarked that this widely-distributed continental plant, though figured accidentally in "English Botany" in 1799, was not really detected in Britain till 1842, to which time the totally distinct hybrid Oxlip (*P. acaulis* × *veris*) was, by British botanists, confused with, and mistaken for it, as is still frequently the case. In Britain, *P. elatior* occupies a sharply defined area, divided by the valley of the Cam, with only two outlying localities, so far as Mr. Christy could ascertain. This area covers the two most elevated and unbroken portions of the boulder clay district, the loams and gravels of the river-valleys and the chalk being entirely avoided. The boundary-lines (some 175 miles in length) which had been traced by Mr. Christy with precision were, in consequence, very sinuous. They enclosed together about 470 square miles, over which area the Oxlip flourishes in immense abundance in all old woods and some meadows; while the Primrose (which grows all around) is entirely absent. Along the dividing line between the two, which is very sharply defined, hybrids are produced in great abundance. On the other hand, the Cowslip (which grows both around and throughout the Oxlip area) very rarely hybridises with it. Mr. Christy believed that the Primrose was, in this country, gradually hybridising the Oxlip out of existence. He then noticed a rare single-flowered variety of *P. elatior*, which he proposed to call var. *acaulis*, and several aberrations, showing upon the screen photographic views of these and of the hybrids, as well as a map of the distribution of the Oxlip in Britain. In a discussion which followed, Mr. C. B. Clarke, F.R.S., and Sir John Lubbock, Bart., M.P., confirmed the accuracy of Mr. Christy's observations.—On behalf of Mr. A. D. Michael, the Zoological Secretary read a report on the *Acari* collected by Mr. H. Fisher, naturalist of the Jackson-Harmsworth Polar Expedition, at Cape Flora, Northbrooke Island, Franz Josef Archipelago, in 1896. The collection had been formed under great difficulties, and consisted of five species, two of which (*Erethræus Harmsworthi* and *Oribata Fisheri*) were regarded as new to science.—Sir John Lubbock, Bart., M.P., F.R.S., communicated the substance of a paper entitled "Further observations on Stipules," in continuation of a former paper communicated by him to the Society on March 18 last.

The present paper, which was illustrated by diagrams, has reference, *inter alia*, to the Ash, Hop, and two species of Pea (*Lathyrus grandiflora* and *L. pratensis*). Mr. W. Carruthers, F.R.S., in commenting upon this paper, expressed the satisfaction which he was sure would be felt by botanists at the way in which the author was carefully working out details in the life-history of British plants, and in that respect conforming to the spirit of the charter of the Society which expressly defined the object of its formation to be "the cultivation of the science of natural history in all its branches, and more especially of the natural history of Great Britain and Ireland."—Prof. Conway Macmillan, of the University of Minnesota, communicated the principal points of a paper on minor tension-lines between plant-formations.

PARIS.

Academy of Sciences, June 28.—M. A. Chatin in the chair.—The President announced to the Academy the loss it had sustained by the death of M. Schützenberger, Member of the Chemical Section.—On the integration of the equation $\Delta u = F(u, x, y)$, by M. Émile Picard.—On uniform quadruply periodic functions of two variables, by M. Émile Picard.—On the rotatory parts of the transversal components of the velocity in a permanent flow gradually varied, by M. J. Boussinesq.—M. de Lapparent was nominated as Member in the Section of Mineralogy, in the place of the late M. Des Cloizeaux.—On psoriasis and its relations with syphilis, by M. F. Bouffé. The injection of orchitine appears to be specific as a cure for psoriasis. The latter frequently masks the symptoms of syphilis. In the cases cited, if the treatment had been sufficiently prolonged, there was no return of the disease.—On the treatment of cancer, and of several infectious diseases by ozone, by M. Charles Chardin.—On the causes of differences of quality in harmonic chords, by M. Bourcoud.—Observations on the sun, made at the Observatory of Lyons with the Brunner equatorial, during the first quarter of 1897, by M. J. Guillaume. A tabulated statement of observations on sun-spots and faculæ.—On the geodesic lines of oppositely curved surfaces, by M. Hadamard.—On the enumeration of primitive groups of which the degree is below 17, by M. J. A. Miller.—On the determination of the integrals of certain non-linear partial differential equations by their values on a closed surface, by M. E. Le Roy.—On the permanent deformations of metals, by M. G. A. Faurie.—Influence of the intensity upon the pitch of a sound, by M. André Broca. If the intensity of a sound decreases, the note goes up, even though the period of vibration remains the same. The effects are small, and in the experiments described amount to about $\frac{1}{4}$ of a tone.—Researches on nickel-steels. Magnetic properties and permanent deformations, by M. C. E. Guillaume. The effect of temperature upon the magnetic properties of the nickel-steels was first studied, and it was found that these alloys could be divided into two classes, those containing from 0 to 25 per cent of nickel, for which the effects produced by heat were irreversible, whilst in the second class, containing higher percentages of nickel, the effects were reversible. The permanent changes of length set up in these alloys are of the same order as those in the hard glass used in thermometers.—The sulpho-antimonites of silver, by M. Pouget. The salts KAg_2SbS_3 and Ag_3SbS_3 are described. K_2AgSbS_3 could not be prepared.—On the function of manganese in certain oxidations, by M. Ach. Livache. A discussion of the action of manganese salts in quick-drying oils.—The colour of the phosphorescence of strontium sulphide, by M. José Rodriguez Mourelo. The phosphorescence depends largely upon the nature of the impurities present, and hence upon the method of preparation. The sulphide produced by the action of sulphur upon strontianite at a red heat gives the finest green colour.—Observations on the molecular volumes of several crystallised carbohydrates at 0°, by M. Pionchon. An extension of an observation of Joule and Playfair to the effect that the molecular volumes of cane-sugar and milk-sugar were exactly equal to the volume occupied in the state of ice, of the water of which this mass contains the elements. The same relations hold approximately for xylose, glucose, levulose, mellitose and raffinose.—Trioxymethylene and paraformaldehyde, by M. Delépine. The heats of formation of trioxymethylene and paraformaldehyde from its elements were determined, and also the heat of solution of the former in water.—On some combinations of phenylhydrazine with metallic iodides, by M. J. Moitessier. The compounds $ZnI_2.2(C_6H_5.N_2H_3)$, $ZnI_25(C_6H_5.N_2H_3)$, $CdI_2.2(C_6H_5.N_2H_3)$, $MnI_2.2(C_6H_5.N_2H_3)$, and $NiI_26(C_6H_5.N_2H_3)$ are described.—On the combination of metallic salts with organic bases homologous with aniline and their isomers, by M. D. Tombeck.—On the action of acetylene on silver nitrate, by M. G. Arth.—On the tetrameric regeneration of the tarsus of the Phasmidia, by M. Edmond Bordage.—The *N'djembo* the caoutchouc plant of Fernan-Vaz, by M. Henri Jumelle. The plant is described and named *Landolphia Foreti*. It is distinguished from *Landolphia owariensis*, among other points, by the superior quality of the caoutchouc produced from it.—A new remedy against mildew and black rot, by M. Gaston Lavergne. The mixture proposed consists of copper sulphate (500 gr.), black soap (1000 gr.), and water (100 litres).—Observation on a French meteorite, the fall of which (at Clohars in 1822) was unnoticed, by M. Stanislas Meunier.—The nerves of the heart and thyroid gland, by M. E. de Cyon.—Researches on the ostioles of the mucous membranes, by M. J. J. Andeer.—Effects of a hailstorm, by M. A. Forel. This hailstorm of June 2, at Morges, was remarkable for the duration of the fall of hail, more than ten minutes; the great electrical disturbances, the lightning being almost continuous; the magnitude of the hailstones, 5 to 6 cm. in length; and the peculiar structure of some of the pieces of ice.

BOOK, PAMPHLETS, and SERIALS RECEIVED.

BOOK.—The Chlorination Process: E. B. Wilson (Chapman).

PAMPHLETS.—Hints to Meteorological Observers: W. Marriott, 4th edition (Stanford).—The Fallacy of Marx's Theory of Surplus Value: H. Seymour (Murdoch).

SERIALS.—Den Norske Nordhavs-Expedition, 1876–1878, xxiv. (Christiania).—Synoptical Flora of North America, Vol. 1, Part 1, Fasc. 2 (New York, American Book Company).—Bulletin de l'Académie Royale des Sciences, &c., de Belgique, 1897, No. 5 (Bruxelles).—Journal of the Royal Agricultural Society of England, June (Murray).—Zeitschrift für Physikalische Chemie, xxiii., Band, 2 Heft (Leipzig, Engelmann).—National Review, July (Arnold).—Economic Journal, June (Macmillan).—Scribner's Magazine, July (Low).—Fortnightly Review, July (Chapman).—Geographical Journal, July (Stanford).

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