THURSDAY, JANUARY 31, 1889.

MIND IN MAN AND BRUTE.

Mental Evolution in Man: Origin of Human Faculty. By G. J. Romanes, M.A., LL.D., F.R.S. (London: Kegan Paul, Trench, and Co., 1888.)

THE subject with which Mr. Romanes deals in this volume is one which presents great, if not insuperable, difficulties. Whether or not there be a difference in kind—that is, in origin—between the mind of man and the mind of the brute, it is only in terms of the former that the latter can be interpreted. We can only reach minds other than our own by an ejective process of inference. Fully admitting that the evidence is amply sufficient to justify us in inferring the existence of mental processes in our dumb companions, the fact remains that there are enormous difficulties in getting at the nature of these mental processes. Our mental life is carried on in a rare atmosphere of self-conscious conceptual thought. And before we can put ourselves ejectively into the place of the brute, we have to divest ourselves of our conceptual habiliments; nay, more, we have—if current views be correct—to strip off the inner garment of our self-consciousness. Hence, some thinkers are driven to the extremity of agnosticism in this matter, and hold with Prof. Max Müller that, "according to the strict rules of positive philosophy, we have no right to assert or deny anything with reference to the so-called mind of animals." This, no doubt, is going too far. But, seeing that mind in the animal world and in very young children has to be interpreted not only by, but also in terms of, human consciousness, it behoves the investigator to at least express his opinions with becoming modesty. I cannot say that Mr. Romanes's modesty is obtrusive. There is, indeed, a tone of "cocksureness" ill befitting the subject in hand, and painfully marring the dignity of a work the ability and earnestness of which are conspicuous.

The problem which Mr. Romanes has set himself to solve in this volume is the genesis of self-consciousness and conceptual thought. He therefore begins by analyzing and classifying *ideas*. "Psychologists," he says, "are agreed that what they call particular ideas, or ideas of particular objects, are of the nature of mental images, or memories of such objects—as when the sound of a friend's voice brings before my mind the idea of that particular man. Psychologists are further agreed that what they term general ideas arise out of an assemblage of particular ideas, as when, from my repeated observation of numerous individual men, I form the idea of man, or of an abstract being who comprises the resemblances between all these individual men, without regard to their individual differences. Hence, particular ideas answer to percepts, while general ideas answer to concepts." This twofold classification, thus broadly and somewhat unsatisfactorily stated, Mr. Romanes deems inadequate. Defining *idea* as a generic term to signify indifferently any product of imagination, from the memory of a sensuous impression up to the result of the most abstract generalization, he classifies as under.

A "simple idea," "particular idea," or "concrete idea," is the mere memory of a particular sensuous perception.

A "compound idea," "complex idea," or "mixed idea," is the combination of simple ideas into that kind of composite which is possible without the aid of language.

A "general idea," "abstract idea," "concept," or "notion," is that kind of composite idea which is rendered possible by the aid of language, or by the process of naming abstractions as abstractions.

With regard to these, he says that the first division has to do only with what are termed percepts, while the last has to do with what are termed concepts. And there being no word to meet the middle division, he coins the term *recept* (= generic idea), which appears to him exactly to meet the requirements of the case, because in *receiving* such ideas the mind is passive, whereas in conceiving abstract ideas the mind is active.

I do not regard this classification as very satisfactory, and I doubt whether it will find much favour among modern psychologists. Regarding, as I do, every percept as a synthesis effected by the mind at the bidding of a sense-impression, I am not prepared to regard the mind as passive in what Mr. Romanes calls "reception." And I think that a subdivision of percepts into particular and generic would have been sufficient to meet all the requirements of Mr. Romanes's argument. As it is, he narrows down perception to a very limited province; for he admits that the ideation of infants is from the first generic. Throughout the whole of this chapter on *ideas*, Mr. Romanes seems to ride the "sensitive plate" analogy too hard. His percepts are photographs of particular objects; his recepts are composite photographs, like Mr. Galton's picture of the average blackguard. But this is to lose sight of the activity of mind, which, automatic though it be, is none the less real. In the great body of percepts and recepts there is far more give than take in the mental operation involved.

Turning to one of the examples of what, I presume, Mr. Romanes regards as a recept, he says: "All the higher animals have general ideas of 'good-for-eating' and 'not-good-for-eating,' *quite apart from any particular objects of which either of these qualities happens to be characteristic.*" I very much question whether any animals have the power of isolating qualities, implied in the words I have italicized. Nor should I call the idea of such an isolated quality either a percept or a recept. A dog may, by an automatic action of the mind, build into his percepts or recepts the element of niceness or nastiness as part of the object constructed by mental synthesis. But this is a very different thing from having a general (or generic) idea of niceness or nastiness apart from the object. Such an idea is the result of analysis, and the hanging of the isolated results of analysis on separate name-pegs.

Much of Mr. Romanes's work is necessarily devoted to language, and here, although he does not profess to speak as an expert, will be found much that will repay careful perusal. He introduces the term "denominative" for a sign consciously bestowed as such with a full conceptual appreciation of its office and purpose as a name. He considers that a parrot may use *bow-wow* as a denotative sign for a particular dog, and then extend it to other dogs, thus using it as a connotative sign. No parrot, however, could employ a word in its truly denominative sense. This is a conceptual, as opposed to a merely re-

ceptual, act. Natural or conventional signs may thus be built, by the animal, into the structure of its percepts or recepts. They cannot be consciously given for the purposes of conceptual thought. Mr. Romanes, at this stage of his inquiry, extends his classification, marking off four stages of ideation.

(1) *Lower recepts*, comprising the mental life of all the lower animals, and so including such powers of receptual connotation as a child when first emerging from infancy shares with a parrot.

(2) *Higher recepts*, or *pre-concepts*, comprising all the extensive tract of ideation that belongs to a child between the time when its powers of receptual connotation first surpass those of a parrot up to the age at which connotation as merely connotative begins to become denominative.

(3) *Lower concepts*, comprising the province of conceptual ideation when this first emerges from the higher receptual, up to the point where denominative connotation has to do, not merely with the naming of recepts, but also with that of associated concepts.

(4) *Higher concepts*, comprising all the further excellencies of human thought.

With this apparatus of terms, Mr. Romanes is prepared to enter upon the question of self-consciousness, which, he says, consists in paying that same kind of attention to internal or psychical processes as is habitually paid to external or physical processes, or in bringing to bear upon subjective phenomena the same powers of perception (*sic*) as are brought to bear upon the objective. I question whether Mr. Romanes's opponents will be quite satisfied with this definition. Starting with it, however, Mr. Romanes contends that, "given the protoplasm of the sign-making faculty so far organized as to have reached the denotative stage; and given also the protoplasm of judgment so far organized as to have reached the stage of stating a truth without the mind being yet sufficiently developed to be conscious of itself as an object of thought, and therefore not able to state to itself a truth as true; by a confluence of these two protoplasmic elements an act of fertilization is performed, such that the subsequent processes of mental organization proceed apace, and soon reach the stage of differentiation between subject and object." In working out this contention he makes use of the fact that a large number of the recepts of the brute have reference, not to objects of sense, or even to muscular sensations, but to the mental states of other animals. We wish he had given us more information on this head—not as to the fact, which can hardly be questioned, but as to the mode of origin of this ejective element, and as to how far such an element modifies the perceptual or receptual nature of the mental product or synthesis into which it enters. The ejective element is so purely inferential, and would seem to be reached by so indirect a process through the mental states of the animal itself, that further information on Mr. Romanes's view of the matter would have been welcome. Proceeding, however, from this basis, he takes it to be a matter of general observation that animals habitually and accurately interpret the mental states of other animals, while they well know that other animals are similarly able to interpret theirs—as is best proved by their practising the arts of cunning, concealment, hypocrisy, &c. Thus the truth is "gradually borne in upon the mind of an animal that it is a separate individuality; and this, though it is conceded that the animal is never able, even in the most shadowy manner, to think about itself as such. In this way there arises a sort of 'outward self-consciousness,' which differs from true or inward self-consciousness only in the absence of any attention being directed upon the inward mental states as such." Turning then from the animal to the child, Mr. Romanes contends that at an early age he only possesses outward or receptual self-consciousness. As yet he has paid no *attention* to his own mental states further than to feel that he feels them: he speaks to and of himself in the third person or by his proper name. "The change of a child's phraseology from speaking of self as an object to speaking of self as a subject does not take place—or but rarely so—till the third year. When it has taken place, we have definite evidence of true self-consciousness, though still in a rudimentary stage." These in brief—and it is difficult to condense the argument into a small compass—are the steps by which Mr. Romanes ascends to rudimentary self-consciousness as it first dawns upon the child-mind. I find myself unable either to accept or to criticize Mr. Romanes's account of the genesis of self-consciousness. I have read and re-read it, but find myself incapable of thinking myself into the gradually ascending stages. I fail adequately to imagine the mental condition of the dog or the very young child in which outward or receptual, and eventually inward or conceptual, self-consciousness is being evolved. I believe with Mr. Romanes that the evolution has taken place; but I fail to realize the *how*. This is, of course, not his fault: he gives me the steps of the process; he cannot give me the capacity to conceive them. In any case, Mr. Romanes claims to have shown—and how far the claim is justifiable the reader must determine for himself—"that, in whatever way we regard the distinctively human faculty of conceptual predication, it is proved to be but a higher development of that faculty of receptual communication, the ascending degrees of which admit of being traced through the brute creation up to the level which they attain in a child during the first part of its second year,—after which they continue to advance uninterruptedly through the still higher receptual life of the child, until, by further though not less imperceptible growth, they pass into the incipiently conceptual life of the human mind."

I have left myself no space to deal with the purely philological part of the work. I may note, however, that, in speaking of the roots into which language may be analyzed, Mr. Romanes contends that they can only be regarded as original or primary in the sense that they are the ultimate results of analysis, *i.e.* that they are not original in the sense of representing the ideation of really primitive man; and, again, that they for the most part stand for named recepts or lower concepts, and in a comparatively small degree for higher concepts or the results of conceptual analysis. In both these contentions I conceive he is right. Speaking as a layman of the work of one who freely admits that he is not an expert, the philological analysis seems to me extremely well done.

In conclusion, I would congratulate Mr. Romanes on this his latest volume, which undoubtedly contains much excellent and painstaking work. If I am not altogether satisfied with his psychology; if I am unable to agree

with him that "the phases of development which have gradually led up to conceptual thought admit of being as clearly traced as those which have led to any other product, whether of life or of mind"; if I even go further, and confess my belief that mental evolution never will be and never can be independently established, though it may be accepted as a corollary from organic evolution by those who are content to remain naturalists;—this does not lead me to welcome any the less cordially the valuable researches of Mr. Romanes in a very interesting but exceedingly difficult field of investigation.

C. LLOYD MORGAN.

THE MICROSCOPICAL STUDY OF MINERALS IN ROCKS.

Microscopical Physiography of the Rock-making Minerals: an Aid to the Microscopical Study of Rocks. By H. Rosenbusch. Translated and Abridged for use in Schools and Colleges by Joseph P. Iddings. Illustrated by 121 Woodcuts and 26 Plates of Photomicrographs. (New York: John Wiley and Sons. London: Macmillan and Co., 1888.)

Hülfstabellen zur mikroskopischen Mineralbestimmung in Gesteinen. Zusammengestellt von H. Rosenbusch. (Stuttgart: E. Koch, 1888.)

Les Minéraux des Roches. Par A. Michel-Lévy et Alf. Lacroix. (Paris: Libraire Polytechnique, Baudry et Cie. 1888.)

IT has been well said that this is an age of books. With equal propriety it might be characterized as an age of text-books. Indeed, so rapidly do these aids to learning increase and multiply, that it seems almost incredible that any rational proportion can still exist between demand and supply. In works on petrography, the year just passed away has been exceptionally fruitful. From the ponderous tome, replete with detail and illustrated by magnificent plates, down to the superficial shilling primer, we have before us a remarkable series of volumes in which rocks and their constituent minerals are treated from all the most recent points of view. It was in the early months of 1888 that Prof. Rosenbusch's invaluable "Mikroskopische Physiographie," was completed by the publication of the second part of Volume II., and the same year has also witnessed the appearance of Mr. J. P. Iddings's translation of the first volume, on the "Mikroskopische Physiographie der petrographisch wichtigen Mineralien." The usefulness of this book as a work of reference cannot be over-rated, as will be acknowledged by all those who have had occasion to use it. Unfortunately, it has hitherto been sealed to those who possessed no knowledge of German, and Mr. Iddings has earned the thanks of English-speaking petrographers in undertaking its translation, a task involving no inconsiderable amount of patient labour.

In the English edition the book has been slightly abridged, but in doing this the translator has "endeavoured to retain all that appeared essential to a fair general comprehension of the subject, omitting what seemed to be refinements beyond the need of the average student, and for which the advanced student is referred to the original work. Thus most of the historical portions have been omitted, as well as the elaborate treatment of the optic anomalies of certain minerals, and many notes on European localities; while a number of notes on American occurrences have been inserted." We cannot help thinking, however, that it would have been an advantage to retain the alphabetical index to petrographical literature, which, on account of its completeness, forms one of the most valuable features of Prof. Rosenbusch's work. Reference to original sources should be encouraged to the utmost in a students' book.

Mr. Iddings has added some useful information on allanite, or orthite, as some prefer to name it. According to his researches, carried out in conjunction with Mr. Whitman Cross, the occurrence of this mineral as an accessory constituent of rocks is much more wide-spread than is usually supposed. These authors have shown it to be widely distributed through a great variety of rocks in the United States, it having been found in gneiss, granite, granite-porphyry, quartz-porphyry, diorite-porphyrite, andesite, dacite, and rhyolite. It is possible that it has sometimes escaped recognition, owing to its resemblance in colour and pleochroism, to some varieties of hornblende and biotite. It may, however, be distinguished from the former by its higher double refraction, and from the latter by its larger optic axial angle.

The translator must be congratulated on the very successful way in which he has rendered the original into clear and concise English, while keeping strictly within the author's meaning; indeed, were any fault to be found with Mr. Iddings's style, it would perhaps be that he has a tendency to translate too literally. But this is erring on the safe side. Occasionally, however, he goes to the other extreme, the translation becoming so free as to be inaccurate, as, for instance, when "*crystallinische Schiefer*" is rendered "Archæan formation," so that phenomena of dynamic metamorphism (such as the marginal crushing of crystals, or "cataclastic structure"), that are common to the crystalline schists of whatever age, are thereby limited, inferentially of course, to rocks of Archæan age (pp. 251, 277, 279, 284, 307, 309, 310). The word *Sphärokrystal* has been rendered *spherulite*, on the ground that the latter has become well established in English literature. This is true; but the word spherulite is equally well known in Germany. On p. 392 of the "Physiographie der massigen Gesteine," Prof. Rosenbusch carefully distinguishes between the meanings he attaches to *spherocrystal* and *spherulite* respectively; the former being applied by him to spherular bodies consisting of radially-aggregated fibres of a single mineral (*e.g.* chlorite), the latter to those imperfectly individualized fibrous bodies so common in vitreous rocks.

In one or two instances only has Mr. Iddings been led astray by the peculiarities of the German idiom. The most serious of these slips occurs on p. 286, where we read that, "in the so-called pseudomorphs of cassiterite after orthoclase from Huel Coates, tourmaline and quartz, besides cassiterite, *form a principal part of the muscovite.*" The meaning of the original, which is, it is true, somewhat ambiguously expressed, is, that besides cassiterite, tourmaline, and quartz, muscovite forms one of the principal constituents of the pseudomorphs after orthoclase from Huel Coates.[1]

[1] "Auch bei der sog. Pseudomorphose von Cassiterit nach Orthoklas von Huel Coates im Kirchspiel St. Agnes, Cornwall, bildet neben Cassiterit, Turmalin und Quarz der Muscovit einen Hauptgemengtheil."

Typographical errors are rather numerous; but these, with few exceptions, are corrected in the page of errata inserted after the title-page.

Prof. Rosenbusch's "Tables for the Microscopic Determination of Minerals in Rocks" is one of the most useful compilations which have appeared for some time. It has doubtless been suggested by, and to some extent modelled on, Dr. E. Hussak's "Anleitung zur Bestimmung des gesteinsbildenden Mineralien," which, in spite of numerous inaccuracies, was found to be in such demand among students that soon after its publication it was translated into English, errors and all. Tables of this kind are sure to be favourably received by the practical worker, on account of the saving in time and labour resulting from their use, a single glance being sufficient to obtain all the requisite information about a given mineral. The book consists of nine two-page tables, in which we find recorded data concerning the cleavage, form, crystallographic development, colour, pleochroism, indices of refraction, optic orientation, dispersion, crystal-system, specific gravity, behaviour with reagents, and chemical composition of all the minerals occurring in rocks, whether as essential or accessory constituents. Many will be surprised to hear that these amount to as many as 190. There can be no hesitation in predicting a wide circulation for this very serviceable little book. An English edition is being] prepared, we understand, by Messrs. Swan Sonnenschein and Co.

"Les Minéraux des Roches," by Messrs. A. Michel-Lévy and A. Lacroix, is a more elaborate work, dealing with the same subject. This book, as we are informed in the preface, is complementary to the "Minéralogie Micrographique," published in 1878 by the first-named author in collaboration with M. Fouqué. It is divided into two parts: (1) the application of optical and chemical methods to the microscopical study of minerals, by A. Michel-Lévy alone; (2) a descriptive summary of the principal minerals occurring in rocks, by both authors.

The first part contains a mathematical exposition of the optical properties of minerals, which, though tending occasionally to abstruseness, is characterized by a true French elegance of treatment, the excellent use made of curves in representing graphically the variation of extinction-angles being especially worthy of commendation. On p. 54 we have a description of an instrument for the measurement of double refraction, which has been constructed for the author by M. Nachet, the celebrated Parisian microscope-maker. The *comparateur*, as it is named by its inventor, consists of a special eye-piece, to which is attached an arrangement of prisms and lenses, by which the tint and luminous intensity of a given mineral can be compared with those of a movable quartz wedge. A series of measurements of the double refraction of the principal rock-forming minerals, made by the authors with this instrument, follow on p. 66, together with the colours presented by plates of 0·01, 0·02, and 0·03 mm. respectively. At the end of the book there is also a magnificent plate, representing Newton's scale of colours up to the fifth order. By an ingenious contrivance, the colours given by the different minerals are shown for thicknesses ranging between 0 and 0·06 mm.

In the second part of the book the minerals are arranged in accordance with a scheme which is partly alphabetical, partly systematic—*i.e.* the members of a natural group (*e.g.* the felspars, micas, amphiboles, and pyroxenes) have not been separated. This method is, perhaps, not quite satisfactory, as the advantage of an alphabetical arrangement is in great part lost, while at the same time the systematic classification is necessarily incomplete. But reference to the minerals is much facilitated by an excellent index.

This part of the book contains a number of new determinations made by the authors, who have "endeavoured," and let us add with success, "to make it as complete as is consistent with the present state of the science." It concludes with a synoptical table, in which the optical data are again briefly recapitulated. F. H. H.

SEWAGE TREATMENT, PURIFICATION, AND UTILIZATION.

Sewage Treatment, Purification, and Utilization. By J. W. Slater, F.E.S. (London: Whittaker and Co., 1888.)

THIS is the work of an advocate of chemical precipitation processes for the treatment of sewage. It cannot claim to be an impartial review of the "sewage question," for the bias of the author is exhibited in nearly every page. The author is evidently of opinion that his case is likely to derive support from what is known as *argumentum ad hominem*, or abuse of the other side (those who hold different views from his own). The Rivers Pollution Commissioners come in for a considerable share of these attentions, as the following passages will show:—"Such a man was by nature qualified for a Royal Commissioner, who can never admit that either himself or any of his predecessors can have been mistaken" (p. 165). The spoiling of an effluent from a chemical precipitation process by fermentation of the deposited sediment is spoken of as a result "to gladden the heart, and for once justify the representations of ex-Royal Rivers Pollution Commissioners" (p. 172). "Mr. Bailey-Denton—who seems to be to Prof. Frankland what Ali was to Mahomed and Mr. Grant Allen to Charles Darwin" (p. 79). The Royal Commissioners on Metropolitan Sewage Discharge are alluded to in the following terms (p. 86): "That Commission refused or neglected—and in such a case these two terms are nearly equivalent—to examine fully and fairly into the merits of precipitation. . . . It would not, or at least did not, visit Aylesbury. It was satisfied to condemn precipitation on the faith of the archaic reports of the Royal Rivers Pollution Commissioners, reports which, if true at the date when written—and this is a fairly strong concession—are demonstrably false if applied, *e.g.*, to the process now in operation at Aylesbury."

It will perhaps raise a smile amongst *connoisseurs* in sewage matters to learn that managers of sewage works require protection from the (dishonourable) tricks of critical visitors. The author, at any rate, believes their innocence is likely to be imposed upon. He writes (p. 168):—"A few hints may here be given about sampling effluents for analysis or for preservation. I write here mainly for the guidance of officials left in charge of

sewage works, that they may know what tricks may be attempted. It is commonly said 'that any stick is good enough to beat a dog with,' and on a similar principle, any unfair, dishonourable stratagem is held legitimate to bring discredit on a process for the chemical treatment of sewage." "Another necessary precaution relates to sampling. If any visitor asks for a sample, it should be given him solely on the condition that he takes and seals up at the same time a check sample, to be left at the works for analysis by some independent chemist. Without this precaution he may, for instance, add to his sample a little urine or blood, or a culture solution, and still represent it as a normal sample" (p. 170). These passages serve to show the opinion in which the author holds his brother experts.

It is very plain that the author rejects *in toto* all experience but what is favourable to his own views. The following passage is a specimen of the assertions constantly made throughout the book:—"Just in proportion as a sewage is purified by precipitation, its manurial value for irrigation will decrease down to that of plain water" (p. 70). This statement, which implies that complete purification is attainable by precipitation processes, is at total variance with the truth, and has been disproved over and over again; but it is a sufficient index of the kind of treatment the subject throughout receives.

On the subject of sewage manures the author quotes, as representative of their average composition and value, the results of Dr. Tidy's analysis of the sewage manure from the "A.B.C." process at Aylesbury. Can the author not be aware that the Aylesbury manure has become one of the wonders of the scientific world? How is it that the "A.B.C." process can convert a nearly worthless substance—sewage sludge—into a rich and paying manure? Can the author tell us?

OUR BOOK SHELF.

The International Annual of Anthony's Photographic Bulletin. Edited by W. Jerome Harrison, F.G.S., and A. H. Elliot, Ph.D. (London: E. and H. T. Anthony and Co., 1888.)

IN the pages of this volume we have a valuable collection of articles written by men many of whom are eminent in the art and science of photography.

At the present day, considering the great number working, either as amateurs or professionals, at this subject, and that that number is still on the increase, and also the numerous books that have been published, one would think it hard for another work to differ a great deal from those preceding it. The editors, in their preface, tell their readers to "partake of and enjoy the feast that they have set before them; and, if the viands tickle their palates, praise rather the maker of that particular dish than those who have spread the table."

The present work consists of a popular account of nearly every branch of the subject, including stellar photography.

The volume is beautifully illustrated by specimens of various methods of printing, engraving, &c. The appendix contains a list of Photographic Societies of the British Isles, colonies, and of America, with numerous tables.

The editors have produced a volume which will not only be appreciated by members of the photographic world, but will be interesting to any ordinary reader.

Instruction in Photography. By Captain W. de W. Abney, C.B., R.E., F.R.S. Eighth Edition. (London: Piper and Carter, 1888.)

ALL that is needed for photographers, whether amateur or professional, will be found in this well-known book, which has been thoroughly revised and brought up to date. By the addition of new matter the volume has been slightly increased, and an alteration of some importance consists in the introduction of both the French and English measures for the various formulæ used throughout.

The work is profusely illustrated, and the least we can say is that no studio ought to be without it.

Lessons in Elementary Physics. By Balfour Stewart, M.A., LL.D., F.R.S. New and Enlarged Edition. (London: Macmillan and Co., 1888.)

THE present edition of this well-known book was prepared only in part by the late author. The task has been completed by Mr. W. W. Haldane Gee, B.Sc., Lecturer of the Victoria University. No material alterations have been made, except in the chapters relating to electricity and magnetism, which have been rearranged, and expanded by the addition of new matter and figures.

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.*]

Supposed Fossils from the Southern Highlands.

IN the article in your last number upon my paper lately read before the Royal Society of Edinburgh, respecting the discovery of some supposed annelid tubes in the quartzites of Loch Fyne, some observations are made on the interest attaching to the question as bearing on the geological horizon of the metamorphic series which constitute the great bulk of the South-Western and Central Highlands. With reference to this question, however, I am anxious to disclaim attaching any great importance to the discovery of annelids, because I do not admit that any real doubt exists as to the Silurian horizon to which our rocks were referred by Murchison. In this country, particularly, the evidence seems to me complete whether fossils be, or be not, found in them; because in this country we have complete stratigraphical evidence from the occurrence of a small local coal-basin in the district of Kintyre. The backbone of that long peninsula consists of the same metamorphic rocks as the rest of the country. Along its shores it is fringed by cakes of Old Red Sandstones which have resisted denudation, or have survived destructive dislocations. At the southern end of the peninsula these sandstones have survived in considerable masses—including beds of conglomerate, of freestone, and of limestones. All these beds rest unconformably on the metamorphic schists and limestones, whilst they are, again, also to be seen dipping and passing under the coal-measures and Carboniferous limestones in their usual and natural order. There can be no doubt of the order of succession in this case, and it establishes the position of our metamorphosed slates and quartzites as rocks which belong to the horizon below the Old Red.

Of course, the discovery of fossils would put an end to the new surmise that they are not sedimentary deposits at all, but intrusive rocks, simulating true bedding in consequence of "foliation," or some other process of mineralization. But this surmise is so wild that I feel no doubt about its early disappearance.

In this, I believe Dr. Geikie entirely agrees; and he has consequently expressed a confident expectation that fossils will be found in our schists and quartzites some day.

I may add that since my return from Edinburgh a correspon-

dent has sent to me an unmistakable specimen of annelid piping from a rock at Killin. Now that we are all on the scent, I have no doubt that my Loch Fyne worms will be found at the head of a long procession. ARGYLL.

Inveraray, January 28.

Mr. Howorth on the Variation of Colour in Birds.

PERMIT me to point out that the fact cited by Mr. Howorth (*anteà*, p. 294), of the similarity between the birds of Western Europe and those of Japan, which, according to him, illustrates "from an unexpected quarter" the views expressed in his work "The Mammoth and the Flood," is by no means so novel as the general reader might, from his communication, suppose. On the contrary, it has been before the world for more than half a century, and is, or ought to be, familiar to every well-informed ornithologist, since it was in 1835 that Temminck gave ("Manuel d'Ornithologie," Part 3, Introd. pp. l.–liii.) a list of 114 species of birds, which he said were common to the Japanese Empire and to Europe. It has subsequently been shown that this number was exaggerated; but, as observed in 1857 by Mr. Sclater, in his classical paper on the geographical distribution of birds, "there can be no question as to the general strong resemblance of the Japanese avifauna to that of Europe" (Journ. Linn. Soc., Zoology, ii. p. 134).

That the birds of Siberia differ in appearance from those of Japan and of Western Europe has also been abundantly shown by the long succession of illustrious explorers and naturalists from whom we derive all but an infinitesimally small portion of our knowledge of Siberian and Central Asiatic zoology; but Mr. Howorth does not seem to be aware that another hypothesis has usually been brought forward to account for that difference, as well as for the similarity of the Japanese avifauna and our own. In regard to the latter, this hypothesis has been propounded to my certain knowledge for more than five-and-twenty years (*Ibis*, 1863, p. 189); and, whether true or false, has not, so far as I am aware, been refuted. It is that the resemblance is an effect due to "the prevalence in both localities of an insular, as opposed to a continental climate," for it has been observed over and over again in various parts of the world (and not only in birds) that island forms possess a darker coloration than their continental representatives (*cf.* Gould, Proceedings of the Zoological Society, 1855, p. 78), while the fact that neither British nor Japanese birds exhibit the brilliant hues of their continental kinsfolk is notorious.

Another remark upon Mr. Howorth's communication I would offer. His theory, of which he has "little doubt," that "the willow grouse of the Continent is an altered form, and that our red grouse is the parent," is not new, but was definitely stated some eight or nine years ago in the "Encyclopædia Britannica," from the article "Grouse" in which I venture to quote a passage showing that there is a side of the question which he does not seem to have considered.

"A very interesting subject for discussion would be whether *Lagopus scoticus* or *L. albus* has varied most from the common stock of both. We can here but briefly indicate the more salient points that might arise. Looking to the fact that the former is the only species of the genus which does not assume white clothing in winter, an evolutionist might at first deem the variation greatest in its case; but then it must be borne in mind that the species of *Lagopus* which turn white differ in that respect from all other groups of the family *Tetraonidæ*. Furthermore, it must be remembered that every species of *Lagopus* (even *L. leucurus*, the whitest of all) has its first set of *remiges* coloured brown. These are dropped when the bird is about half-grown, and in all the species but *L. scoticus* white *remiges* are then produced. If, therefore, as is generally held, the successive phases assumed by any animal in the course of its progress to maturity indicate the phases through which the species has passed, there may have been a time when all the species of *Lagopus* wore a brown livery even when adult, and the white dress donned in winter has been imposed upon the wearers by causes that can be easily suggested, for it has been freely admitted by naturalists of all schools that the white plumage of the birds of this group protects them from danger during the snows of a protracted winter. On the other hand, it is not at all inconceivable that the Red Grouse, instead of perpetuating directly the more ancient properties of an original *Lagopus* that underwent no great seasonal change of plumage, may derive its ancestry from the widely-ranging Willow-Grouse, which, in an epoch comparatively recent (in the geological sense), may have stocked Britain, and left descendants that, under conditions in which the assumption of a white garb would be almost fatal to the preservation of the species, have reverted (though doubtless with some modifications) to a comparative immutability essentially the same as that of the primal *Lagopus*."

In conclusion, let me recommend those interested in the local variation of colouring in the plumage of birds to study Gloger's "Das Abändern der Vögel durch Einfluss des Klima's" (Breslau, 1833), a treatise which, though naturally out of date in many respects, contains much that ornithologists would be the better for not overlooking. ALFRED NEWTON.

Magdalene College, Cambridge, January 26.

Constitution of the Chlorides of Aluminium and the Allied Metals.

IN NATURE of December 27 (pp. 198–200), Dr. Young has directed the attention of your readers to the formulæ of the so-called hexachlorides, R_2Cl_6, and bodies of similar constitution. As this question possesses a great theoretical interest, I may be allowed to say a few words about it.

The constitution of the chlorides R_2Cl_6 was regarded by Friedel as analogous to that of carbon hexachloride, $Cl_3{\equiv}C{-}C{\equiv}Cl_3$, and the metals themselves were said to be tetravalent. Mendelejeff, in his classical paper on the periodic law—a gem of chemical literature—was the first to point out that it is not necessary to regard aluminium in Al_2Cl_6 as tetravalent, but that a compound of this formula represents only a molecular combination—a polymeric state—of $AlCl_3$. This view was very little regarded by chemists. It was, ten years later (Proc. Vienna Acad., 1882), extended by the author of the present lines, to other bodies of similar constitution, and it was shown that several chlorides give a vapour consisting partly or entirely of polymeric modifications of the simple chloride. So we have the molecules $Sn_2Cl_4{-}SnCl_2$, $Fe_2Cl_4{-}FeCl_2$ ($N_2O_4{-}NO_2$), and it was supposed that other substances of similar constitution would split up into simpler molecules, if they could bear higher temperatures, especially Al_2Cl_6, aluminium belonging to a natural group of *triad* elements, whose other members, viz. B and In, give chlorides of the simple and molecular formulæ, BCl_3 and $InCl_3$. As further instances of the above case may be quoted to-day, $H_2F_2{-}HF$, $Be_2Cl_4{-}BeCl_2$, $Ga_2Cl_6{-}GaCl_3$.

It may, however, be useful to those readers of NATURE who cannot follow completely the current chemical literature, to know that the values of vapour-densities obtained by Dumas's method are not strictly comparable with those obtained by V. Meyer's method; for, as has been shown lately by Victor Meyer and his pupils, especially Biltz, the vapour density of dissociable substances is found smaller by V. Meyer's apparatus than by that of Dumas at one and the same temperature. So Dumas's method shows, for the above chlorides, the existence of double molecules at a temperature at which that of V. Meyer indicates single molecules. It was already pointed out by Dr. Young that the single molecules, $GaCl_2$, $InCl_2$, $InCl_3$, and $CrCl_3$, were found by V. Meyer's method only, and there is no doubt that some of them may be found double by Dumas's method.

The result of the vapour-density determinations of aluminium chloride and the chlorides of the allied metals, carefully collected by Dr. Young in NATURE, is of great theoretical importance, for, as the chlorides RCl_3 exist as single molecules in the gaseous state, the respective metals are undoubtedly *trivalent* in these compounds.

But the question arises, what is the valency of these metals when their chlorides have the double molecule R_2Cl_6?

It is impossible to regard these compounds as analogous to carbon-hexachloride and the said metals as tetravalent, for that compound, when heated to a higher temperature, does *not* split up into two molecules, CCl_3, as the chlorides R_2Cl_6 do. Moreover, it must be admitted that the theory of valency which was developed by the study of organic compounds (*carbon* derivatives) does not strictly hold good in the case of the remaining elements. It is impossible to state the number of "bonds" by which the chlorides RCl_3 are kept together in double molecules, R_2Cl_6. This number is certainly not *one* ($Cl_3R{-}RCl_3$); just as two molecules of $SnCl_2$ in Sn_2Cl_4 cannot be regarded as being united by one bond, $Cl_2Sn''{-}Sn''Cl_2$, for no one will assume that tin is trivalent in this compound. If we admit any bonds at all between the two Sn atoms, we must admit two, $Cl_2Sn{=}$

$SnCl_2$. Again, silica (as has been shown by Mendelejeff long before Henry) certainly has a more complicated molecular formula than SiO_2, say $nSiO_2$, otherwise it would be a gas, analogous to CO_2, for $SiCl_4$ boils at 57° and CCl_4 at 76°. But would it be reasonable to say that the SiO_2 molecules are held together by the fifth valency of Si?

The only satisfactory answer to the above question is that in molecules R_2Cl_6 the two RCl_3 groups are held together by their own—let us say residual—affinity.

I think that the study of the question touched in the above lines will greatly add to the development of our theoretical ideas in chemistry, and deserves the careful attention of chemists.

B. BRAUNER.

Bohemian University, Prague, January 8.

IN my letter, referred to by Dr. Brauner, I considered only the molecular formulæ of the chlorides, as indicated by the experimental results.

Dr. Brauner has now, in his interesting letter, enlarged the field of discussion by introducing the question of the constitutional formulæ of these compounds, involving the vexed question of the valency of the elements. Dr. Brauner points out the importance of the proof of the trivalency of these metals in their chlorides when in the gaseous state at high temperatures, and he then discusses the valency of the metals when their chlorides have the formula R_2Cl_6.

Although I am inclined to believe that the views expressed by Dr. Brauner may eventually prove to be correct, yet I cannot help thinking that we are not yet in a position to speak with certainty on one or two points. Dr. Brauner states that the number of "bonds" by which the atoms of the metal in the compounds R_2Cl_6 are united is certainly not *one*, and again, that Sn_2Cl_4 cannot be expressed by the formula $Cl_2Sn'''—Sn'''Cl_2$. But is this quite certain? Indium, the metal next to tin in the seventh horizontal series, is mono-, di-, and tri-valent in the compounds InCl, $InCl_2$, $InCl_3$; is it, then, quite unwarrantable to assume that tin is di-, tri-, and tetra-valent in the compounds $SnCl_2$, Sn_2Cl_4, $SnCl_4$?

As regards silica, $nSiO_2$, the properties of the compound seem to indicate that n is a large number, and here, unless we arrange the Si atoms in a ring, like the carbon atoms in benzene, we must probably look on the compound as "molecular."

It is difficult to find experimental evidence which bears directly on the question; perhaps such results as those obtained by Dr. Ramsay and myself on the dynamical and statical methods of measuring vapour-pressures may throw some light on the matter. We find that the two methods give identical results with ammonium chloride, nitrogen peroxide, and acetic acid, just as they do with all stable solids and liquids, but very different results with all the other dissociating substances examined. This appears to indicate some difference in the molecular arrangement of the two groups of compounds, but it is quite uncertain whether the difference is one between "molecular" and "atomic" compounds, or between compounds formed in a very simple manner, such as $2O_2N=O_2N—NO_2$, and those in which there is a breaking down of a stable molecule, as in the case of chloral hydrate, $Cl_3C—C\begin{matrix}H\\ \diagup\\ \diagdown\\ O\end{matrix}+H.OH=$

$$Cl_3C—CH\begin{matrix}OH\\ \diagdown\\ \diagup\\ OH\end{matrix}.$$

I am at present engaged in a study of the vapour pressures of halogen compounds by both methods, and it is just possible that some further light may be thrown on this question by the results of the investigation.

SYDNEY YOUNG.

University College, Bristol, January 15.

Remarkable Rime and Mist.

YOU have a letter in NATURE of January 17 (p. 270), signed "Annie Ley," which induces me to add the following:—We had here on January 6 an extraordinary rime formed at a temperature varying between 21°·5 and 25°·7 (1° warmer on the grass than at 4 feet), the air being almost calm. This rime increased in thickness and in length with the height above the ground. The length measured of the deposit on a birch-tree at 5 feet was ⅜ of an inch; at 10 feet, 1 inch; at 15 feet, 1¼ inch; and at 25 feet, 1½ inch. The hoar was nearly horizontal, pointing downwards at an angle of 15°. That deposited on the grass, however, was perpendicular, rising with a thin stem and having a large funnel-shaped head. Suddenly, at 10 a.m. of the 7th (next morning), the whole of the rime (still frozen) fell to the ground, and under the birch-tree of 30 feet in height and 18 feet across (sparse of branches, and none for 10 feet), the fallen rime covered the ground to the depth of rather more than 2 inches, and this, when melted, yielded 0·550 of an inch of water (or 3¾ inches of rime to 1 of water). The rime on the grass when carefully collected and melted yielded 0·033 of an inch. There was a dense mist whilst the rime was being deposited.

From this elevation (530 feet) we frequently look over dense mists that cover the water of the Bristol Channel and see the hills of Somerset, Devon, Monmouth, and Glamorgan. On the 19th instant, with a hoar frost, over the Bristol Channel was a dense dark mist apparently extending 100 feet into the air. This mist, at 8.30 a.m., rapidly changed on its upper surface to cirri clouds, and then to transparent vapour, and in an hour the whole mist by this process had disappeared. Elsewhere the sky was cloudless. These mists of the Bristol Channel change on their upper surface sometimes to cirro-strati, sometimes to cumuli, and twice they have been known to change to thunder-clouds during the last two years. The change to cirri has only been seen once.

E. J. LOWE.

Shirenewton Hall, near Chepstow, January 22.

Cercyonis alope and *nephele*.

IN his review (NATURE, December 27, 1888, p. 193) of my work on butterflies now in course of publication (in which I receive a far more generous treatment than I am accustomed to), Captin Elwes thinks me illogical in holding to the probable specific distinction of *Cercyonis alope* and *nephele*, and at the same time the specific unity of the Eastern American forms of *Cyaniris pseudargiolus*, *lucia*, *violacea*, and *neglecta*; and suggests as to the former that climatic differences in the regions they respectively occupy may have brought about the distinctions noted.

On general grounds, it seems in the highest degree probable that climatic differences have had much to do with the origin of the different forms in both cases, be they species formed or forming. But surely Captain Elwes is confusing the judgment when he fails to make a distinction between the successive seasonal forms of a digoneutic butterfly, as in the case of *Cyaniris* and de Nicéville's Indian species to which he alludes, and the synchronous variation of a monogoneutic species, like those (or that) of *Cercyonis*.

SAMUEL H. SCUDDER.

Cambridge, U.S.A., January 10.

MODERN VIEWS OF ELECTRICITY.[1]

PART IV.—RADIATION.

XIII.

Possible Accounts of the Faraday and Hall Effects.

THE account I have given of the magnetic rotation of the plane of polarization has made it depend on the phenomenon of hysteresis, in a way which may be thus summarized. The value of μ for increasing magnetization is different from that for decreasing magnetization; an electric displacement such as occurs in every half-swing of a light-vibration is resolvable into two opposite circular components, one of which increases, while the other decreases, any magnetization already existing in the direction of the ray: the value of μ affects the speed of transmission of light; hence the two circular components will not proceed at the same pace, and the direction of vibration will infinitesimally rotate. The same thing is repeated at every half-swing, the elemental rotations being all in the same sense, and so the ultimate rotation of the plane of polarization in transparent bodies is accounted for.

[1] Continued from p. 13.

The Hall effect observed in conductors follows at once; for the rotation of a displacement is equivalent to combining it with a small perpendicular displacement; and it is this perpendicular or transverse E.M.F. exerted by a magnetic field which Hall discovered. At the same time, there are one or two facts which militate against this view of the Hall effect, chief among which is the singular behaviour of nickel, which rotates light one way and electric displacement the other way. For some time it was possible to hope for a way out of this through the usual convenient avenue of "impurity"; but now that both experiments have been performed on the same identical piece of metal, still with opposite results, this exit is closed. In this unsettled state, so far as I know, the connection between the rotation of light and the Hall effect at present stands.

It may be well here to repeat the caution, appended as a footnote to the last article, not to assume that this account of the magnetic rotation of light and the Hall effect is true. If true, however, it is convenient as linking the phenomena on to hysteresis, and the direction of the effect in iron is correctly given—namely, a rotation against the magnetizing current.

Prof. Ewing has since pointed out, in a letter to me, that, attending more precisely to the instruction of his curves, we find the difference in μ for positive and negative magnetizing forces only lasts through a number of cycles for the time during which the final state has been approached, and does not persist after a steady state has been reached. This would make the magnetic rotation of light a function of time; and certain experiments by Villari on spinning a glass disk between the poles of a magnet, so that fresh and fresh portions of glass were continually exposed to the magnetic field, showed a marked falling off in the amount of rotation as soon as high speeds were obtained; thus proving, apparently, that a certain short time was necessary to set up the effect. This experiment, and other modifications of it, want repeating, however.

Prof. Ewing has subsequently expressed a doubt as to whether the kinematic resolution of a displacement into two equal opposite circular components is, under the circumstances, legitimate.

Prof. Fitzgerald has further pointed out that, although when attending to one element only the theory might possibly work, yet, as soon as one takes into account the whole wave-front, it breaks down; for all the main magnetic disturbance lies in the wave-front, as is well known, and the extra magnetic disturbance which I have postulated as a consequence of electrostatic displacement is annulled by interference of adjacent elements.

If I were quite sure that there were no vestige of truth in the suggestion I have made, I should, of course, withdraw it; but, as I do not feel perfectly sure either way, I leave it in a dilapidated condition for the present.

Another and apparently distinct account of the magnetic rotation can also be hinted at, which links the phenomenon on to the facts of thermo-electricity. It labours under worse disadvantages than the preceding, being more hazy.

Referring back to NATURE, vol. xxxvii. p. 12, we find that, to explain what is called the "Thomson effect" in metals, we were led to suppose a connection between one kind of electricity and some kinds of matter more intimate than between the other kind of electricity and the same matter. Thus, the atoms of iron were said to have a better grip of positive electricity than of negative; while copper, on the other hand, had a better grip of negative than of positive. All metals could be arranged in one or other of the two classes, with the exception of lead, which appears to grip both equally. It is the same phenomenon as was originally named by Sir W. Thomson, "the specific heat of electricity in a substance." Certain it is that vibrating atoms of iron push positive electricity from the more rapid to the less rapid places of vibration—that is, from hot to cold—and a whole class of the metals do the same; while another class, like copper, push it from cold to hot.

Permitting ourselves to picture this effect as a direct consequence of the Ohm's law relation between electricity and matter, combined with a special relationship between certain kinds of matter and one or other kind of electricity, a relationship which can exhibit itself in other ways also, we get a possible though rather hazy notion of a Faraday rotation in a magnetic field by supposing that the Amperian molecular currents in these substances consist not of precisely equal positive and negative currents, but of opposite currents slightly unequal; say, for instance, that the density of the positive constituent of the bound ether of a substance is slightly different from that of the negative constituent, so that on the whole the bound ether in a magnetized molecule is slowly rotating one way or the other, at a pace equal to the resultant rotation of its constituents. Suppose that in iron the positive Amperian electric current is the weaker of the two, then the ether, as a whole, will be rotating with the negative current, and accordingly an ethereal vibration entering such a medium will begin to screw itself round in a direction opposite to that of the magnetizing current. Whereas in copper or other such substance it would be rotated the other way.

According to this (admittedly indistinct) view, lead ought to show no rotatory effect at all; and of course, therefore, no Hall effect either. And the classes into which metals are divided by the sign of their Hall effect should coincide with the classes into which the sign of their Thomson effect throws them.

Hall finds that, of the metals he examined, iron, cobalt, and zinc fall into one class, while gold, silver, tin, copper, brass, platinum, nickel, aluminium, and magnesium fall into the other. Now, referring to the thermo-electric results of Prof. Tait, we find iron, cobalt, platinum, and magnesium with a negative sign to their Thomson-effect-coefficient, or with lines in the thermo-electric diagram sloping downwards; while gold, silver, tin, copper, aluminium, and zinc slope upwards, or have a positive sign to their "specific heat of electricity."

According to this, therefore, the discordant metals are zinc, platinum, and magnesium. The proper thing to say under these circumstances is that the metals used in the very different experiments were not pure. They certainly were not; but I do not feel able to conscientiously bolster up so inadequate a theory by help of this convenient fact.

In the *Philosophical Magazine* for May 1885, Mr. Hall gives some more measurements, showing that in bismuth the effect is enormous, and in the same direction as in copper, whereas in antimony it is also great, and in the same direction as in iron. All these things seem to point to some thermo-electric connection—whether it be of the sort I have vaguely tried to indicate, or some other.

Other Outstanding Problems.

Outstanding problems bristle all over the subject, and if I pick out any for special mention it will only be because I happen to have made some experiments in their direction myself, or otherwise have had my thoughts directed to them, and because they have not been so directly called attention to in the body of the articles.

Referring back to the end of Part II., "a current regarded as a moving charge," it is natural to ask, Is this motion to be absolute, or relative to the ether only, or must it be relative to the indicating magnetometer? In other words, if a charged body and a magnetic needle are flying through space together, as, for instance, by reason of the orbital motion of the earth, will the needle experience any deflecting couple?

It is one of many problems connected with the ether

and its motion near gross matter—problems which the experiments of Fizeau (showing that a variable part of ether was bound with matter and transmitted with it, while another constant portion was free and blew through it) began to throw light upon; aberration problems such as have been partially solved by the genius of Stokes; problems connected with the motion of ether near great masses of matter, like those which Michelson is so skilfully attacking experimentally: it is among these that we must probably relegate the question whether absolute or relative motion of electric charges is concerned in the production of magnetic field, and what absolute motion through the ether precisely means. It is doubtless a question capable of being attacked experimentally, but the experiments will be very difficult. I believe that Prof. Ayrton has attempted them.

Referring back to Parts I., II., and III., we find a number of questions regarding momentum left unsettled. Has an electric current any true momentum mechanically discoverable? Now, this question, before it can be answered in the negative, will have to be attacked under a great number of subdivisions. One may classify them thus. Two main heads: (1) When steady, Does a magnet behave in the least like a gyrostat? (2) When variable, Is there a slight mechanical kick on starting or stopping a current? With four or more subsidiary heads under each, viz. (*a*) in metallic conductors; (*b*) in electrolytes; (*c*) in gases; (*d*) in dielectrics.

Suppose the answer turns out negative in metals, it by no means follows that it should be negative in electrolytes too. In fact, as matter travels with the current in the case of electrolytic conduction, it is hardly possible that there is not some momentum, though it may be too small to observe—either a kick of the vessel as a whole at starting and stopping, or a continuous impact on an electrode receiving a deposit. The present writer has looked for these things, but after gradually eliminating a number of spurious effects the result has been so far negative. In a light quill vessel fixed to the end of a torsion arm, the main disturbance was due to variations of temperature which gradually introduced a minute air-bubble, and by kicking this backwards and forwards simulated the effects sought. In the case of the suspended electrode, convection currents in the electrolyte, caused by extra concentration or the reverse, seem determined to mask any possible effect.

One obvious though very troublesome source of disturbance in all cases is the direct effect of terrestrial magnetism on the circuit. To get over this, the writer not only made his circuits as nearly as possible of zero area, but also inclosed them in the iron case of a Thomson marine galvanometer, lent for the purpose by Dr. Muirhead.

In gases, the experiment of Mr. Crookes, where a stream of particles propels a mill inside a vacuum-tube—perhaps even the ancient experiment of the blast from a point—shows that momentum is by no means absent from an electric current through a gas.

To see if there are any momentum effects accompanying variation of electric displacement in dielectrics, the writer has suspended a mica-disk condenser at the end of a torsion arm, and arranged it so that it could be charged and discharged *in situ*. Many spurious effects, but no really trustworthy ones, were observed.

In the writer's opinion the subject is by no means thoroughly explored, and he only mentions his old attempts as a possible guide to future experimenters.

Then, again, there is the influence of light on conductivity. Annealed selenium, and perhaps a few other things, improve in conductivity enormously when illuminated. The cause of this is unknown at present, and whether it is a general property of matter, possessed by metals and other bodies to a slight degree, is uncertain; for the experiments of Börnstein with an affirmative result for the case of metals have been seriously criticized.

Even though metals show no effect, yet electrolytes might possibly do so, but the effect, if any, is small; and it is particularly difficult in their case to distinguish any direct radiation effect from the similar effect of mere absorbed radiation or heat.

The writer has found that a glass test-tube kept immersed in boiling water conducts distinctly better when the blinds of a room are raised than when they are lowered, though nothing but diffuse daylight falls upon it. But as the effect could have been produced by a rise in temperature of about the tenth of a degree, and as the absorption of diffuse daylight is competent to produce a rise of temperature as great as this in the glass of a thermometer-bulb even though immersed in boiling water, he feels constrained to regard the result, though very clear and distinct, as after all a negative one, and has accordingly not published it.

A few months ago I should have put in a prominent position among outstanding problems the production of electric radiation of moderate wave-length, and the performance with this radiation of all the ordinary optical experiments—reflection, refraction, interference, diffraction, polarization, magnetic rotation, and the like. But a great part of this has now been done, and so these things come to be now mentioned under a different heading.

Conclusion.

"Conclusion" is an absurd word to write at the present time, when the whole subject is astir with life, and when every month seems to bring out some fresh aspect, to develop more clearly some already glimpsed truth. The only proper conclusion to a book dealing with electricity at the present time is to herald the advent of the very latest discoveries, and to prepare the minds of readers for more.

Referring back to Part IV., vol. xxxviii. p. 418, we spoke confidently of a radiation being excited by electric oscillations, a radiation which travelled at the same rate as light, which is reflected and refracted according to the same laws, and which, in fact, is identical with the radiation able to affect our retina, except in the one matter of wave-length. Such a radiation has now been definitely obtained and examined by Dr. Hertz, of Karlsruhe, and in the last month of last year, Prof. von Helmholtz communicated to the Physical Society of Berlin an account of Dr. Hertz's latest researches. The step in advance which has enabled Dr. Hertz to do easily that which others have long wished to do, has been the invention of a suitable receiver. Light when it falls on a conductor excites first electric currents and then heat. The secondary minute effect was what we had thought of looking for, but Dr. Hertz has boldly taken the bull by the horns, looked for the direct electric effect, and found it manifesting itself in the beautifully simple form of microscopic sparks.

He takes a brass cylinder, some inch or two in diameter, and a foot or so long, divided into two halves with a small sparking interval between, and by connecting the halves to the terminals of a small coil, every spark of the coil causes the charge in the cylinder to surge to and fro about five hundred million times a second, and disturb the ether in a manner precisely equivalent to a diverging beam of plane-polarized light with waves about twice the length of the cylinder.

The radiation, so emitted, can be reflected by plane conducting surfaces, and it can be concentrated by metallic parabolic mirrors; the mirror ordinarily used being a large parabolic cylinder of sheet zinc, with the electric oscillator situate along its focal line. By this means the effect of the wave could be felt at a fair distance, the receiver consisting of a synchronized conductor with a microscopic spark-gap, across which the

secondary induced sparks were watched for. By using a second mirror like the first to catch the parallel rays and reconverge them to a focus, the effect could be appreciated at a distance of 20 yards. If the receiving mirror were rotated through a right angle, it lost its converging power on this particular light.

Apertures in a series of interposed screens proved that the radiations travelled in straight lines (roughly speaking, of course).

A gridiron of metallic wires is transparent to the waves when arranged with the length perpendicular to the electric oscillations, but it reflects them when rotated through a right angle, so that the oscillations take place along the conducting wires; thus representing a kind of analyzer proving the existence of polarized light. The receiver itself acted as analyzer, however, for if rotated much it failed to feel the disturbance.

Conducting sheets, even thin ones, were very opaque to the electrical radiation; but non-conducting obstacles, even such as dry wood, interrupt it very little, and Dr. Hertz remarks, "not without wonder," that the door separating the room containing the source of radiation from that containing the detecting receiver might be shut without intercepting the communication. The secondary sparks were still observed.

But the most crucial test yet applied is that of refraction. A great prism of pitch was made, its faces more than a yard square, and its refracting angle about 30°. This being interposed in the path of the electric rays, they were lost to the receiver until it was shifted considerably. Adjusting it till its sparks were again at a maximum, it was found that the rays had been bent by the pitch prism, when set symmetrically, some 22° out of their original course, and hence that the pitch had an index of refraction for these 2-foot waves about 1·7.

These are great experiments. As I write, they are but a month old, and they are manifestly only a beginning. They are very simple: I have repeated some of them already. They seem likely to settle many doubtful points. There has been a long-standing controversy in optics, nearly as old as the century, as to whether the direction of the vibrations was in, or was perpendicular to, the plane of polarization; in other words, whether it was the elasticity or the density of the ether which varied in dense media; or, in Maxwell's theory, whether it was the electro-magnetic or the electrostatic disturbance that coincided with that plane. This point has indeed by the exertion of extraordinary power been almost settled already, through the consideration of common optical experiments; but now that we are able electrically to produce radiation with a full knowledge of what we are doing, of its directions of vibration and all about it, the complete solution of this and of many another recondite optical problem may be expected during the next decade to drop simply and easily into our hands.

We have now a real undulatory theory of light, no longer based on analogy with sound, and its inception and early development are among the most tremendous of the many achievements of the latter half of the nineteenth century.

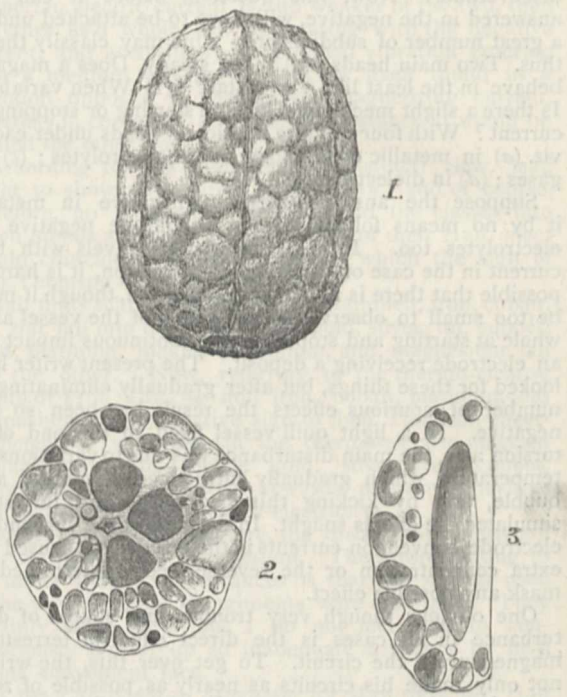
In 1865, Maxwell stated his theory of light. Before the close of 1888 it is utterly and completely verified. Its full development is only a question of time, and labour, and skill. The whole domain of Optics is now annexed to Electricity, which has thus become an imperial science.

OLIVER J. LODGE.

A JAMAICA DRIFT-FRUIT.

IN 1884, I made a collection of drift-seeds and seed-vessels washed ashore on the spit of land inclosing Kingston Harbour, Jamaica, called the Palisadoes. The collection was sent to Kew, and it was utilized by Mr. Hemsley in the appendix to the "Botany of the *Challenger* Expedition," vol. i. pp. 277-304, when discussing the oceanic dispersal of plants. In the collection there was a fruit I had not seen before, and which was equally new to Mr. Hemsley and the other officers at Kew. There were several specimens of this fruit obtained, and these were afterwards placed in the Kew Museums amongst other drift-fruit, to wait until sufficient material was forthcoming to lead to their identification.

The general character of the drift-fruits collected at Jamaica points to the conclusion that they were brought by the Gulf Stream current from the mouths of the Amazon and Orinoco. Jamaica lies directly in this current, and for a long period fruits unknown in the island itself have been collected on its shores. The most striking of these is the fruit of *Manicaria saccifera*, a palm confined to Trinidad and the mainland of South America. Sloane ("Natural History of Jamaica," vol. ii. p. 186) noticed this fruit more than two hundred years



Representation of a Jamaica drift-fruit (natural size). 1, external aspect; 2, cross-section; 3, longitudinal section.

ago, and states that "it is frequently cast up by the waves on the shores of this island, and it is one of those fruits thrown (also) on the north-west islands of Scotland by the currents and seas." None of these fruits appear to have germinated in Jamaica, for the palm, which is a most striking object, with entire leaves, could not fail to be noticed if it existed there. The fruits are known at Jamaica as *sea-cocoanuts*, while at Barbados they are called *sea-apples*. Other South American fruits found drifted at Jamaica were *Carapa guianensis*, *Dimorphandra mora*, and *Astrocaryum* sp. The collection of drift-fruits, although by no means a new subject, is one which has not received the attention it deserves. Since the publication of the "Botany of the *Challenger*," the active part played by the sea in the dispersion of plants has been more fully recognized. Mr. Hemsley has given a summary of results, in which many interesting facts have been brought to light, and doubtless observers in numerous parts of the world are now engaged in making observations.

But to return to the unknown drift-fruit. It is seldom that specimens remain at Kew for a long period without something occurring to call attention to them. It was so in this instance. In November 1887, Mrs. Hubbard sent Prof. Oliver a drift-fruit from the coast of Devonshire which was found to be exactly identical with the fruits collected at Jamaica. The specimen had the same water-worn appearance, and there was little doubt that it had travelled across the Atlantic in the drift of the Gulf stream.

This fruit, a representation of which is given opposite, possesses such distinctive characters that it can easily be recognized. It is evidently a drupaceous fruit, but the fibrous or fleshy outer layer (the sarcocarp) has either decayed or been worn away while drifting. What is now left is the woody indehiscent putamen or pericarp, externally marked by a mammillated surface corresponding, as shown in sections, with numerous cavities or resin-cysts existing in its walls. The fruit is normally five-celled, but two of these are suppressed, and only three remain. The seeds, as shown in Fig. 3, are solitary, and they possess abundant albumen. The presence of resin-cysts is a character of some value in seeking for the order or genus to which such a fruit could belong. In the Kew Museums, there are some fruits collected by G. Mann, on the Gaboon River, West Africa, which afford a clue. These are the fruits of *Aubrya gabonensis*, Baill, belonging to the natural order *Humiriaceæ* (Oliver, "Flora Trop. Afr.," vol. i. p. 275). They are smaller than the Jamaica drift-fruit, and are covered with a brown, fibrous or leathery epicarp 3 millimetres in thickness. The bony endocarp is, however, similarly developed and plentifully furnished with resin-cysts. The resemblance altogether is very close. The natural order *Humiriaceæ* is a very small one, and consists of genera entirely confined to Brazil and Guiana, with the exception of the single African genus already mentioned. There can be little doubt that the drift-fruit is derived from tropical America, and not from Africa. The American genera of *Humiriaceæ* are *Vantanea*, *Humiria*, and *Sacoglottis* ("Gen. Plant.," vol. i. p. 247). It is not necessary to give all the details, but I may say at once that Prof. Oliver is of opinion, and in this I agree, that the drift-fruit will doubtless be found to belong to a species of *Humiria*, and possibly to *H. balsamifera*, Benth. (Hook., *Kew Journ.*, vol. v. (1853), p. 102).

This species is said by Aublet (who figures the leaves and flowers only in "Plant. Guian.," p. 564, t. 225) to grow in all the forests of French Guiana, where it is known, from the colour of the wood, as *bois rouge*. Strange to say, the fruit of apparently so common a plant is unknown in European herbaria. Urban, who described it, with a figure, in "Flora Brasiliensis" (vol. xii. p. 439, t. 92), had not seen a mature fruit. The specific name is derived from the fact that the bark, when wounded, yields a reddish balsamic juice, possessing an odour like that of storax, and which after a time becomes hard and brittle. It is then used as a perfume. An ointment is also prepared from it.

For the present, therefore, we must leave the question open as regards the exact determination of this drift-fruit. There can be little doubt that it belongs to the genus *Humiria*, but until we obtain fruits of *H. balsamifera* we are unable to say whether it is that species or not.

D. MORRIS.

P.S.—Since the above was in type, I have gathered information which considerably increases the interest connected with this fruit. It is first figured and described (as a drift-fruit) by Clusius in his "Exoticorum libri decem," lib. 2, cap. 19. This work bears the date of 1605. The description adds nothing as to the origin of the fruit, except that it was received from Jacob Plateau. The figure given by Clusius, with the description, is reproduced by J. Bauhin, nearly eighty years afterwards, in "Historia Plantarum" (1680), tom. i., lib. 3, cap. cxi., Fig. 1. There is another figure, still from a water-worn and drifted specimen, given in "Petiveri Opera," tab. lxxi., Fig. 5 (1764), with the information that "it is a hard oval fruit with seed-holes [resin-cysts] round its surface. Cat. 605. Found on the shore of Jamaica." Finally, Mr. E. G. Baker, F.L.S., to whom I am indebted for the references to Bauhin and Petiver, has recognized the fruit in the Sloane Collection at the British Museum (Natural History), labelled "No. 1656." We are still, however, without information as to the origin of the fruit or the plant bearing it. D. M.

HAZE.

I HAVE for some time given in my lectures an explanation of the common summer haze which appears to me to be very probable. I do not know whether it is new, but it has not been referred to in the discussion raised by Prof. Tyndall's letter on Alpine haze. Some time since I mentioned it to Prof. Lodge, and at his suggestion I send it to you, though its extension to other kinds of haze is somewhat speculative.

It is that haze is often due to local convection currents in the air, which render it optically heterogeneous. The light received from any object is, therefore, more or less irregularly refracted, and, through the motion of the currents, its path is continually varying. The outline of the object, instead of appearing fixed, has a tremulous motion, and so becomes ill-defined. At the same time, reflection occurs where there is refraction at the surfaces of separation of heterogeneous portions. Much of the light which, in a homogeneous medium, would come straight from the object, is thus lost for direct vision, and the contrast between neighbouring objects is lessened. The reflected light is diffused as a general glare. The combination of the quivering of outline, and the loss of direct light, with the superposition of the reflected light as a diffused glare, gives the appearance we call haze.

This explanation appears to me to accord well with the obvious facts of summer haze—the haze which is seen in the middle of a hot, cloudless, summer day. The lower layers of air, being heated by contact with the earth, rise in temperature till equilibrium is no longer possible, and convection begins, streams of the heated air rising, and streams of colder air falling to take its place. The variation of temperature and density gives optical heterogeneity. The existence of these streams is sometimes shown by the quivering of distant objects, looked at through the air close to the ground, but a telescope will often show the quivering of outline at higher levels, and when quite invisible to the naked eye. Accompanying this refraction, reflection must occur. We have a direct proof of its occurrence in the fact that the glare is greatest under the sun, where reflection occurs at angles approaching grazing incidence, for which it is a maximum; while it is least opposite the sun, where reflection occurs at angles approaching normal incidence, for which it is a minimum. The opening lines of the "Excursion" perfectly describe the resulting appearance:—

> "'Twas summer, and the sun had mounted high;
> Southward the landscape indistinctly glared
> Through a pale steam; but all the northern downs,
> In clearest air ascending, showed far off
> A surface dappled o'er with shadows flung
> From brooding clouds."

During the night the lower strata become colder than the upper ones, and the atmosphere passes into a state of stable equilibrium. We should therefore expect that, if the foregoing explanation is true, there would be

complete absence of haze, and it is well known that the air is peculiarly clear in early morning, when we get above the fog-level.

According to this account of heat haze, it stands in sharp contrast to fog, of which it is so often supposed to be a relative in reduced circumstances. While the one requires convection, the other usually occurs when the air is in stable equilibrium, the lowest strata being the coldest. In the fog, for example, which so frequently heralds or accompanies the break-up of a frost, the lower strata are still cold, while above the wind has changed, and the air comes up warm and vapour-laden. The vapour diffuses downwards into the lower, cold strata, and is there condensed, and it is possible that the more rapid diffusion of water vapour has something to do with the continuance of the fog, for it would diffuse downwards more rapidly than the rest of the air with which it has come.

There are other cases of haze which may, perhaps, be explicable by optical heterogeneity. In the dry east winds of spring we frequently have a haze when the air is far from saturation-point, and the clouds, if they exist, are at a high level. It appears possible that this haze is due to small convection currents of the cold air from above, the temperature falling too rapidly from below upwards for equilibrium.

Sometimes the heterogeneity may be due to water vapour. After rain, when the ground is still wet, the drying of exposed surfaces often shows that the air is not saturated, yet there is a haze or mist which is supposed to be thin fog, *i.e.* water-dust. Evaporation must be going on, and the air must certainly be unequally charged with vapour. With this inequality there must also be convection. I have never been able to detect, with certainty, quivering of outline either in this case or in the previous one of the east wind haze, though I have sometimes suspected its existence. Possibly someone who has used a high-power telescope for terrestrial objects might be able to give information on this point. But it is to be noted that the differences of density in both these cases are much smaller than in the case of summer haze, and the currents should therefore be on a smaller scale.

It seems worthy of inquiry whether the haze observed under cumulus clouds, referred to by the Rev. W. Clement Ley, may not also be due to water-vapour heterogeneity. The cumulus cloud indicates the existence of a large body of vapour-laden air extending no doubt below, as well as above, the condensation level. As this mass sweeps along, the lower part of it is retarded by the earth and by the lower strata, and more or less disturbance and mixture with the surrounding air will occur. There will therefore be heterogeneity. I do not know whether this would be at all sufficient to account for the haze observed, but the suggestion seems worth considering.

J. H. POYNTING.

THE EARTHQUAKE AT EDINBURGH.

THOUGH no earthquake of great destructive energy has passed across the area of the British Islands within historic times, the number of actual shocks which have been experienced and recorded amounts now to many hundreds. Scotland, being more generally mountainous than the other divisions of the United Kingdom, has hitherto enjoyed by far the largest share of these manifestations of terrestrial disturbance. Hardly a year passes without adding to the list. The latest addition is that which startled the inhabitants of Edinburgh, on Friday morning, the 18th instant, a few minutes before 7 o'clock, when a large part of the population was still in bed. It agreed in general character with the usual type of Scottish earthquakes, and might indeed be taken as an illustrative example of them—not strong enough to do damage to property or life, but yet quite sufficiently marked to arrest attention and to exhibit some of the more prominent features of seismic movements.

The earthquakes that visit Scotland so frequently are always singularly local in character. Now and then a more vigorous shaking may be felt across the breadth of the Highlands, but as a rule the tremor is confined to a comparatively circumscribed district. Again, not only are they local, but there is usually some centre or median belt of ground where the effects have been more distinctly perceptible than elsewhere. Some districts are specially liable to them. Thus, the tract around Comrie, in the south of Perthshire, has long been noted for the frequency of its earthquakes. Another area often similarly affected embraces the West Highlands up to Inverness. It is worthy of remark that this latter region was considerably disturbed by a series of shocks almost exactly a year before, viz. on February 2, 1888. If we look at the geological structure of these earthquake districts, we observe that they are traversed by some of the most important lines of fissure by which the crust of the earth within the area of Britain has been disrupted. Comrie stands on the line of a powerful fault which runs across Scotland from sea to sea, and which, by bringing the softer and less prominent sandstones of the low country against the harder and more precipitous schists of the hills, has been in some measure the origin of the line between the Lowlands and Highlands, and thus of the limitation of the Saxon and the Gael. Again, in the West Highlands, a profound dislocation has defined the line of the Great Glen from Inverness to the Linnhe Loch. The relation of the chief earthquake centres to these ancient lines of fracture in the terrestrial crust can hardly be accidental. The actual shock that starts the seismic wave is probably in these areas to be traced to some slipping of the rocks along these lines of rupture. Though the faults are of great geological antiquity, they doubtless remain lines of weakness, along which any changes due to the secular cooling and contraction of our planet may be expected to show themselves.

The area shaken by the earthquake of Friday, January 18, is not one which has been much subject to experiences of this kind, though a few shocks are spoken of as having been felt there in the past. But its geological structure shows how well fitted it is to become a theatre of disturbance of the usual feeble Scottish type. It extends from the edge of the Firth of Forth southwards into the interior across the site of Edinburgh, and thence along the chain of heights known as the Pentland Hills. These hills consist mainly of volcanic rocks belonging to the period of the Lower Old Red Sandstone. The beds of lava and sheets of tuff increase in thickness towards the north-east, until in the Braid Hills, which lie immediately along the southern outskirts of Edinburgh, they are replaced by the materials that fill up what seems to have been the chief vent from which they were discharged. These volcanic eruptions had long ceased when the Carboniferous rocks of the district began to be laid down upon their upturned and worn edges. During a prolonged period of deposition and depression they gradually sank and were buried under some thousands of feet of sedimentary strata. In later times the area was disrupted by a group of long parallel fractures running in a general north-east and south-west line. Vast denudation likewise took place. By degrees the deep cover of Carboniferous strata was worn away from the tops of the volcanic ridges which now once more appear at the surface as the chain of the Pentland Hills. Thus the site of the earthquake coincides with an ancient volcanic centre and with a belt of country which has been dislocated by lines of fault.

The area within which this earthquake was most perceptible is tolerably well defined by that of the geological features here described. It is rudely elliptical in shape, about fifteen or twenty miles along the longer, and from five to seven across the shorter axis. Outside these limits, the shock, though in some places distinctly felt, seems to have rapidly lost force, so that at Linlithgow, about ten miles away, it was hardly perceptible. The effects by which the passage of the seismic wave made itself sensible were of the usual kind. For the most part all that was noticed was a tremor or quivering movement of the ground or houses, accompanied with the rattling of any loose objects. I was myself awake, and about to rise, when I was aware of a peculiar grinding noise and the jangling of all the crockery and glasses on the wash-hand-stand. It seemed as if some heavy load had been discharged from a waggon on the ground immediately outside the house. But as the position of the house on the outskirts of the southern suburbs of the city made this impossible, I was at a loss to conjecture the cause of the disturbance. I thought of an earthquake, but found that no other inmate of the house had noticed anything peculiar. In the course of the day, however, accounts came from all parts of the district affected, which put the real nature of the event beyond any doubt. The undulation of the ground was experienced by many observers, and the general impression was that the wave moved from west to east, or from south-west to north-east. Some who were not yet astir felt first one end of the bed and then the other depressed and raised. To others who were already on foot the ground seemed to sink away from their feet and to rise upward again. Chairs appeared to slide forward and backward. Pictures, lamps, and other hanging objects were set swinging. In one recorded case, an eight-day clock, which had been standing at the time, and of which the pendulum swings in an east and west line, was made to go. On the other hand, the parish clock of Currie was stopped at the moment of shock. One boy is said to have been pitched out of bed, and was found immediately afterwards with a hammer in his hand ready to attack someone whom he supposed to be concealed under the bed. Numbers of witnesses spoke of the feeling of giddiness or nausea that so frequently accompanies earth-movements. Dogs barked or howled to mark their sympathy in the general alarm. No damage of any kind, however, seems to have been done, unless under that name be included the dislodgment of a portion of the plaster from the ceiling of a church at Portobello.

The most violent motion appears to have been felt along the north-west base of the Pentland Hills and thence in a north-easterly direction through the northern parts of Edinburgh. There can be little doubt that the source of the shock lay somewhere along the line of these hills. We may plausibly connect it with the failure of support, and consequent fall, of some part of the rocks along one of the main lines of fault that define the chain of the Pentlands.

The greater frequency of earthquakes in the winter half of the year has often been remarked upon. It is certainly during that season that they most generally occur in Scotland. With regard to the shock of last week, we find that a strong gale had been blowing for some time, and that the barometer had fallen four-tenths of an inch between Thursday and Friday. The position of the moon, according to some seismologists, conduces to the determination of those disturbances of the terrestrial crust that give rise to earthquakes. With regard to the disturbance of the 18th instant it is noticeable that full moon happened the previous morning, when there was a lunar eclipse. It is about the time of new moon and the first quarter that the chief earthquake-maxima are said to take place.

A. G.

DECOMPOSITION OF NICKEL AND COBALT.

CHEMISTS have recently heard with great interest that Dr. Krüss, of Munich, a well known and trusted worker, has succeeded in "decomposing" nickel and cobalt. Judging from the accounts which thus far have reached us, it would appear that his discovery consists in finding that cobalt and nickel contain about 3 per cent. of a new element which is common to both as ordinarily prepared. By the removal of this hitherto unrecognized "impurity," the properties of the cobalt and nickel salts are slightly modified as to colour, &c. It is to be expected that the discovery will serve to explain the discrepancies which are to be noted among the various determinations of the atomic weight of nickel and cobalt. We give the following details from a short note upon the subject in the *Chemiker Zeitung* of January 27:—

Dr. Krüss, in conjunction with Herr Schmidt, read a paper at the meeting of the Munich Chemical Society of January 11, upon the results of their attempted redetermination of the atomic weights of these two metals. Clemens Zimmermann, as the outcome of a determination made some years ago, found the atomic weight of cobalt 58·74, and that of nickel 58·56. The method followed by Krüss and Schmidt was a revival of the older process of Winkler, and consisted in determining the relative equivalents of gold and nickel, and of gold and cobalt. Such a method ought now to be very much more trustworthy, on account of the recent exceptionally accurate determinations of the atomic weight of gold made simultaneously by Dr. Krüss himself, and by Prof. Thorpe and Mr. Laurie in this country. The process simply consisted in precipitating the gold from a neutral solution of gold chloride or sodium gold chloride by weighed quantities of metallic nickel or cobalt, chlorides of the two latter metals passing into solution. The results, however, were not what were expected, and differed among themselves to a remarkable extent. It was found impossible to precipitate the equivalent in gold of the nickel or cobalt employed, owing to the inverse effects of polarization, small quantities of metallic nickel or cobalt being reprecipitated, and thus mixed with the finely divided gold. In order to determine the amount of metal which had been dissolved, the precipitate was weighed, dissolved in aqua regia, and the gold reprecipitated by sulphurous acid. The weight of gold thus obtained, deducted from the weight of the whole precipitate, of course gave that of the admixed nickel or cobalt. Even after making this correction, the method afforded such surprisingly untrustworthy values that it became necessary to seek for the disturbing cause. On washing the reprecipitated gold, it was noticed that the red colour of the filtrate due to chloride of cobalt gradually paled, and eventually took a greenish tint. On evaporating a quantity to dryness and igniting in a platinum dish, the small residue obtained was found to dissolve in warm concentrated hydrochloric acid forming a beautiful green solution. On cooling, the liquid again became almost colourless, and gave a white precipitate of hydrate on addition of ammonia, which on ignition gave a white oxide; and a brownish-black precipitate of sulphide with ammonium sulphide. A number of other reactions also show that the compounds of this metal, which was itself obtained as a black powder by reduction of the oxide with charcoal, are not to be identified with those of any known element. The most interesting fact, however, is that the washings from the gold obtained in the nickel determinations gave precisely the same indications; the same residue on ignition, a green solution on treatment with warm hydrochloric acid, and the same hydrate and oxide. Several other methods were also described in the memoir, which we hope shortly to see published, by which this same common ingredient could be extracted from both nickel and cobalt. It is very interesting that Dr. Krüss has also obtained a green double chloride of the

new metal and red cobalt chloride, which possesses all the properties of green nickel chloride, which has thus been decomposed into a red and a colourless salt.

NOTES.

THE Royal Society has recently entirely recast the regulations under which the Government fund of £4000 for the promotion of scientific research is administered.

MR. COMMON'S 5-foot telescope is now completed, and photographs of the moon and nebulæ have already been taken to test the figure of the silver-on-glass speculum. We hear the results are quite satisfactory. Congress is to be asked to vote 250,000 dollars for the purchase of a refractor of the same dimensions for the Washington Observatory.

MR. ISAAC ROBERTS, working on the lines laid down by Mr. Common, has recently, by exposures of over four hours, obtained most important additions to our knowledge of the nebulæ of Orion, Andromeda, and the Pleiades.

WE believe that the Royal Astronomical Society has this year awarded its medal to M. Lœwy, of the Paris Observatory.

PROF. CORFIELD has been elected an Honorary Member, and Dr. Louis Parkes a Foreign Associate, of the Société Française d'Hygiène.

LAST week's number of the *Electrician* contains a notice of the work of Sir William Thomson, accompanied by an admirable steel engraving.

THE new Laboratory at the Normal School of Science, built for the accommodation of the students in the practical courses in physics and astronomical physics, is now finished. It accommodates about eighty students.

THE Medals and Funds to be given at the anniversary meeting of the Geological Society on February 15 have been awarded by the Council as follows: the Wollaston Medal to Prof. T. G. Bonney, D.Sc., F.R.S.; the Murchison Medal to Prof. James Geikie, F.R.S.; the Lyell Medal to Prof. W. Boyd Dawkins, F.R.S.; and the Bigsby Medal to Mr. J. J. Harris Teall; the balance of the Wollaston Fund to Mr. A. Smith Woodward, of the British Museum; that of the Murchison Fund to Mr. Grenville A. J. Cole, of the Science Schools, South Kensington; and that of the Lyell Fund to M. L. Dollo, of the Royal Museum at Brussels.

AT the last meeting of the Mineralogical Society, there was described a new mineral species, an oxychloride of lead, to which the name of "daviesite" was assigned. This mineral was found as very minute crystals in a specimen from Sierra Gorda in Bolivia. The crystals are very rich in faces, and belong to the ortho-rhombic system; their parametral ratios are $a : b : c = 1{\cdot}2594 : 1 : 0{\cdot}6018$; they are elongated in the direction of the vertical axis, parallel to which there are faces of the prism (110) and the pinacoid (100), and they are terminated sometimes by a simple basal plane (001), sometimes by the domes (011), (031), (101), (301), (501), and the pyramids (211), (121), (221), (521). The optic axes are visible when the basal plane is normal to the axis of the convergent polarized light.

THE Scientific Department of the Scotch Fishery Board, in view of the approaching great spawning period of the marine food-fishes, have begun a series of systematic investigations at some of the more important fishing-grounds lying off the east coast of Scotland. From a report presented to the Fishery Board by Prof. Ewart, it appears that one of the Board's naturalists (Mr. T. Scott) has recently made some interesting observations on board the large steam-trawler *Southesk*, of Montrose, as to the spawning of the plaice (*Pleuronectes platessa*) at Smith Bank, a well-known ground in 20 fathoms of water, lying off the Caithness coast, where operations were carried on for several days. A great variety of fish were obtained; but, except a few gurnards, only the plaice, which were present in great numbers, were spawning. Specimens both quite ripe and partly spent were captured by the trawl, while the tow-net revealed the presence of countless multitudes of floating eggs on the surface—in all stages of development—as many as 10,000 being obtained in one haul. These were shown to be almost entirely the ova of plaice, the remainder being the ova of the gurnard. Such an opportunity of witnessing the spawning of a shoal of flatfish on so gigantic a scale, and of proving so clearly the relationship between the spawning fish and the pelagic ova, does not often occur.

A BOTANICAL STATION was established early last year at St. Lucia on the most unpretentious footing. A Committee appointed to supervise the work of the Curator, Mr. John Gray, reports that, "considering the difficulties incidental to the starting of such an undertaking, the peculiar nature of the ground, and the limited funds available for the purpose, the work thus accomplished is satisfactory." The Committee says that the most encouraging feature of Mr. Gray's report is the general appreciation shown by the agriculturists of the district in the success of the Station, as shown by their increasing disposition to seek advice from the Curator, and to try and obtain seeds from him. Already the demand for cocoa, coffee, and nutmeg plants is so great that additional land will have to be acquired for the extension of the Garden.

LORD WOLSELEY, who is not often caught tripping in making hasty statements, writes as follows in the current number of the *Fortnightly Review*:—"The battles of the future will be very different from even those of 1870. . . . One remarkable change will be the absence of nearly all that terrific noise which the discharge of five or six hundred field guns, and the roar of musketry caused in all great battles. . . . The sound of cannon will be slight, and will no longer indicate to distant troops where their comrades are engaged, or the point on which they should consequently march. Our sentries and advanced posts can no longer alarm the main body upon the approach of the enemy by the discharge of their rifles. The camp or bivouac will no longer be disturbed at night by the spluttering fire of picquets in contact with the enemy. Different arrangements for giving the alarm upon the approach of hostile columns will have to be resorted to. The main column on the march cannot in future be warned, by the shots of flanking parties, of the enemy's proximity, and a battle might possibly be raging within a few miles of it without that fact becoming at once apparent." Will some competent member of the "Scientific Corps" kindly explain, or are they all in civil employ?

WE make the following extract from a letter addressed by Mr. A. W. Tuer to a contemporary:—"The melodious hum of skating was perhaps never heard to greater advantage than through the crisp air of a bitterly cold morning little more than a fortnight ago—the first Sunday in the year. Almost as soon as Kensington Gardens were entered, one became conscious of a clearly-defined musical sound coming from the direction of the Round Pond—G as nearly as I could judge, but corrected to G sharp, when, half an hour later, I got to a piano. I had wished to compare the notes—probably lower—given forth by other and larger sheets of ice, but procrastination strangled an opportunity which perhaps others will take when it again offers. Comparing a sheet of ice to a taut string, and the countless skates to the hairs of a bow—scientifically, a poor comparison enough—the sound might be expected to have been like that produced by the scraping of a fiddle, but it exactly resembled the whistle of a distant locomotive."

PROF. J. H. GORE, of the Columbian University, has in preparation a bibliography of geodesy. During two trips to Europe he has collected about seven thousand titles, having examined nearly every large library except that at St. Petersburg. He begins with the first effort to ascertain the shape of the earth by triangulation in the seventeenth century. The work will be published soon by the Coast Survey. Prof. Gore is trying to make his service complete by personal application for data, he having written to all astronomers and other mathematicians in the world whose addresses he could obtain.

THE American Society of Naturalists (*Science* reports) held in Baltimore, on December 27 and 28, one of its largest and most successful meetings. Methods of instructing large classes in botany were presented by Profs. Goodale and Wilson, and in geology by Profs. Niles and Williams. The Society fully approved the excellent work of its committee on education, in paving the way for better instruction in the natural sciences in all grades of schools, especially the lower ones. Mr. J. E. Wolff showed a photographic method of class illustration, and Prof. W. M. Davis explained a most interesting series of paper models, illustrating the development of certain topographic forms and their relation to base-levels of erosion. The Society is composed largely of teachers, and desires to so arrange its meeting next year that the members may be able to attend the meetings of specialists held about the same time.

WE referred recently to the investigations in the Torres Straits of Prof. A. C. Haddon, of the Royal College of Science, Dublin. The *Ceylon Observer* now publishes extracts from some later letters from Prof. Haddon, from which it appears that he was anxious to spend some time in Ceylon, to work out the life-history of the Ceylon turtle and to add to his collections; but it is unlikely that he will be able to do more than call at Colombo on his way home. Writing in November from Thursday Island, Prof. Haddon says:—"I have now been out nearly three months, and have had a very pleasant time, and have seen and learnt much. I find that the anthropology is an untouched field, absolutely so as regards the manners and customs of the past, and I have taken some trouble and a great deal of interest in collecting what information I can in the short time at my disposal. In most of the islands the people are dying off; the younger men know nothing of the life of their forefathers, and there are but few old men left. In a few years' time it will be too late, so I have deemed it desirable to turn some of my attention to that subject, although I had no intention of so doing when I started. Experts at home must judge whether my information is of value. I have had a little peep at New Guinea for a few hours—Mowat—to this end. In April and May I am going to the Louisiades, Sudest and other islands of the south-east end, and also to Port Moresby and Motu-Motu. Mr. Chalmers strongly urged me to give an extra month to that end of New Guinea, promising to take me about, an opportunity which money could not purchase, and which falls to the lot of very few. So I shall conclude my stay in this part of the world with a good look at New Guinea under the best of guidance. It has been a great grief to me that I could not manage Ceylon as well, but I feel I have done quite right in not yielding to the strong temptation."

EXPERIMENTS have recently been made (says *Science*) showing in what order a fatigued eye recovers the power of perceiving different colours. The important factor is what colour has been used to induce fatigue. If the eye has been fatigued by long exposure to red, the sensitiveness for green is the first to reappear, then for blue, then yellow, and finally red. After a "blue-fatigue," the order is yellow, red, green, blue; after a "green-fatigue," the order of recovery is red, blue yellow, green; after "yellow-fatigue," it is red, blue, green, yellow. The eye recovers last the perception of the colour by which the fatigue has been induced, and first recovers the sensitiveness for the complementary colour. The fatigue is in the retina, for it is an independent phenomenon in the two eyes. The point of finest vision, the fovea, requires a longer time to recover from colour-fatigue than the less sensitive lateral portions of the retina. The physiological process is considered to be related to the visual purple of the rods and cones. On the sense of taste, the same journal states that in the case of a patient whose entire tongue, including the large circumvallate taste-papillæ at the root of the tongue, had been removed, it was found that some power of taste remained. The sensations of sweet, bitter, and sour could be obtained by applying appropriate substances to the back of the pharynx or the stump of the tongue, though if applied to the tongue the taste was apparent only during swallowing. The taste of salt was not perceived. Though these results are not fully in harmony with previous experiments, they are helpful in localizing the tasting-powers of various portions of the mouth cavity.

THE Indian papers report that a severe earthquake, lasting about four seconds, followed by slight momentary shocks at intervals, occurred at Quettah on the morning of December 28. The shocks were felt at intervals till December 31. No injury, beyond the destruction of a few native shops and bazaars, is reported.

TURKESTAN has again been the scene of earthquakes. On November 28 last, at 11.40 a.m., a shock of earthquake, much stronger than any lately experienced, was felt at Tashkent. After a feeble earth tremor, which lasted for four or five seconds, there was a violent shock; the houses cracked, windows rattled, and the inhabitants rushed into the street. The wave of the earthquake came from the east, and at Khojent some houses were damaged.

PROF. MUSHKETOFF has made a gift to the Russian Geographical Society of a very interesting album of 175 photographs, showing the effects of the last great earthquake at Vyernyi. It illustrates with perfect accuracy, the damage done in the houses, as also several geological changes due to the earthquake.

A MEMBER of the Astrakhan Scientific Society has been taking photographs of fishermen at work at the mouth of the Volga, and of the inplements used by them. An album of 200 photographs gives a complete representation of the present state of these important fisheries, and a copy is to be deposited at the St. Petersburg Academy of Sciences.

IN December last, a Chinese scientific expedition, under the learned functionary Miao, arrived at Irkutsk.

AT a recent meeting of the Geological Society of Stockholm, Dr. N. O. Holst exhibited the forehead and part of the leg of the skeleton of a bison found in a bog near Vadstena. The discovery was made by a farmer as far back as 1865, but it has only recently been proved that the parts are those of a bison. Only two similar discoveries have been made in Sweden, viz. in the province of Scania. Baron de Geer maintained that recent careful researches disproved the theory held by some that a sound had in prehistoric times separated Scania from the rest of Sweden, and thus prevented the immigration of the bison thither.

IN a recent British Consular Report on the Agriculture of the Department of the Maritime Alps, Consul Harris says that the reckless destruction of the forests had already considerably altered the climate and other conditions of that region in the first half of this century, and had caused a large portion of the soil, or the "flesh of the mountains," as Elisée Reclus calls it, to disappear from the summits, which are now only the most barren slopes. When the snows of winter melt off the higher mountains, devastating floods are very common, and the population has, within the past twenty years, decreased very

much on account of these floods. It has been calculated that in one year alone the amount of soil carried down by the two rivers, the Loup and the Paillon, was sufficient to have covered the whole department to a depth of 6 centimetres. The Consul adds that, though something has been done to encourage replanting, a more serious effort than has yet been made is needed to reafforest the country.

FROM a recent British Consular Report on the trade of Maranham, it appears that a large number of india-rubber producing trees were discovered last year in the district of Pinheiro. The principal traders, who were suffering severely from the depression in the sugar and cotton industries, formed themselves into a company to work up the new discovery, but up to the present the trees have produced little.

THE *Ceylon Observer*, commenting on the destruction wrought by the scaly insect on the cocoa-nut palm in the West Indies, says that it is most remarkable that in Ceylon the palm has been absolutely free from this and other such pests. This fact perhaps is due to the absence of those long-continued droughts which have so grievously affected Jamaica and its neighbouring islands. While the palm, however, has flourished so well in Ceylon, the coffee-plant is almost extinct in the island, a few isolated fields in each district being all that have survived the ravages of the green scale insect. Frequently the finest coffee-trees, with fresh and vigorous-looking bushes, and with stems as thick as a man's thigh, are so completely under the influence of the pest that no crop is produced. Experiments with soap, lime, kerosene oil, &c., have up to the present produced no satisfactory results. Tea seems to flourish where the coffee-plant dies, and even where the tea plantations are attacked by fungoid or insect pests, the plants can be pruned down till not a leaf is left ; or, if the attack is a very severe one, the tea-garden can be burnt to the ground without suffering any permanent injury, for the roots and stems in a very few months again display their luxuriance as richly as before.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, presented by Mr. Lishman ; a Serval (*Felis serval*) from Malindi, East Africa, presented by Mr. H. C. Hunter ; a Common Fox (*Canis vulpes* ♂), British, presented by Mr. E. Baldwin Cashel ; a Common Fox (*Canis vulpes* ♀), British, presented by Lieutenant H. F. Sparrow, "The Buffs" ; a Chough (*Pyrrhocorax graculus*) from Ireland, presented by Mr. A. Mudge ; a Gold Pheasant (*Thaumalea picta* ♂), a Silver Pheasant (*Euplocamus nycthemerus* ♂) from China, presented by Mrs. Theodore Lloyd ; a Sharp-nosed Crocodile (*Crocodilus acutus*) from the West Indies, received in exchange.

OUR ASTRONOMICAL COLUMN.

ROUSDON OBSERVATORY, LYME REGIS.—The observations at Mr. Peek's private observatory have been carried on during the past year. 163 nights were available for observations, as compared with 165 in 1887. As last year, the attention of the observers has been chiefly directed to transit-observations for time, and to observations of variables of long period. The object of the observations of variables is to determine the exact dates of maxima and minima, and, as far as possible, the light-curve of each star. The list of stars under examination is gradually being revised, circumpolar stars being substituted for those withdrawn, in order that uninterrupted observations may be made throughout the year. Owing to the lengths of the periods of the stars taken, the complete observations are not yet ready for publication. The importance of these light-curves cannot be over-estimated, as they will undoubtedly throw much light on the origin of the variability.

A sidereal clock, by Grubb, has been added to the equipment of the observatory.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1889 FEBRUARY 3-9.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 3

Sun rises, 7h. 36m. ; souths, 12h. 14m. 7·4s. ; sets, 16h. 52m. : right asc. on meridian, 21h. 9·6m. ; decl. 16° 22′ S. Sidereal Time at Sunset, 1h. 48m.

Moon (at First Quarter February 7, 21h.) rises, 9h. 25m. ; souths, 14h. 58m. ; sets, 20h. 43m. : right asc. on meridian, 23h. 54·3m. ; decl. 5° 49′ S.

Planet.	Rises.	Souths.	Sets.	Right asc. and declination on meridian.
	h. m.	h. m.	h. m.	h. m. ° ′
Mercury..	8 3 ...	13 19 ...	18 35 ...	22 14·9 ... 9 24 S.
Venus.....	9 0 ...	15 7 ...	21 14 ...	0 3·3 ... 0 40 N.
Mars	8 47 ...	14 26 ...	20 5 ...	23 22·3 ... 4 51 S.
Jupiter....	5 8 ...	9 3 ...	12 58 ...	17 57·8 ... 23 6 S.
Saturn....	16 53*...	0 26 ...	7 59 ...	9 19·7 ... 16 48 N.
Uranus ...	23 5*...	4 28 ...	9 51 ...	13 22·1 ... 7 58 S.
Neptune..	11 11 ...	18 54 ...	2 37*...	3 50·8 ... 18 25 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Feb.	h.	
3 ...	20 ...	Venus in conjunction with and 5° 37′ north of the Moon.
5 ...	12 ...	Saturn in opposition to the Sun, southing at midnight.
5 ...	12 ...	Mercury stationary.
8 ...	16 ...	Neptune stationary.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·5 ...	81 17 N. ...	Feb. 7,	19 50	*m*
Algol	3 1·0 ...	40 32 N. ...	,, 8,	4 10	*m*
λ Tauri...	3 54·6 ...	12 11 N. ...	,, 5,	21 55	*m*
R Canis Majoris ...	7 14·5 ...	16 11 N. ...	,, 6,	21 16	*m*
		and at intervals of		27 16	
W Virginis	13 20·3 ...	2 48 S. ...	Feb. 9,	5 0	*m*
S Virginis	13 27·2 ...	6 38 S. ...	,, 9,		*M*
U Coronæ	15 13·7 ...	32 3 N. ...	,, 7,	22 52	*m*
R Draconis	16 32·4 ...	66 59 N. ...	,, 5,		*m*
T Vulpeculæ ...	20 46·8 ...	27 50 N. ...	,, 7,	19 0	*m*
			,, 8,	21 0	*M*
Y Cygni	20 47·6 ...	34 14 N. ...	,, 3,	17 40	*m*
		and at intervals of		36 0	

M signifies maximum ; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
	°	°	
Near η Aurigæ	74 ...	42 N.	
,, λ Draconis	168 ...	71 N.	
,, θ Draconis	240 ...	61 N. ...	February 6.

GEOGRAPHICAL NOTES.

THE paper read at Monday's meeting of the Royal Geographical Society was on the Gran Chaco of the Argentine Republic and its rivers, by Captain John Page, of the Argentine Navy. The Gran Chaco, Captain Page said, is a vast central tract of country lying between the southern tropic and 29° S. lat., bounded on the north by Brazil and Bolivia, on the south by the Argentine province of Santa Fé, on the east by the Paraná and Paraguay Rivers, and on the west by Santiago del Estero and Salta. It contains about 180,000 square miles, or considerably more than the superficies of Great Britain and Ireland. About one-third part of this vast area belongs to Paraguay. The Gran Chaco has been called, particularly in allusion to the low-lying Paraguay section, the *oceano firme*, or solid ocean. This section and the central section of the Argentine rise from the Paraguay River towards Bolivia almost imperceptibly, having numerous and very extensive marshes and jungle, which are drained by many small streams likely to become, as the country progresses, important local waterways. The monotonous level of these sections is relieved by various prominent points of great beauty along the Paraguay River. Both are well wooded, although the predominating woodland

feature is the great and almost interminable palm forests, which, singularly enough, in the Chaco are a sure indication of marshy lands subject to inundation, although in the province of Entre Rios, and other parts of the world, they are the exact contrary. On the northern and eastern borders of the River Bermejo the Central Chaco rises sensibly, as if to form a barrier to the waters of that river in their easterly progress. The Chaco Austral of the Argentine is the most favoured in natural riches of the three great sections. Its surface rises gradually from the Paraná River, and is intersected by several small streams, which are even now useful as a means of water-carriage to the many colonists settled along their courses; after rising thus up to the parallel of 25° 40′ S., the ground dips towards the valley of the San Francisco, sending its waters with those of that river to the Bermejo, sometimes in untimely floods. This depression extends across the Central into the Paraguayan Chaco, taking in the sections of the two rivers that are subject to yearly overflows between long. 61° and 62° W. of Greenwich, thus making a point of analogy between the two. The Austral is favoured with extensive primæval forests, notably that on the north-western border extending into Salta and covering a superficies of many hundreds of miles, quite unexplored, and sometimes designated by the name of "impenetrable." The principal water-courses of these territories are the Pilcomayo and Bermejo, which are undoubtedly destined to become highways of commerce. The waters of these rivers differ in colour, those of the Pilcomayo being dark and sometimes brownish, and those of the Bermejo red, as its name indicates; both are long, narrow, and tortuous, as are most of the interior rivers of the La Plata system; both run in a general south-east direction, preserving a remarkable parallelism throughout their entire course, running distant from each other as nearly as possible 180 miles. Neither of these streams receives tributaries of any kind over the greater part of their course, and their waters are consequently subjected to a great and constant drain from evaporation, in a climate whose average temperature is 80° F., as well as from absorption by the deep alluvial covering overlying the compact argillaceous bed, which is a geological characteristic of the whole Chaco subsoil. The impermeability of this bed probably arrests the effect of absorption, and in a great measure accounts for the non-diminution of the wealth of waters delivered into the Paraguay; such a geological formation may also account for the saline properties of the waters found in the Chaco, wherever wells have been made. The density of the Bermejo water is greater than that of the Pilcomayo; the amount of sediment it brings down is enormous, and it is deposited with such extraordinary rapidity that it cannot but be considered a peculiarly strong feature of the mechanical work of this river, by which its geological formations are rapidly made, and, indeed, unmade as well; this swift precipitation of its detritus, which it replaces by an increasing abrasion of the banks, may be caused, to some extent, by the quantity of salt contained in its water. This constant precipitation goes on in the Bermejo, even when at its height, and when in the exercise of its greatest carrying power, with a speed quite equal to the square of its normal current; a fact which would seem to say that its currents are swifter on the surface than over its bed. Captain Page has seen this river eat away an entire point of land, and, by way of compensation, deposit, just a turning below, an amount of detritus sufficient to form a similar promontory, which, in one season of low water, became covered with a thick and luxuriant growth of red willow. The Pilcomayo—the Piscumayu, as it is called in the Quichua tongue, signifying Bird River—is to a great extent unknown. The section that is *quite* unknown, and that is surrounded by a certain mythical halo which it will be a geographical triumph to dispel, is that comprised between long. 61° and 62° W., and the parallels of 22° and 23° S.; the river at this point was said, by theorists who forgot to account for its reappearance immediately below, to disappear altogether. Captain Page then gave an historical sketch of the various expeditions which have explored the Gran Chaco, concluding with an account of an expedition in a steamer up the River Bermejo, which he himself led, amidst many dangers from banks, and snags, and wrecks, as well as from the widespread flood that suddenly overtook him.

WITH the first number for 1889 a useful modification has been introduced into *Petermann's Mitteilungen*. For the last few years, in addition to the classified list of geographical publications each month, there has been a separately paged supplement containing critical analyses of the more important works. These were often carried to such length that many of the notices were from six to twelve months behind date. Now, the two lists are to be amalgamated, the notices are to be greatly reduced in length, and thus it is hoped that new works in the various departments of geography will be promptly made known to the readers of the *Mitteilungen*. In the first number of this year is an important paper on valleys of erosion, by Dr. V. Hilber. The paper consists mainly of an analysis of the nine theories that have been advanced to account for the formation of such valleys. The author himself favours the regression theory, according to which valleys have mostly been formed by retrogression, through the erosion of a river from its mouth backwards.

CAPTAIN VAN GÈLE, the explorer of the Mobangi-Wellé, was to leave Antwerp on the 29th for the Congo, to undertake a special mission. He is accompanied by Lieut. Le Marinel, Lieut. De Rechter, and M. Ferd. Meunier, as naturalist.

M. MAUREL, who has explored French Guiana, recently described the results of his observations and investigations to the Geographical Society of Toulouse. From the orographical point of view, he stated, French Guiana comprises four zones, rising in stages to the Tumac Humac Mountains. The first consists of a broad band of alluvial country. The second zone is hilly, covered throughout by a series of hillocks and bluffs, not exceeding 650 feet in height, and frequently separated by shallow valleys. The third zone M. Maurel describes as mountainous, with an irregular surface, abrupt slopes, and deep valleys. The Tumac Humac chain constitutes the fourth zone, and it rises by a series of gradations to a height of about 4000 feet. M. Maurel has collected a number of flint objects, which he believes belonged to a pre-historic race that must have inhabited the country before the alluvial period. He accounts for the present formation of Guiana by two long-separated volcanic outbursts, acted on subsequently by a large river, which he believes gave origin to the deposits of the first zone.

MR. J. Y. BUCHANAN, PROF. A. H. KEANE, AND MR. J. T. WILLS, are candidates for the Lectureship in Geography at Cambridge, vacant by the resignation of Dr. Guillemard.

THE Russian Geographical Society has just brought out, as an appendix to the nineteenth volume of its Memoirs, an atlas containing all the measurements made by A. Kaulbars in the delta of the Amu-daria. These measurements, which will be invaluable to those who may hereafter study the changes going on in the delta of the great Central Asian river, could not be embodied in M. Kaulbars's capital work "The Old Beds of the Amu," published by the Society in 1887. Now they are given partly in the atlas (on the scale of 1 : 1,500,000), and in full in the text which accompanies it.

THE PRESENT STATE OF SEISMOLOGY IN ITALY.[1]

THIS group of papers affords the reader a very fair means of forming a mental estimate of what Italy has been doing to study her earthquakes during the last year or eighteen months.

Signor E. Brassart, for some years the Mechanical Constructor of the Central Office of Meteorology and Geodynamics, has produced a seismoscope in which a small slug perched on a thin column was overturned by the earthquake, and fell into an umbrella-like balance-pan surrounding the peg. In this way the direction of the shock was supposed to be indicated by the

[1] "Sismoscopi o Avvisatori Sismici," Ermanno Brassart. "I Sismometri Presentemente in Uso nel Giappone," esaminati e descritti da Ermanno Brassart; con proposta di un Sismometro di Nuovo Modello. "Il Sismometrograph a Tre Componenti con Una Sola Massa Stazionaria," Nota di Ermanno Brassart. "Sulla Sistemazione delle Osservazioni Geodinamiche Regolari," del Prof. Giulio Grablovitz. "Relazione della Sottocommissione Incaricata di Studiare alcune Proposte per l'Ordinamento del Servizio Geodinamico nell' Italia Meridionale e nelle Isole," del Prof. T. Taramelli. "Relazione alla R. Sottocommissione Geodinamica sulla Distribuzione delle Aree Sismiche nell' Italia Superiore e Media," del Prof. T. Taramelli. "Il Terremoto nel Vallo Cosentino del 3 Dicembre, 1887," Studio del Dott. Giovanni Agamennone.—All these papers are published in the *Annali dell' Ufficio di Meteorologia e di Geodinamica*, vol. viii. Parte 4, Anno 1886. (Rome, 1888.)

"Alcuni Risultati di uno Studio sul Terremoto Ligure del 23 Febbraio, 1887," Nota di T. Taramelli e G. Mercalli, *Rendiconti d. R. Accad. dei Lincei*, vol. iv. fasc. 1. (Roma, 1888.)

fold in which it fell, and its weight disturbed the equilibrium of the balance, which by making contact gave notice of the shock. Many of these are at present in use in Italy. A recent improvement is to suppress the balance, the contact is made by the slug being caught between the supporting style and surrounding umbrella-shaped grooves. The author of the paper experimented on earthquake alarms for vertical shocks, and found that, with three wire spirals, two supporting different weights and one without, the last gave less repeated oscillatory movements after the shock, returning more quickly to rest; and he therefore suggests this as an improvement on the old spring and bob seismoscope.

The next point discussed is whether it is preferable to stop or start a clock at the moment of an earthquake, and is in favour of starting one, as the few minutes between the shock and the arrival of the observer could afford little time-error, whereas there is no means of correcting the time-error of a clock stopped by the shock.

Following an observation of Prof. J. Milne on the facility with which light objects, such as pens, pencils, &c., when propped up nearly vertically, fall by the slightest movement, the author has constructed a seismoscope. A long thin bar, standing in a concavity, is supported by a small prop that can be regulated so as to put the bar almost in a vertical position, which is surrounded by an isolated ring of brass. On the occurrence of a shock, the bar falls and completes a circuit with the brass ring so as to ring a bell, start a clock, &c. Experiments made by the inventor and Prof. Tacchini showed the extreme sensibility of this seismoscope compared with others placed on a marble wall-bracket upon which small weights were allowed to fall. Drawings and descriptions are given of a method of using this seismoscope to start a clock, the pendulum of which is retained ready to vibrate by a short catch. The ring surrounding the falling bar is supported on a jointed base and the falling bar displacing it, and acting on a system of jointed levers the catch falls out of the way of the clock pendulum.

Next, Signor Brassart alludes to the different ideas current about the best method of connecting seismic apparatus to the ground, and shows the necessity of a series of experiments to determine this by using stakes, walls, &c., and employing seismographical instruments of different types.

In the next memoir by the same author, a description and drawings of the principal apparatus used in seismological research in Japan is given, together with a criticism of each. He concludes the review of these instruments by pointing out that it is only those in which a pendulum is employed, together with those possessing a rolling base, either spherical or cylindrical, that do not require adjustment, beyond rendering the base horizontal. His own choice would be a vertical pendulum, because not only does it not require adjustment and is constantly ready to indicate the shock, but is always in the same condition; and then adds, "In other arrangements it is possible greater stasis or neutrality of the mass is obtained, but notwithstanding that, for the above-mentioned reasons I should show a propensity for pendulums." This is a preference I fear few other seismologists would share with the author, since he undoubtedly alludes to vertical forms. The floating seismograph of Gray is favourably mentioned, but troubles from evaporation of the liquid, &c., pointed out. This is similar to the opinion expressed by the writer of this article, some years since, in a paper on seismographs published in NATURE.

Signor Brassart then proceeds to suggest an instrument consisting of an annular pendulum suspended by a silken cord 1 metre long, attached at its upper end in the middle of another horizontal cord made taut by side screws in the frame. In the middle of the bob, near the centre of gravity, is a pin which slides in two slots placed at right angles to each other. These slots are cut in the ends of levers of the first order, one being bent at right angles so as to bring the opposite ends of the levers side by side, to which are attached writing needles. These are made to trace on a smoked glass plate held on a truck, which by a seismoscope is liberated and drawn along at a uniform and known rate by a clock. This proposition was soon carried out with some modifications, and at the end of the paper is an appendix describing it. The changes of design consist of the suspending silk cord being attached to a stage supported on three vertical cork cylinders, the object of which is not very evident, except, perhaps, to absorb a part of the vertical component. This latter is registered by a Gray's compensated bob attached to the same frame, and by means of levers made to trace side by side with those of the two horizontal component styles on the same plate, or, as the author suggests, in some suitable cases upon an endless band of paper. This seismograph has many defects which it will be more convenient to discuss later on. This paper is dated December 1887.

It has doubtless been the ambition of most inventors of seismic instruments to be able to register the three components of an earth-movement employing but one steady-point or mass. Anyone who makes such an attempt, however imperfect be his result, deserves much credit for trying such a herculean feat in mechanical construction.

Signor E. Brassart's later production is described in February of this year, and, in so far as the registration of the horizontal components goes, is quite similar to that described in December 1887. Inserted in the suspending cord is a spiral spring inclosed in a tube, which consequently also allows the bob movement up and down. The peg or rod then slides in the slots of the horizontal component levers, is prolonged downwards a suitable distance, and terminates in a ball, which is engaged in a short tube or cup at the end of a bar. A gimbal is a mechanical arrangement by which a bar supported in its centre can rotate around any theoretical axis in the horizon of the gimbal, whilst any motion along a line normal to the horizon or plane of the gimbal would be resisted; or, if the gimbal be suspended to a lever, this will be moved in proportion to the vertical movement applied to the gimbal arrangement. (The writer of this article believes the gimbal was first applied by himself in seismological instruments, but he is open to correction.)

Signor Brassart takes advantage of this, and makes the sphere at the end of the peg from the pendulum, form a ball-and-socket joint with the tube or cup bar of the gimbal arrangement, which is supported horizontally at the end of a lever. Now all horizontal excursions of the peg, joint, and gimbal bar, are quite free, but vertical excursions will disturb the whole gimbal system with its lever, the motion of which by suitable mechanical arrangements is traced by the side of the horizonal component styles.

It will be convenient now to examine the favourable points and disadvantages of these instruments. In the first place, we have the well-known defects of the vertical pendulum for registering the horizontal components of an earthquake. Then, the author's method of the peg sliding in the two slots of levers introduces an amount of friction, even where the finest workmanship and materials are adopted, as to modify the results to an important extent. In regard to the gimbal arrangement, that answers perfectly during vertical without horizontal movement; but the moment that lateral displacement takes place, the bar of the gimbal, and the pendulum length, form two sides of a triangle instead of a straight line. On the principle that two sides of a triangle are always greater than the third, the more the horizontal components are, the less would the vertical component be registered. And even there is a point in which the motion of the pendulum bob would simply resolve itself in a greater tilt of the gimbal bar.

The next study by Prof. G. Grablovitz is a kind of programme of seismological observations to be made in Italy. The paper shows a clear conception of the known or probable relationship of different seismic phenomena, and apparently the best methods to adopt for their study. One most favourable point about the author's writing is a total absence of that long-winded style, charlatanism, and seismic magic, which has characterized the writings of many Italian seismologists up to quite recently. Very little, however, is new: similar suggestions may be found scattered through the writings of many other seismologists, and part, at least, were thrown out by the writer of this article in many of his papers relating to Ischia. It is, in fact, in organizing the new observatory on that island by Prof. G. Grablovitz that has led that gentleman to the considerations contained in his paper. From observations made with the mercury cup in the temporary Ischian Geodynamic Observatory, passing carriages and numbers of people could be detected at a distance of 100 metres; therefore the author considers this as the minimum distance of isolation such an observatory should possess.

The next is a report of a sub-committee, drawn up by Prof. T. Taramelli, dated December 1886. It consists of a review of the principal earthquakes that have affected different regions of Southern Italy, and the means then in existence for their study. This was preceded by another report referring to Northern and Central Italy. The author opens his report by discussing the views of different writers as to the causes of earthquakes, with-

out, adding in any way to those views. Chapter ii. is a review of the earthquake parts of Italy referred to in the report, together with an attempt to separate the country into seismic provinces, a work already in part carried out by Mercalli, and where observatories are wanting to suggest the establishment of them. Appended to this memoir is a map of Italy coloured in nine tints, showing the seismic intensity in different regions. If the reader compare this with a geological map of the country, he will be struck with the relationship of earth-movements and the rocks. We notice intense foci near Sienna, north of Florence, and the alluvial flats of the mouths of the Po, another in Umbria, and a very intense one between Aquila and Solmona, where the Apennines reach their greatest elevation. There are the two volcanic centres of Naples and Melfi, with the intervening of Benevento and Ariano, a district in which comparatively recent rocks are much metamorphosed, whilst to the south-west of Potenza we observe a large but only moderately intense focal area. The toe of the Italian boot looks very dark with the two intense centres of Cosenza and Aspromonte, together with the Messina district in Sicily. In these we have granite, gneiss, and other crystalline rocks, covered chiefly by more or less friable Tertiary deposits, much eroded into many narrow deep valleys, and sharp crumbling intervening ridges. One cannot but be struck by the striking relationship between the distribution of seismic areas and the alluvial flats, the volcanic regions and more active points of mountain-building in the geologically-speaking young country of Italy. In fact, this map constitutes the most important part of the report.

The last two memoirs are descriptive in character, dealing with the two recent destructive earthquakes. Of these two, the first, by Dr. J. Agamennone, refers to the earthquake which occurred on December 3, 1887, in the Cosenza Valley. Besides the topographical, a geological map is given, with a description from which we learn that this strip of mountainous land lying between the Gulfs of Taranto and of Policastro is composed principally of granite and allied rocks with gneisses and schists. The depression constituting the valley is filled by clays, sand, marls, and other more or less incoherent rocks of Tertiary age, which have been eroded by innumerable side valleys into pinnacles, and tongues of land with more or less perpendicular sides very liable to slips. Bisignano, which suffered most severely, is situated on some of these pinnacles or almost isolated tongues of molasse. Although the town has been destroyed by nine or ten earthquakes, many of these had their foci at some considerable distance. This last earthquake occurred during a barometric maximum corresponding to a marked centre of high pressure that crossed Europe from December 1–3, and three days after full moon. The author could find no relationship between increase or decrease of microseismic movements in Italy and this earthquake. As there were probably three shocks, the first being comparatively feeble, the people had already escaped from their houses when the second arrived, so that, comparatively to the ruin, few lives were lost. These are the results of the statistics: houses down or threatened ruin, over 900; deaths, 22; wounded, 60; and damage done to the value of 1,000,000 lire.

It appears that here stone must be brought from some distance, and building materials are very dear, hence bad construction and ruin. This but too well recalls the appalling scenes that passed under the eyes of the writer of this article after the earthquakes of Ischia [1] which might have been far less destructive, had it not been for the horribly bad walls, &c.

From the exceedingly incorrect time kept and the few approximately accurate records, the calculations afford for the *velocity of propagation* from 650 to 3300 metres per second.

The author shows that the epicentre was near the station of Mount Grassano, and that the greatest damage was on the loose unsupported friable rocks resting inclined against the sloping faces of the older compact rocks—conditions of effect identical with what occurred in the great Calabrian earthquake of 1783, and noticed by Mallet in 1857. The intensity of this earthquake the author calculates, on somewhat flimsy grounds, at eleven times less than the Andalusian, and four times less than that studied by Mallet in Italy in 1857. The sound seems to have been communicated to much greater distances through the compacter and more elastic rocks than through the loose detritic deposits. What, however, is strange, is the manner in which the author talks of one shock being subsultory and another, in the same locality, as undulatory, as if they were two entirely different kinds of earthquakes.

In fine, we pass to the consideration of the Ligurian earthquake of February 23, 1887 (described by Prof. Taramelli and Mercalli), which drove so many people away from the towns of the Riviera. The first eight pages are devoted to the geology of the district, which may be said to be composed of a range of compact fairly elastic rocks close to the shore-line. The valleys that incise the cliff along the coast extend not only to the sea line, but some distance beneath the water, whilst near the coast they are partly filled by platforms of late Tertiary, and very incoherent deposits. It is on these small somewhat triangular planes that most of the towns are met with. The region is one of the most disturbed by earthquakes of Upper Italy, no less than twelve, more or less destructive, occurring since the thirteenth century.

The authors sent out 1100 circulars to different localities, and from the answers were able to obtain much information. It appears that, as on former occasions, slight shocks were felt over the whole district, and preceded the great one, no less than four occurring during the previous night to February 23, 1887. The area affected extended southwards to Rome, Mount Ferru (Sardinia), east to Pordenone, west to Perpignan, and north to Lyons and Basle. The mesoseismic area was crescentic in shape, 100 miles long between Mentone and Albissola. The form was due to the focus being beneath the sea, and to the region occupied by the elastic crystalline rocks. The effects of geological structure in affecting the limitation of isoseismal areas was beautifully illustrated in the Ischian earthquakes described by the reviewer. It is not customary to call the region above mentioned the mesoseismal area, which should be limited to that space around the epicentre and above the focal area: a better definition would be that of almost total destruction. The zone of severe injury extended to the Langhe of Piedmont and Astigiano. The limits of severe shaking reach Turin and the lower Canovese, whilst the earthquake was strongly felt as far as Como, Arona, Parma, Leghorn, Marseilles, and nearly all of Corsica.

The main shock seems to have had two maxima, and to have lasted about 30 seconds. The authors calculated the *velocity of projection* at 9·4 m. at Oniglia, 3·53 m. at Faggia, and 4·7 m. per second at Nice. As in other cases of localities not epicentral, the rumble preceded the shock, the more, the farther the observer was from the focus.

Azimuths point to the epicentre being 15 miles from the beach, midway between Oniglia and San Remo, which is confirmed by the isoseismals being concentric to a point 20 kilometres south of Porto Maurizio. The shock appears to have started at about 6.19 a.m. The velocity of propagation was calculated at 1452 m. per second westward, and 584 m. per second towards Genoa: this the authors consider to be due to a main and secondary focus, whilst the depth obtained from emergence angles appears to be 18 kilometres. Little disturbance of the sea occurred, but it is said to have remained at a lower level for some days at Loano and Porto Maurizio. Dead fish of deep-sea character were found along the coast some days after. No meteorological phenomena of importance were noted, but strong telluric currents were set up at the moment of the earthquake. After nine minutes, another destructive shock occurred, another at 8.53 (M.T. Rome), and in the ruined area there occurred another twenty-two slight shocks, and others continued to occur with diminished force to March 11, so that at Savona fifty were perceptible in all.

The first three earthquakes killed 640 persons, and wounded as many, and the damage in the provinces of Porto Maurizio, Albenga, and Savona, was valued at 21,500,000 lire.

The greatest damage occurred on thin layers of incoherent rocks superposed on the more elastic and crystalline ones, at sharp boundary lines of different rocks, and unfavourable topographical positions. The effects were augmented by bad and unscientific construction of the houses, or badly repaired buildings, that have suffered in former shocks.

In this article, already of inordinate length, fair justice has hardly been done to the works reviewed, but the reader will see that Italy is awaking to her duty towards humanity and science in organizing the study of her seismic phenomena, and shaking off that conservatism and isolation which ruled her in this department up to the year after the great Ischian earthquake.

H. J. JOHNSTON-LAVIS.

[1] H. J. J.-L., "Monograph of the Earthquakes of Ischia: a Memoir dealing with the Seismic Disturbances in that Island from Remotest Times, with Special Observations on those of 1881 and 1883." (Naples: Furcheim, 1885.)

FRIENDLY SOCIETIES AND THEIR FUNDS.[1]

M. DE LAFITTE is the Vice-President of a Friendly Society numbering some 150 members and of a somewhat advanced type. He has evidently discharged his duty as Vice-President with exemplary devotion to the work, and has extended his studies and observations over the wider area covered by the French Friendly Societies generally. From a Report of the Minister of the Interior, it appears that the number of these Societies on December 31, 1885, was just upon 8000, that the average number of members in each was 136, and that, consequently, the total number of members whose names were inscribed in their rolls at that date was more than a million.

The volume before us is professedly an elementary treatise on Friendly Society finance. The author, in the opening chapter, selects, as the typical Society, one which possesses no other resources than the contributions of its members, and which, in return, undertakes to provide three distinct benefits: viz. (1) an allowance during sickness, (2) an old age pension to commence at a specified age, and (3) a sum of money to be paid to the relatives, on the decease of a member, to cover funeral expenses. He deals, throughout the book, with the various conditions under which contributions are levied and benefits conferred; but as a rule he assumes that new members are admitted at the age of 16, that the contributions cease at age 70 (or thereabout), when members become pensioners, and that sickness allowances, so far as money allowances go, are, at the same time, also discontinued.

The author, at the outset, urges the desirability of apportioning the total contribution of each member into three parts, corresponding to the three kinds of benefits assured to the member; and of keeping an exact account of the fund accumulated, from year to year, out of each part, *i.e.* of keeping an exact account of the resources available, at any moment, for each kind of benefit.

He points out, what is indeed obvious enough, that the share of contribution allotted to pensions must accumulate for many years; in fact, till the age for commencing pensions is attained by the members of the Society. He points out that, of the share of contribution allotted to meet sickness claims, a fraction of it only is required in the earlier years of life, when periods of sickness are less frequent and less prolonged, the remainder of it forming a provision against the heavier disbursements of later years, when the periods of sickness have become more frequent, more protracted, and more costly. Also, he points out that with the share of contribution intended to secure funeral moneys, there is likewise a gradual accumulation going on from the earlier years of life, when deaths are fewer in number, to the later years of life, when they are doubly and trebly as numerous. In respect of all three kinds of benefits, then, each member of the Society, during his years of active membership, has an increasing interest in the adequate accumulation of the funds of the brotherhood. These funds are trust funds, a collection of deposits confided to the Society by its members, and for which it remains accountable till the time arrives for restoring them, in the shape of aid to the members in sickness, or old age, or to the relatives upon the occurrence of decease. The preceding considerations show that every Society has not only accumulating funds fed by unused portions of the contributions received year by year, but also, and on the other hand, growing liabilities, and it has therefore to take care that the liabilities do not grow faster than the funds accumulate.

Every Society renders accounts year by year, but they are of the usual form, and that is not enough: at the same time that it exhibits its resources, it should know how to calculate with exactness its actuarial liability under current contracts with its members. By actuarial liability we mean the obligation of the Society to gradually accumulate a fund out of which future benefits may be paid as they mature. By inserting the amount of such actuarial liability in its balance-sheet, the Society completes its statement of liabilities and assets, and shows conclusively whether its accumulated funds are more or less than they should be. Such a balance-sheet, if the liabilities and assets are shown separately for each of the three kinds of transactions—sickness allowances, pensions, and death payments—is a perfect balance-sheet. It should be made out every year, and carefully studied by those responsible for the management of the Society.

The author's chief object in writing the present treatise is to give tables of actuarial liability, and to enunciate, prove, and illustrate rules by which such liability may be calculated. He proposes to explain to Friendly Societies how two or three of their constituted officials, in the course of an afternoon, may determine the liability of the Society with precision, and without possessing any preliminary knowledge other than that of the elementary rules of arithmetic, such as are taught at the primary schools to children of between ten and thirteen years of age.

Considering the labour usually expended on actuarial valuations, and the special knowledge and skill usually regarded as indispensable in such investigations, these are brave words. Impressed, as we are, with the immense amount of good that would accrue from the accomplishment of the author's design, we wish him whatever success is possible. There is nothing so much needed for the stability of Assurance Companies as well as Benefit Societies as a fuller acquaintance on the part of the public with the nature of actuarial liability. If such knowledge were general, we should hear little more of the insolvency of such associations, and see little more of the sad spectacle of a group of dependent and helpless persons finding in sickness or old age that the savings of long years of self-denial have been sacrificed.

In the calculations of Friendly Societies the average mortality and sickness found to have been experienced under more or less similar conditions must form the basis of all reasoning, and the effect of compound interest, combined with mortality and sickness, must, in some form or another, be introduced as further necessary preliminary information. The author lays before us, as giving such necessary preliminary information, several tables. In addition to two tables of mortality, viz. the table of the Caisse des Dépôts et Consignations, and the table of the English Institute of Actuaries, known as the H^M (healthy males) table, and a sickness table, showing the average number of days of sickness per head at each year of age, we have two tables of a somewhat unusual kind for the present purpose. These tables embody new rates of the Caisse Nationale des Retraites pour la Vieillesse, of whom pensions are bought, and show, for any present age, the amount of deferred annuity, to commence at age 50, 55, 60, or 65, corresponding, in the first table, to a payment, cash down, of 100 francs, and, in the second table, to a payment of 10 francs a year until the pension commences. A table of the present values of temporary annuities, terminable at any one of the four ages first mentioned, completes the group of fundamental tables.

The fact that both the above-named tables of mortality are frequently used in one and the same solution is, as the author appears to be conscious, open to criticism; and so is the fact that contributions are sometimes assumed to be payable at the beginning of the year and sometimes at the end of it. In a particular case, instanced by the author himself as showing that the consequent error is insignificant, the error amounts to 4 per cent. of the true figure, and this is hardly to be regarded as an insignificant difference. With respect to the tables themselves, they display appreciably different rates of mortality, and if one is found to be suitable for a particular Society, the other can hardly be suitable also. The H^M is a table of which English actuaries are justly proud; but a record of the mortality experienced by the middle and upper classes of this country is hardly to be accepted as a measure of the mortality to be expected amongst the artisans and mechanics and the mechanical and agricultural labourers of France. It might not, possibly, be inapplicable to some of the rural districts of that country, but if so, it would probably not be applicable to the districts of the large towns and the cities. Strictly speaking, no one table of mortality is suitable in all the varying conditions of locality and occupation to be found within the boundaries of French territory; and herein lies an obvious objection to the application of stereotyped results, such as those prepared for general use by the author, to the circumstances of all the Friendly Societies of an entire country, indiscriminately.

In selecting a sickness table on which to base the calculations of sickness liability, the author very properly observes that sickness tables, when compared one with another, often present discordant results. This is explained to be due to the limited number of observations or individual experiences on which the tables are based, and partly to the difficulty of saying exactly when a period of sickness begins or ends—of drawing, with precision, the line of demarcation between positive sickness and mere indisposition; besides, chronic and incurable maladies have been

[1] "Essai d'une Théorie Rationnelle des Sociétés de Secours Mutuels," par Prosper de Lafitte. (Paris: Gauthier-Villars et Fils, 1888.)

dealt with differently in the tables compiled for publication. Of the tables at the author's command, he has chosen that given by M. Hubbard as being, in his judgment, the best representative of the circumstances with which he is immediately concerned.

We cannot, at this point, do better than compare M. Hubbard's figures with those we are familiar with in England, viz. those of the Manchester Unity of Oddfellows and the Foresters. We give, then, the average number of days of sickness per annum at each of the undermentioned ages, as shown by the several tables specified. In the cases of the Oddfellows and the Foresters, the total average sickness in the year is shown in two parts—sickness within six months of its commencement, and sickness counting only beyond this limit. The rules of French Societies generally do not continue aid in money beyond the term of six consecutive months, a large proportion of them not beyond three.

Age.	M. Hubbard	Manchester Unity of Oddfellows: first six months and subsequently.		Foresters: first six months and subsequently.	
20	4·4	4·6	0·3	5·6	0·3
30	5·6	5·2	0·9	5·4	0·9
40	6·0	6·4	1·8	6·9	2·0
50	7·1	9·1	4·8	9·1	4·5
60	11·7	15·0	13·2	13·8	13·1
70	17·1	25·8	44·8	24·0	48·6

A glance at the above table affords sufficient evidence that the author is right in his assertion that sickness tables present very discordant results; and we should be somewhat failing in our duty if we did not utter a word of caution as to the use of M. Hubbard's tables by unskilled persons, more especially so as the author is inclined to advocate the continued payment of the sickness allowance in prolonged sickness rather than its curtailment. The experience of the Oddfellows and the Foresters may not supply a suitable basis for the calculations of *les Sociétés de Secours mutuels*; but this experience is extensive, has been carefully tabulated by competent actuaries, and is, at least, worthy the attention of anyone proclaiming, as our author does, the narrowness of existing and available data.

We have not the space to follow the author in detail through the numerous rules and explanations given by him in connection with the calculation of actuarial liabilities and kindred matters. We must content ourselves with an examination of one only, and that a simple one. We propose to consider the method recommended for the calculation of the actuarial liability attaching to the receipt of contributions on account of pensions. As an example, the author takes the case of a member of 47 years of age, who has contributed 10 francs a year since the age of 16, and who is looking forward to a pension of 294 francs 11 centimes to commence at the age of 65. He then proceeds on the basis of the Caisse des Retraites tables, substantially, as follows:—

According to the second of the two tables, an annual contribution of 10 francs, the first payment being made at age 47, secures a pension, to commence at age 65, of 41 francs 35 centimes a year. Whilst, for the same annual contribution, the first payment being made at age 16, the pension is one of 294 francs 11 centimes a year. The equivalent at age 47 of the earlier contributions (from age 16 to age 47) is, therefore, a pension amounting to the difference of the two preceding ones, 252 francs 76 centimes a year. But, according to the first of the two tables, the cost, at age 47, of a pension of 34 francs 53 centimes a year is 100 francs. It follows that the cost of a pension of 1 franc is $\frac{100}{34{\cdot}53}$ francs, and of 252 francs 76 centimes is $\frac{100 \times 252{\cdot}76}{34{\cdot}53}$, *i.e.* 732 francs.

We do not think the tables on which this calculation is based are more convenient in form than those in general use, or that they lend themselves more readily to a simple presentation of the theory of the subject; and we do not think the method of arranging the calculation is any improvement upon that commonly adopted. Annuity tables intended as aids to arithmetical computation are usually constructed to the unit of annuity, and not to the unit, or ten, or hundred, of contribution or purchase money. A common form of annuity table gives, for each year of life, the present value of a temporary annuity, payable to one of certain ages, say to age 65, accompanied by the present value of a deferred annuity to commence immediately thereupon, the two present values added together giving the present value of a life annuity to run during the whole of the annuitant's life. The ordinary calculation, which may be called the method of present values, then proceeds to estimate the liability of the Society to provide the future benefit, on the one hand, and the claim against the member to provide future contributions on the other:—

Present value, at age 47, of a pension of 294 francs 11 centimes a year, after age 65, is the tabular number (2·90) × 294·11	853 francs
Present value of contribution of 10 francs, payable from age 47 to age 65, is the tabular number (12·10) × 10	121 francs
Leaving the actuarial net liability as before ...	732 francs

The principle of present values which distinguishes the usual method of calculating actuarial liabilities, is quite as easy for the general public to understand as the inverted method of using tables, proposed by M. de Lafitte; indeed, easier, because of the uniformity with which it is applicable to all cases of annuity, assurance, or sickness contracts. M. de Lafitte himself makes reference to it in explaining the calculation of sickness liabilities. We are of opinion, however, that there is a still simpler way of explaining to the general public the calculation of actuarial liabilities than that depending on the principle of present values. The latter looks to the future, the former to the past. The latter is a prospective method of procedure, the former is sometimes described as a retrospective method. It consists in imagining a number of persons, equal to the number in the table of mortality or sickness, to have actual existence, and to live and die as indicated in the table of mortality, and to fall ill as indicated in the table of sickness, and for the periods mentioned therein. By supposing contributions to be received year by year from all who live to pay them, and the various benefits to be paid out as they accrue due, the amount of money remaining in hand, as thus shown, is the sum that a Society of the tabular number of members should have in hand, and therefore the amount also of the Society's actuarial liability as required. For any other number of members than that suggested by the table, the amount of the actuarial liability would be proportional.

We have confined our observations, in the main, to the subject of actuarial liability, the use of tables of such liabilities, the mortality and sickness experiences on which they are based, and the principles on which they are explained, because the chief object of the book is to deal with this subject and to popularize it. There is, however, a chapter on the due, or fine, or fee, to be charged new members who join at other than the age for which the rates of contribution are arranged; another chapter on raising the contributions of existing members to provide increased benefits or to meet a deficiency; another on the mission and the proper sphere of Friendly Societies; and others beside, all affording excellent reading, and on which, had space permitted, we should like to have said a few words; but we must conclude this notice. The author manifests an enthusiasm in the work he has undertaken, has expended a great deal of time and thought upon it, and evidently has the welfare of Friendly Societies at heart. If one may judge of literary composition in a language which is not one's own tongue, we should like to express the opinion that the author's writing is clear and attractive. In his efforts to promote and encourage a wider knowledge of the somewhat abstruse subject of actuarial liabilities or valuation reserves, he has our very best wishes.

WATERSPOUTS IN THE HUGHLI.[1]

ON Tuesday, the 4th instant, a fine waterspout was projected from the level vapour-plane of a silvery-edged towering cumulus cloud—or, as our American cousins would term it, a "thunder-head"—over the western side of Kulpee anchorage, and near the village of Jiggerkolly, which, by the aid of a good telescope, showed well the downrush on the inside of the tube, and its counterpart the whirling uprush on its outside, twisting and coiling round and round against the watch-hands (face upwards).

[1] Reprinted from the *Englishman* of September 13, 1888.

The day had been close, hot, and breezeless, so far as the surface was concerned, and the cloud in question formed a grateful screen to the afternoon's sun, which was shining brightly north and south of our position; and continued to do so until old Sol hid his face for the night in lower clouds later on. At about 5 p.m., a well-formed waterspout was observed trailing away north-eastward from the cloud's northern verge; then about 40° or 30° high. Near the dense cloud from which it grew its mass was dark and opaque; but from half way down its length to below where it terminated in an unfinished turmoil of jags and rags, it was semi-transparent, the clouds beyond in the background being distinctly seen through it; and there was a light-coloured tube within its gauzy mass which at times was very pronounced and conspicuous.

There seemed to be no commotion on the river or the shore, over which its lower part hung at a height of five or six hundred feet, from the time when it was first observed until it began to wane and draw itself upwards. It was then, when it had shrunk and shortened, that the inside downrush was seen to advantage, and the simultaneous upward whirl around the dense remains of the tube, which, so far as I was able to make out from the motions of the cloudlets, I cannot do better than liken to the turning inside out of a coat sleeve or of a stocking, only the end of the tube was always ragged; and here, where this reversing process was taking place, there was great commotion in the air currents, more especially after the tube had withdrawn itself up to its opaque head.

I had a good telescope, observed these phenomena very carefully, and was on the alert for optical illusions; and, as the upper part of the spout remained intact for a long time after the gossamer-like lower continuation had melted into invisible vapour, I had an opportunity of studying it well.

It was very remarkable to see two or three common kites hovering high up in the vapour plane round and round the dense tube, every now and then becoming hidden behind it as they performed their gyrations, and in the same direction as the ragged fragments of rack or scud which were rushing round and upwards towards the dense head of the spout, until they were actually lost to sight in the very cloud itself.

The "thunder-headed" cloud, from the lower part of which the spout issued, gradually melted away, and grew less gaudy as it dwindled, without, as is usual under similar circumstances, pouring forth a torrent of rain. But there was a double rainbow projected on the clouds banking up over to the eastward, and evidently rain was falling in the space between them and the sun for some time after the last remains of the spout had disappeared, and all was again tranquil aloft.

The following evening, during a heavy thunderstorm and severe squall from the north-east, some twenty miles further down the river, a flash of lightning revealed the existence of a grand waterspout close by. This thunderstorm was remarkable, as it stretched south and north from the pilot station to far north of our position off Kedgeree, and struck both places at nearly the same hour, 7 p.m. Possibly all these phenomena had some connection with the small whirl reported in Mr. Pedler's useful weather bulletin issued daily from the Meteorological Office. The squall itself was seen from an early hour in the evening as a tract of dark streaks hovering ominously high up behind the accumulating white clouds away in the north-east and east, and threatening to quench the light north-west wind blowing in the estuary.

Subsequent information concerning this sudden thunderstorm shows that it was one of the class, referred to lately in NATURE by the Hon. Ralph Abercromby, which extend in an almost straight line for maybe hundreds of miles. It was felt at nearly the same hour all the way from Titighur on the north, to a point forty or fifty miles south of the Hughli Pilot Station—or, say, nearly 200 miles. S. R. ELSON.

SCIENTIFIC SERIALS.

Journal of the Russian Chemical and Physical Society, vol. xx. fasc. 8.—On the properties of allene, by G. Gustavson and N. Demianoff. The existence of this isomer of allylene ($CH_2:C:CH_2$) was foreseen since 1872; now, it has been obtained by the action of zinc dust and alcohol on $C_3H_4Br_2$. It is an uncoloured gas, the smell of which resembles that of allylene. It smokes freely when burning.—A note on the atomicity of bore, by G. Gustavson.—On unorganized ferments, by N. Kravkoff, being an inquiry into the properties of pure vegetable diastase.—On a general law of contraction during the formation of solutions of salts, by A. Geritsch. The author comes to the conclusion that the contraction (δ) is proportional to the produce of the respective percentages of water and salt in the solution $\delta = C(100 - p)p$; for Na_2CO_3 the constant C is $= 0{\cdot}0086$, and the contraction calculated by means of the formula for solutions at from 3 to 13 per cent. are very near the contractions directly measured by Gerlach and Mendelejeff.—On the solutions of sulphuric acid from the molecular point of view, by M. Teploff.—On the heat of combustion of stilbene, the mononaphthenes, and some organic acids, by J. Ossipoff.—An apparatus for the demonstration of thermic conductibility, by O. Chwolson.—On a new method of measuring the index of refraction, used by E. Forsch for measuring the same in the lenses of the Pulkowa refractor.—A note on the mutual influence of electrized bodies, by A. Stepanoff.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, January 17.—Mr. W. Carruthers, F.R.S., President, in the chair.—On behalf of M. Buysman, of Middleburg, Mr. B. D. Jackson exhibited a series of careful dissections of *Nymphæa cærulea* collected by Dr. Schweinfurth in Egypt.—Mr. D. Morris exhibited specimens of drift fruit from Jamaica, where he had collected no fewer than thirty-five different kinds brought by the Gulf Stream from the mouths of the Orinoco and Amazon. Although the species exhibited had not been determined with certainty, it was believed to be probably *Humiria balsamifera*, Aud., the flower of which is figured by Eichler ("Flora Brasiliensis," vol. xii. part 2, p. 440, pl. xcii. fig. 1), but the fruit undescribed. It was commonly known in French Guiana as *bois rouge*, and from it was obtained a gum used medicinally and burnt as incense. An interesting discussion followed, in which Mr. J. G. Baker, Mr. Rolfe, and Mr. Breese took part.—Mr. T. Christy exhibited a material felted from Manilla hemp, and waterproofed, very strong and light, and particularly useful for surgical bandages, for which purpose it was highly recommended by army surgeons.—Mr. F. Crisp exhibited some specimens of agate so curiously marked as to lead to the erroneous supposition that they inclosed fossil insects and Crustacea.—A paper was then read, by Mr. J. G. Tepper, on the natural history of the Kangaroo Island grass-tree, *Xanthorrhœa Tateana*. This tree grows abundantly in Kangaroo Island, South Australia, in poor gravelly and sandy soil, intermixed with ferruginous concretions, and attains a height of from 6 to 14 feet, with a diameter of 6 to 18 inches, and a floral spike of from 10 to 19 feet. It is thus a most conspicuous plant, and lends a peculiarly weird aspect to the country it occupies. Its rate of growth is described as very slow, old settlers having remarked but little change in individual trees after thirty years' observation. The most remarkable feature in the structure of the stem is the formation of a dense ligneous central core immediately above and connected with the roots, exhibiting numerous annular zones traversed by transverse (medullary) fibres. The flowers are borne in a dense spike upon a smooth peduncle. Individually they are inconspicuous, of a whitish colour, and develop a strong odour and abundant nectar during the warmer part of the day, when they are visited and fertilized by Hymenopterous insects, the most remarkable being a large metallic-green carpenter-bee (*Xylocapa*), which tunnels out cells in the dead flower-stalks. An interesting discussion followed upon the botanical position of the grass-trees, and the antiquity of the type, in which the President, Mr. A. W. Bennett, Mr. J. G. Baker, Mr. Morris, and Mr. Rolfe took part.

EDINBURGH.

Royal Society, December 17, 1888.—Sir W. Thomson, President, in the chair.—Mr. R. Kidston read a paper on some fossil plants from Teilia quarry, Gwaunyscor, near Prestatyn, Flintshire.—Dr. G. Sims Woodhead communicated an abstract of the results of an inquiry into the causation of Asiatic cholera. The first part (general) was by Dr. Neil McLeod and Mr. W. T. Milles. The second part (with special regard to the reproduction of the disease) was by Dr. McLeod. The disease was shown to be due to the comma bacillus. In forty out of forty-four cases this bacillus was present; while, in a large number of spurious cases, it was only once or twice detected. It was found that symptoms similar to those accompanying cholera in

man followed injection of the comma bacillus into the stomach of the guinea-pig, care being taken to neutralize the acid products which are fatal to the organism.—Prof. Tait described some preliminary observations with a large rotatory-polarization spectroscope. In this apparatus the light passes through a slit and collimator, a Nicol's prism, a train of cylinders of quartz, a double-image prism, and an ordinary direct-vision spectroscope. The instrument is so arranged that the two spectra produced are in exact juxtaposition side by side, each spectrum being alternately crossed by dark interference bands corresponding to successive rotations of the plane of polarization through 180°. A scale is thus applied to the spectrum, and the interval between successive bands can be subdivided to any required degree of accuracy. Wave-length is thus measured with extreme accuracy by the amount of rotation of the plane of polarization. When the apparatus is used, not with bright-line spectra but, with continuous spectra, the excessive loss of intensity by dispersion which occurs in ordinary spectrometers may be avoided.—Dr. Woodhead communicated a paper by Mr. G. Brook, entitled "Preliminary Remarks on the Homologies of the Mesenteries in Antipatharia and other Anthozoa." After describing the arrangement and musculature in the common shore anemone, *Edwardsia*, Cerianthidæ, in Alcyonaria, Madreporaria, Mr. Brook pointed out that the Antipatharia are generally supposed to be degenerate forms, and to have lost a considerable number of the mesenteries that were present in their ancestors. Mr. Brook, who is examining the *Challenger* collection of Antipatharia, has been able to make sections of twenty-three species, from which he finds that the arrangement, number, and relative development of the mesenteries cannot be explained in accordance with the views current on the subject. With the exception of two pairs of directives the mesenteries do not appear to show the paired arrangement usually looked for. He gives the arrangement of the mesenteries in *Cladopathes* (six mesenteries), *Antipathes* (ten mesenteries), *Leiopathes* (twelve mesenteries), and points out that the arrangement in these forms receives its explanation by a comparison with the order in which the first twelve mesenteries are, according to Lacaze-Duthiers, developed in Hexactiniæ. In *Actinia* and *Sagartia* the first twelve mesenteries are developed in pairs which are not adjoining mesenteries, but are situated one on each side of the stomodæum. The order in which they are developed in *Sagartia bellis* (and in *Actinia equina*?) precisely corresponds *with their relative length* in *Leiopathes*. The first pair to be developed are those corresponding to the transverse mesenteries in Antipathidæ; next follow the two pairs of directives, and afterwards the three pairs which he has termed "secondary" in Antipathidæ. The shortest mesenteries in *Leiopathes* are the last of the six pairs to be developed in *Sagartia*. Evidently, then, the mesenteries forming a pair are originally opposite mesenteries and not adjacent ones. We thus have, in forms with an elongated stomodæum, a true bilateral symmetry. The two pairs of directives limit an anterior and a posterior unpaired chamber. Between these two the cœlenteron may be imperfectly divided into any number of paired lateral chambers. On this interpretation the arrangement in Alcyonaria, *Edwardsia*, Cerianthidæ, *Madracis*, &c., is also easily understood: all are modifications of one plan. In the Hexactiniæ the simple bilateralism is masked, but a careful study of the order in which the mesenteries are developed shows clearly how this is brought about. In all types the mesenteries of a pair are originally on opposite sides of the stomodæum. The two pairs of "directives" come to be *adjacent* mesenteries, for the reason that no new mesenteries are ever formed between them, and with a further development of mesenteries they come to be pushed closer together. As is clearly seen from Hertwig's figures of the embryonic condition in *Peachia*, the other so-called "pairs" of primary mesenteries are not pairs developmentally, as they consist of mesenteries of different ages. They are called pairs because they are arranged in couples, having the retractor muscles on their inner surfaces. In Hexactiniæ the further increase in the number of mesenteries takes place in a modified way. Buds appear which are on opposite sides of the stomodæum between existing "pairs," but, instead of giving rise to a single mesentery as before, each gives rise to two, with the retractor muscles on their inner surfaces. The general plan of development Mr. Brook considers to be as follows. The mesenteries have a radiate arrangement in forms with a round stomodæum; this arrangement becomes bilateral by an elongation of the stomodæum in one axis—the sagittal. In this case the anterior and posterior pairs (directives) come to consist of adjoining mesenteries, whilst the intermediate pairs consist of opposite mesenteries. So long as the folds of the body-wall give rise to only one mesentery each, the simple bilateral arrangement is retained, as in Cerianthidæ (this refers to bilateral arrangement of parts, irrespective of the outline of the polyp). In case the mesenterial rudiments give rise (after the formation of the first twelve mesenteries) to two mesenteries instead of one, the Hexactinian type is reached. In certain Madreporaria (*e.g. Lophohelia*, *Mussa*, and *Euphyllia*) the radiate arrangement appears never to be lost. At any rate, according to Fowler and Bourne, there are no mesenteries distinguishable from the others as "directives," and there is a perfectly radiate symmetry. Such a general plan of development is also found in *Peripatus* and in Vertebrata. In *Peripatus* the blastopore becomes elongated and closes in the centre, but its two extremities remain open as the mouth and anus. The mesoblastic somites are formed in the region in which the blastopore has closed, and these become more numerous as the two extremities become more and more separated. At present, Mr. Brook is only able to indicate the bearing of these views in outline. He hopes, however, shortly to make a more detailed communication on the subject.

January 7.—Prof. Chrystal, Vice-President, in the chair.—At the request of the Council of the Society, Prof. Tait gave an address on the compressibility of water, salt-solutions, glass, and mercury. His address was illustrated by experiments.

[redacted] PARIS.

Academy of Sciences, January 21.—M. Des Cloizeaux, President, in the chair.—On a point in the question of homogeneous elastic plaques, by M. H. Resal. In this note the author proposes to base the hypothesis relative to the expressions of the tangential dilatations on a supposition of a more general character than that hitherto assumed by geometricians.—On the Hæmatozoa detected by M. Laveran in the blood of the inhabitants of marshy districts, by M. Bouchard. Attention is called to the great importance of the discovery made by M. Laveran ten years ago, and now placed beyond all doubt, that marsh fevers are of parasitic character. They offer the first known example in man of an animal parasitism in which the pathogenic agent appears to be placed at the lowest scale of animal life. While most infectious maladies in man and animals are due to vegetable microbism, the most important and widespread infectious disease in man is now shown to depend on animal microbism. The parasite observed by M. Laveran in Algeria has since been found in France, Corsica, Italy, Russia, Madagascar, Tonquin, and America, and is identical with the organism more recently detected by Marchiafava and Celli in the blood of people inhabiting marshy districts.—On the elementary terms in the co-ordinates of a planet, by M. Hugo Gyldén. Supplementing his recent communication on this subject, the author here points out that, the convergence of the terms in question being established, their numerical values may be determined by the methods proposed in the paper on the determination of the radius vector in the absolute orbits of the planets inserted in the *Monthly Notices* of the Royal Astronomical Society, London.—On the distribution of the aqueous vapour in the atmosphere, by M. A. Crova. In a previous note (*Comptes rendus*, cviii. p. 35) MM. Crova and Houdaille communicated the results of the observations made last August at Bedoin and on the summit of Mont Ventoux. From those results M. Crova here deduces the mode of distribution of the aqueous vapours at various altitudes. Although only approximate, the calculations show how rapidly the quantity of vapour must decrease with the increase of altitude. The quantity itself also varies greatly from day to day, which is again explained by the fact that the vapours are mainly confined to the lower atmospheric regions, which are most directly influenced by meteorological phenomena.—Note on the new meridian of France, communicated by the Minister of War. The Geodetic Section of the Service Géographique de l'Armée concluded in 1888 the measurement of the angles for the new meridian begun eighteen years ago. The present note embodies a summary report of the main results, from which it appears that the meridian of Delambre and Méchain, useful in their day, can no longer serve as a base for the triangulation of France, or for further researches on the form of the globe. For these purposes the new meridian offers all the necessary elements except for the south-west region, where fresh measurements are required to secure complete accuracy.—Observation

relative to M. Vaschy's recent note on the propagation of the current in a telegraph line, by M. L. Weiller. The author questions on theoretical grounds some of M. Vaschy's conclusions, on which has been based an application for a patent. M. Weiller submits a specimen of a telephonic cable with two conductors constructed for the purpose of obtaining by self-induction the compensation of the electro-static capacity. In this apparatus the increase of the coefficient of self-induction is obtained by inclosing the chief copper conductor in a covering of soft iron wire.—Observations of the partial lunar eclipse of January 16, 1889, made at the Observatory of Lyons, by M. G. Le Cadet; and at the Paris Observatory, by MM. D. Eginitis and Maturana. The observations at Lyons were made with the Gautier equatorial *coudé*, and at Paris with the west equatorial in the garden. In the latter place the atmospheric conditions were favourable at the commencement and towards the close of the eclipse; but during the middle period the sky became overcast, preventing the complete observation of all the phases.—Experimental verification of M. Charles Soret's method for measuring the indices of refraction in crystals with two axes, by M. Louis Perrot. In a previous note (*Comptes rendus*, cvii. p. 176), M. Soret showed that the three chief indices of refraction in a crystal with double axis may be deduced from the limiting angles of total reflection on any given faces. M. Perrot has now verified this method by experiments with ordinary tartaric acid, employing a Liebisch refractometer for the purpose.—On the electric conductibility of salts in solution, by M. Lucien Poincaré. The author finds that the high polarization of a silver electrode plunged into a saline solution, such as the nitrate of potassa, falls immediately to zero by adding a trace of the nitrate of silver. From this phenomenon follows a means of greatly simplifying in certain cases the method hitherto employed by MM. Bouty and Poincaré for measuring the electric resistances of saline solutions.—Papers were contributed by M. Ch. Antoine, on the expansion and compression of atmospheric air; by MM. C. Vincent and Delachanal, on the extraction of sorbite; by M. J. Meunier, on the dibenzoic acetal of sorbite; by M. A. de Lapparent, on the relation of the acid eruptive rocks to the phenomenon of the solfataras; and by M. H. Morize, on the Widmanstätten figures, illustrated by two photographs obtained in direct and diffused light.

BERLIN.

Physical Society, December 28.—Prof. Kundt, President, in the chair.—Dr. Ritter demonstrated, with the help of an electric arc-lamp, the action of the ultra-violet rays on the electrical discharge at the negative pole.—Dr. Lummer spoke on photometers, and deduced, from the experiences gained with the existing instruments, the following as requirements in their construction: in the first place, the surfaces whose brightness of illumination is to be equalized must not be separated by even the narrowest intervening space; and in the second, the outline of the surfaces must be sharply defined. The first of the above requirements is satisfied in Bunsen's grease-spot photometer, but not the second. A further drawback arises from the fact that the grease-spot reflects light, and the paper allows some to pass through, so that both the spot and the surrounding surface are always illuminated by both sources of light. An ideally perfect photometer ought to reflect no light from its grease-spot, and be impermeable to light over the rest of its surface. The speaker, working in conjunction with Dr. Brodhun, had obtained the above desiderata by purely optical means. When two total-reflection prisms are placed with their hypotenuse surfaces in juxtaposition, and two of the surfaces of the glass-cube thus formed are illuminated by light from bright surfaces, then on looking through the combination of prisms the only light which reaches the eye will be that which enters laterally, whereas that which enters from the opposite side cannot reach the eye. When a drop of Canada-balsam, whose refractive index is very nearly the same as that of the glass, is placed between the opposed hypotenuse surfaces, total reflection is done away with at the place where the drop lies, and thus by illumination from *one* side only either a bright spot is seen on a dark ground or a dark spot on a bright ground. When the illumination is made from *both* sides, equality of illumination can be easily established by adjusting the relative distances of the sources of light until the spot disappears entirely. The drop of Canada-balsam very soon loses its sharply-defined edges, hence some other mode of procedure became necessary. The central portion of the hypotenuse surface of one of the total-reflection prisms was left untouched, while the rest of the surface was ground to a slightly spherical shape. When the surfaces of the prisms were now firmly pressed together, light passed without hindrance across the point of close contact of the surfaces, whereas it was totally reflected at all other points. By this means an ideally perfect "grease-spot" was obtained, which was permeable to light, but reflected none, while the surrounding area reflected light completely and allowed none to pass through. A third method for obtaining an ideally perfect grease-spot consisted in etching figures on one of the reflecting surfaces of the prisms; the etched portions were perfectly transparent, the rest of the surface reflected light completely. The speaker exhibited photometers constructed according to the above methods, and proved theoretically that the ideally perfect grease-spot bears to the real one the ratio of 1 to 2, according to the constants determined in the Imperial Physico-Technical Institute. The sensitiveness of the new photometer is about 1 per cent.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

Realistic Elementary Geography: W. G. Baker (Blackie).—Elementary Inorganic Chemistry: A. H. Sexton (Blackie).—Insect Life, vol. i. No. 6 (Washington).—Mineral Statistics of Victoria, 1887.—Report of the Secretary for Mines (Melbourne).—Les Levers Photographiques et la Photographie en Voyage: Dr. G. Le Bon (Paris, Gauthier-Villars).—Annuaire pour l'an 1889, par le Bureau des Longitudes (Paris, Gauthier-Villars).—A Text-book of Human Physiology, 4th ed.: Dr. A. Flint (Lewis).—Manuel Pratique de Cristallographie: G. Wyrouboff (Paris, Gauthier-Villars).—An Illustrated Manual of British Birds, Parts 8, 9, 10: H. Saunders (Gurney and Jackson).—Annali di Agricultura, 1888: Prof. Giglioli (Rome, Rotta).—The Assistant to the Board of Trade Examinations: Captain Forbes (Relfe).—State Museum of Natural History, Albany, N.Y., 41st Annual Report (Troy).—A Text-book of General Astronomy: Dr. C. A. Young (Ginn).—La Legge del Diretto in Rispetto alle varie leggi di Natura: Prof. G. A. Longo (Catania, Martinez).—New Commercial Plants and Drugs, No. 11: T. Christy (Christy).—A Bibliography of Indian Geology: R. D. Oldham (Calcutta).—Report of the Commissioners on Inland Fisheries and Game for Year ending December 31, 1888 (Boston).—Journal of the Royal Statistical Society, December (Stanford).—Archives Italiennes de Biologie, Tome xi. Fasc. 1 (Turin, Loescher).—Himmel und Erde, Heft 5 (Berlin, Paetel).—Beiblätter zu den Annalen der Physik und Chemie, 1888, No. 12 (Leipzig, Barth).

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