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THE CHEMISTRY OF PAINTS AND PAINTING.

The Chemistry of Paints and Painting. By A. H. Church, M.A., F.R.S. (London : Seeley and Co., 1890.)

CONSIDERING the widespread interest which attaches to all matters connected with pictures and painting, it is perhaps somewhat surprising that up to within quite recent times no attempt has been made to discuss and review in a comprehensive and efficient manner the materials and methods of painting from a strictly chemical point of view. It will, however, be readily conceded that the field is an extensive one, and it is, moreover, obvious that an intimate acquaintance with the technique of painting will be found only very rarely associated in the same individual with a thorough knowledge of chemistry. Neither a mere chemist nor a mere artist could undertake the task with a fair prospect of success.

The author of the present volume, on accepting, some years ago, the Professorship of Chemistry in the Royal Academy of Arts, found there a congenial sphere of activity, and an opportunity of devoting himself thenceforward to chemistry in its bearing on pigments and painting—a subject which long before had had a great attraction for him, as evinced by his early publication referring to these matters, and also by the fact that he has himself practised with no inconsiderable success the art of painting. It is thus that the information given in this work is derived on the one hand from an exact scientific study, whilst on the other hand it is based upon a knowledge of the technical details of the art. As it has been written especially with the view of explaining to the artist and the art student the more important chemical and physical characters of the materials they employ, and of the processes they manipulate, the author has exercised commendable discretion in not encumbering the text with chemical detail beyond the general scope of those for whom the book is intended.

> "In many instances a sketch of the processes for preparing certain pigments and varnishes is given, not in order to turn the painter into a colour-maker or a varnish manufacturer, but rather that he may acquire a clearer insight into the nature and properties of the most important constituents entering into the composition of his pictures."

The author very aptly begins his work by a discussion of the various painting grounds, and briefly describes the essential qualities of paper, vellum, ivory, fresco and stereochrome grounds, of slate and stone, of wood panel and canvas. This part is divided into four short chapters, which contain many valuable practical hints. He next proceeds to the description of the vehicles and varnishes, and this part comprises the oils, resins, waxes, paraffin waxes, yolk and white of egg, size, glue, gums, glycerine, honey, water-glass, lime and baryta-water, solvents and diluents, siccatives and dryers, varnishes and oleo-resinous vehicles.

Describing the several drying oils—namely, linseed oil, poppy oil, and walnut oil, he enters more fully into a discussion of the first-named as being the typical one, and also by far the most important. Here he gives an account of the proper mode of preparing and purifying the oil, and directs attention to the variation of the qualities of the oil of seed of different origin ; he also explains why preference should be given to the cold pressed oils. A very concise and instructive discussion of the chemical composition of linseed oil leads on to a consideration of the chemical change which the oil undergoes in the act of drying. This remarkable change, in which the chief value of these drying oils centres, is greatly accelerated by the presence of certain metallic oxides, such as those of lead, iron, or manganese. Later on, in a chapter devoted to siccatives and dryers, the author directs attention to the excessive and improper use of lead compounds, and very justly refers to the advantage of using instead of them the compounds of manganese, and especially the borate, in the preparation of the strongly drying oils. Such delusive dryers as borates of lime and zinc or sulphate of zinc, however, we think ought to have been mentioned only in order to condemn them.

The chapter on resins, waxes, and solid paraffin, contains a description of these substances and their properties in so far as they are of interest to the painter. In a similar manner the author treats the various other materials considered in this part, such as yolk and white of egg, size, gum, glycerine, water-glass, &c. ; and under the head of solvents and diluents we find a very useful and instructive account of the different kinds of oil of turpentine and the liquid hydrocarbons made use of in the artist's studio. Amongst them, oil of turpentine stands foremost in importance. It is to the painter in oil colours what water is to the painter in water colours ; and in order to fulfil its function in the most perfect manner, it is essential that it should be pure, and should completely volatilize without leaving any phlegma in the substance of the paint. Oil of turpentine is very prone to become changed and acted upon by the atmospheric oxygen, especially in the presence of moisture and under the influence of light. As the author points out, different kinds of oil of turpentine vary very materially in this respect, and the artist has to be on his guard to select the best kinds for his use. The employment of deteriorated or inferior oil of turpentine may give rise to very serious defects which are often ascribed to other causes. Other hydrocarbons, now available for the artist, are petroleum spirit and the benzenes, which comprise liquids of very varied degrees of volatility, and which do not share the objectionable propensity of oil of turpentine just alluded to. Here we would, however, remark that the petroleum hydrocarbons are much less efficient solvents than oil of turpentine, as they do not entirely dissolve even mastic or dammar ; whilst, on the other hand, the benzenes are much superior in this respect, and especially the higher members of this series deserve the attention of the artist and varnish maker.

The last chapter in Part II. discusses varnishes and vehicles, their composition and preparation. Treating of mastic varnish—which is merely a solution of mastic in some volatile solvent, generally oil of turpentine—the author assigns to this substance its proper function, which is that of a surface varnish only. On no account ought it ever to find its way into the body of the painting itself, as is unfortunately the case whenever megilp is used as the painting medium, this being in reality a mixture of mastic varnish with linseed oil. On the other hand, it is important that mastic varnish, when used as the surfacing varnish, should be applied without any admixture of oil varnishes, which, from their rendering the mastic harder, more insoluble, and less friable, make it much more difficult to remove and renew the varnish.

Of a different character and of far greater importance are the fat or oil varnishes, which are compounds of the harder resins, such as amber and the different kinds of copals, with linseed oil, and diluted with oil of turpentine. They form in reality the vehicle or medium for modern oil painting, and consequently furnish ultimately the matrix in which the particles of the colour are embedded and held together. Next to the stability of the colours, it is then the durability of this varnish medium in combination with dry linseed oil, on which the permanency of the oil-painting mainly depends. On the assumption that the valuable qualities of the hard resins are maintained in the varnishes derived from them, it is understood that artists' varnishes are prepared only from the hardest and most tenacious kinds of resins. Unfortunately these are the most unmanageable and the least soluble, and require the highest degree of heat to bring them into fusion for the purpose of effecting the combination with the linseed oil and oil of turpentine in the process of making varnish. Even the most powerful solvents, such as acetone, ether, benzene, chloroform, aniline, and phenol, have only a limited solvent action upon amber or the harder semi-fossil kinds of copal; and their solution can only be effected after they have undergone a profound change by fusion or otherwise. In opposition to what is generally stated, neither amber nor the semi-fossil hard copals are fusible in the ordinary sense of the word; for they require to be kept at a high temperature, in suitable vessels, for a considerable time before they become gradually liquefied by the action of the heavy oily products of their own decomposition. Amber or copal, when thus once melted, are completely changed; they are now fusible at a low temperature; they have become readily soluble in ordinary solvents, and miscible with heated linseed oil; but at the same time the original hardness of the resins is greatly reduced, and the colour has become of a more or less dark tint.

It remains to be proved whether much is gained by using the very hardest resins, instead of softer and more tractable kinds which yield lighter-coloured varnishes; and this is a subject which, in the reviewer's opinion, deserves investigation. Varnish-making is still a secret trade; and the nature of varnishes, more than any other artists' materials, is involved in much obscurity. There are no chemical methods known for ascertaining the nature or proportion of the ingredients used in their preparation, and as time is the most important factor in proving the quality of varnishes, direct practical experimental tests may be misleading.

A new process for making varnish, said to be in use on the Continent, consists in heating the resins with the solvents in autoclaves under high pressure; and there are also processes recommended which seem especially adapted for those who wish to make their own varnishes on a small scale. These latter depend on the peculiar change which the hard copals undergo when exposed for some time, in a state of very fine powder, to the action of hot air, whereby the resin is rendered more soluble without becoming much discoloured. The author describes such a process, in which the finely-powdered resin, after having been exposed for some time to the action of air at a temperature of 220° C., is first dissolved in chloroform, then mixed with oil of turpentine, and after the chloroform has been distilled off, the resulting solution is gradually incorporated with the drying linseed oil. Although 220° C. is repeatedly mentioned as the temperature to which the powdered resins have to be exposed, we venture to suggest that this must be a mistake. Neither amber nor the copals will endure this temperature for any time without melting and becoming of a dark brown colour, or otherwise decomposed.

On the other hand, the writer of this notice has found that the various kinds of copal, which, by exposure in a finely-powdered condition for some weeks to the action of hot air in a steam closet, have become readily soluble in chloroform or acetone, are nevertheless almost entirely precipitated again on adding oil of turpentine or benzene to such a solution, and no amount of digestion, either with or without linseed oil, will redissolve them. Amber thus treated behaves in a similar manner, but the amount rendered soluble in chloroform or acetone is much smaller. It would, then, appear that this matter requires some further elucidation before this new process can be made readily available.

It has already been mentioned that there are no special tests for ascertaining the quality of a varnish. Spreading a thin layer on a sheet of glass, and then observing the character of the film produced on drying, seems all that can be done. It ought to become dry to the touch within eight or ten hours, and not become fissured even when exposed to sunshine during a year; nor should the surface become dull through the appearance of "bloom," caused by the minute exudation of solid fatty acids originating from the linseed oil employed in its preparation.

As the drying of the solution of resins in a volatile solvent depends solely on the volatilization of the solvent, this process is accompanied by a shrinkage of the body of the varnish, which sets up a tendency to breaking up of the surface. Linseed oil, on the other hand, becomes dry or solid in consequence of combining with a large quantity of oxygen, and this is attended by an increase in bulk. It follows that as long as a sufficient proportion of oil is in combination with the resin the tendency to crack is compensated; but if the artist, from habit or other reasons, uses with his colours a medium deficient in oil, he encounters the risk of the body of his paintings becoming fissured in the course of time, and readily subject to the destructive action of the atmosphere.

Part III. treats of pigments, and, as we might expect, this division forms a large and most important part of the work. All the colours which are made use of in painting are here described in detail, and nothing seems to be omitted which may serve to instruct or guide the artist and student. The historical reference with which the description of each of the colours is introduced is followed by a discussion of its chemical composition, and an outline is given of the most approved methods of preparation. Wherever desirable the chemical test is described by which the purity of the colour may be recognized and any adulteration detected; but what will be esteemed as most valuable are the observations and suggestions which bear immediately upon the physical and chemical properties concerned in their special applications. Here the author gives us, in most cases, the results of his own experiments, and especially when he deals with the question of the permanency of the colours. The changes which the colours are liable to, whether under the influence of light, or when mixed with other colours, or under the conditions in which they exist in a painting, are likewise fully gone into and considered. Beginning with the white pigments, the author discusses the flake-white or white lead which occupies a foremost place on the artist's palette on account of its superior whiteness, its excellent working qualities, and the power it possesses of imparting its own strongly siccative character to slow-drying oil colours. He also draws special attention to a valuable property of white lead which has scarcely been clearly recognized, and which depends upon the formation of a kind of lead-soap in the oil colours it is mixed with. This lead-soap imparts a degree of toughness and elasticity to the body of the painting, and thus prevents it from cracking when become dry with age. On the other hand, white lead, like all lead compounds, even when locked up in the medium of the paint, is liable to become brown and dark-coloured when exposed to the action of even minute traces of sulphuretted hydrogen, and this darkening is much favoured by moisture and the absence of light. According to the author, an admixture of baryta white (barium sulphate), in the proportion of one to two, very much lessens this deleterious effect. Zinc white, although free from the last-named defects of white lead, and of great value in water-colour, tempera, and fresco painting, has, nevertheless, only to a limited degree become a substitute for white lead in oil painting on account of its being a bad dryer, its possessing a lesser degree of opacity, and its tendency to crack and scale.

In the chapter on yellow pigments, the author's remarks on the peculiarities of the different shades of cadmium yellow deserve especial notice. We may here add, in passing, that any free sulphur in the raw cadmium yellow may be readily removed by carefully heating it in an open vessel. Aureolin, or cobalt yellow, is very favourably spoken of by the author, and so is baryta yellow and Indian yellow, but these have to be applied with caution when used along with certain other pigments to which he refers.

Very instructive are his observations on Naples yellow, an old favourite of the artist's; also those on yellow lake or brown pink, which, as he remarks, ought to be rigorously excluded from the artist's palette. The chrome yellows are dismissed with a very short notice, for, beautiful as they are, they are quite unfitted for use in tempera or water-colour painting, and although showing some degree of permanency when locked up in a resinous vehicle and protected by varnish, they are peculiarly liable to change when mixed with pigments of organic origin.

Passing on to the red pigments, we find a very full description of vermilion, a colour of great importance, but unfortunately of a very capricious behaviour in respect of permanency. It is a remarkable fact that vermilion prepared from the native mineral cinnabar is found perfectly preserved in old Italian tempera paintings, and even in wall-paintings of Pompeii; whilst the artificial vermilion now generally in use, whether prepared by the dry or by the moist way, and although of finer tint and chemically pure, is very liable to change. All we know at present on this subject is that this is due not to a chemical alteration, but merely to a physical or molecular change of the red crystalline into the black modification of sulphide of mercury, and that this transformation is especially favoured by strong sunlight. Different samples of artificial vermilion, however, frequently exhibit a different degree of liability to change, and as the more finely ground orange vermilions are generally found to be the less stable, it has been inferred that the fine state of division favours the change. In reference to this we may, however, mention that if such pale vermilion is heated for some hours at a temperature approaching volatilization, it gradually assumes a darker red colour, and becomes crystalline like the sublimed cinnabar; and yet by this treatment its liability to turn black in sunlight is not lessened, but on the contrary much increased. It is evident that a great deal has still to be learned about this pigment.

The pigments derived from madder possess particular interest, and are remarkable for their stability as well as for their early introduction in the arts. The author states that such colours were known in Europe as early as the thirteenth century; but red madder pigments have been found in some quantity at Pompeii, and more recently also amongst ancient colour materials in Egypt.

Alizarin and its allied colouring principles, which are the essential colour-giving constituents originally derived from madder-root, are now manufactured artificially from anthracene, and most of the madder colours are at present obtained from this source. Nevertheless, it is a noteworthy fact that the choicer kinds of the madder pigments used by artists are still prepared from madder-root, although artificial alizarin, purpurin, and anthrapurpurin in a chemically pure state are accessible to the colour-maker at a cheaper rate. It is not clear whether it is merely habit of the colour-maker, and a difficulty of adapting the use of the pure colouring-matters to the old methods, or whether it is the presence of some still unrecognized constituent of madder-root, which causes the root to be preferred in the production of fine artists' colours. It is, perhaps, of interest to mention here that a difference in the behaviour of the artificial colouring-matter is also observed in the difficulty of applying it on wool or woollen cloth so thoroughly fast as to stand the operation of fulling. On this account the red cloth of the French army is still dyed with madder, and probably this is the true reason why the cultivation of this plant is still to some extent continued.

The study of the chemistry of the Turkey-red dyeing has fully established the important part which the presence of fatty matter, in some peculiar condition, plays in this remarkable process. That this also holds good with pigments can be shown by trying to produce these colours from artificial alizarins without using such fatty substances; and this may in some way account for the author's failure to obtain the best possible result from pure alizarin, although prepared from madder-root.

Although madder colours are deservedly esteemed for their stability, the author has proved, by a series of experiments with different samples of commercial moist and cake colours, that they are by no means all alike in this respect. Considering their great importance for the artist, as being unique in their special qualities of tint and permanency, it appears highly desirable that a thorough investigation should settle the question as to the composition of the most stable of them, and thus furnish a guide to the preparation of entirely trustworthy colours. A formula quoted by the author on p. 154 for the preparation of madder carmine seems incomplete, as no mention is made of any alum or alumina, which is an essential constituent of this pigment.

Passing on, we take notice of a short account of lac dye and cochineal lakes, which, along with the ancient kermes, are furnished by three different species of coccus. Of these only the cochineal carmine is of interest; but, rich and beautiful as is this colour, the author very justly warns the artist against its use on account of its want of stability. We may take this opportunity of observing that pure carmine, notwithstanding its ready solubility in ammonia, is a true lake, and, in fact, is a definite compound of one of the carminic acids with lime and alumina.

In the chapter on blue pigments, the article on indigo deserves special attention; and many will be disappointed to find that this highly esteemed colouring-matter, generally supposed to be one of the most permanent, does certainly not deserve this character when used in painting. To this pigment is largely due the faded condition of the works of artists who have used it extensively. This proneness to fade is especially noticeable in water-colour paintings where the sulphindigotates have been employed.

Considering the lamentable deterioration of some of the works of artists who have used asphaltum too freely, it is satisfactory to learn that this substance may be safely employed if prepared as directed by the author. In this connection mention is also made of a brown water-colour said to be an ammoniacal extract of asphaltum; but we venture to say that this must be some trade mystification, for genuine asphaltum does not yield its colour to ammonia, or indeed to any other alkaline solvent.

After the detailed description of the pigments, a chemical classification of them is given, which in the main is an arrangement based upon their chemical composition, and which more prominently exhibits the characteristic chemical and physical difference of deportment of the various groups in which the pigments may be classified.

In chapter xxi. tables are given in which the pigments are ranged according to their stability into three classes, and it may be seen at a glance what degree of permanency is ascribed to any of them.

Chapter xxii. is full of most important considerations and useful suggestions with regard to selected and constructed palettes; and after discussing the lists of pigments used by some well-known artists, the author gives his selected palettes for oil and water colours.

In chapter xxiii. the chemistry of the various methods of painting in tempera, fresco, stereochromy, oil and water colour, and pastel, are discussed and explained; and under oil painting the complicated changes which the vehicles and their constituents undergo during the process of painting are recapitulated.

Chapter xxiv. contains a study of old paintings and drawings, with the special object of giving a brief account of the materials used in the production of these early works, and comments on the lessons to be drawn from individual pictures.

Chapter xxv. is devoted to a discussion of the best means for conservation of pictures and drawings, with some useful hints on restoration; and in the concluding chapter xxvi. we have an account of trials of pigments as to their permanency, carried out by the author and other investigators. This is a subject which in recent times has received a good deal of attention, and although the investigations dealing with this matter are by no means concluded, very important results have already been obtained.

This is especially the case with regard to water-colour paints, which, on account of their thinness of application and absence of a protecting medium, are much more susceptible to fading, and therefore give greater facility for examination than the oil colours. It is now well understood that the action of light in conjunction with moisture and air is the principal cause of the fading of the colours; and were it practicable to keep water-colour drawings absolutely dry inclosed between glass plates, front and back, their preservation would be much prolonged. With oil paintings the conditions are different, and in some respects more favourable, especially when the painting has once reached its proper stage of maturity—that is to say, when the volatile vehicles have entirely passed away, and the linseed oil has completed its course of drying and oxidation. Whilst the process of drying is still going on in the early years of the existence of an oil painting, some amount of moisture is produced within the body of the painting as a direct product of the oxidation of the linseed oil, and consequently a picture too freely exposed to sunlight in this stage will be much more liable to suffer and to change than later on, when the resinous and oleaginous vehicles in which the particles of colour are locked up have become firm and quiescent. To fully appreciate this we must bear in mind that even the varnish and resinous vehicles do not so completely exclude air and moisture from without as is commonly supposed.

There is still much to be learned with regard to the chemical processes involved in the so-called drying of linseed oil, and this subject deserves a thorough re-investigation in the light and with the means of modern chemical research. It is, for instance, a well-known fact that linseed oil under certain conditions becomes itself a most powerful oxidizer, so much so that canvas or paper soaked with it will become destroyed in the course of time, and it seems that this effect is especially marked when oil of turpentine has been used along with it. It is quite conceivable that this activity of linseed oil may be one of the agents at work in the deterioration of oil paintings; but whatever dangers may arise from this, the use of linseed oil cannot be dispensed with. It is otherwise with oil of turpentine, for which a very much superior substitute might be found in the higher members of the benzene series, which could now be obtained at a sufficiently moderate cost if a demand for them should arise. These hydrocarbons, whilst indifferent to the action of atmospheric oxygen, possess greater solvent power than any other, and on this account they are also well adapted for the preparation of varnishes. But for this latter purpose a still more suitable vehicle will be found in the amylic acetate, which dissolves even the hardest copals almost entirely after having been previously finely powdered and kept for some time in a hot closet. In this way excellent varnishes may be produced.

In reviewing a work dealing with so vast a number of subjects, it is obviously impracticable to do more than to refer to some few of them ; but we think sufficient has been said in the foregoing notice to show the valuable character of the work before us, and although it will be freely admitted that there are still a good many points which demand further inquiry and elucidation, those who are interested in the subject may be congratulated on now possessing in an accessible form all that chemistry has for the present to say on paints and painting.

HUGO MÜLLER.

POINCARÉ'S THERMODYNAMICS.

Thermodynamique. Leçons professées . . . par H. Poincaré, Membre de l'Institut. Pp. xix., 432. (Paris : Georges Carré, 1892.)

THE great expectations with which, on account of the well-won fame of its Author, we took up this book have unfortunately not been realized. The main reason is not far to seek, and requires no lengthened exposition. Its nature will be obvious from the following examples.

The late Prof. W. H. Miller, as able a mathematician as he was a trustworthy experimenter, regularly commenced his course of Crystallography at Cambridge (after seizing the chalk and drawing a diagram on the black board) with the words :—"Gentlemen, let O*x*, O*y*, O*z* be the coördinate axes." And, some forty years ago, in a certain mathematical circle at Cambridge, men were wont to deplore the necessity of introducing words *at all* in a physico-mathematical text-book :—the unattainable, though closely approachable, Ideal being regarded as a work devoid of aught but formulæ !

But one learns something in forty years, and accordingly the surviving members of that circle now take a very different view of the matter. They have been taught, alike by experience and by example, to regard mathematics, so far at least as physical inquiries are concerned, as a mere auxiliary to thought :—of a vastly higher order of difficulty, no doubt, than ordinary numerical calculations, but still to be regarded as of essentially the same kind. This is one of the great truths which were enforced by Faraday's splendid career.

And the consequence, in this country at least, has been that we find in the majority of the higher class of physical text-books few except the absolutely indispensable formulæ. Take, for instance, that profound yet homely and unpretentious work, Clerk-Maxwell's *Theory of Heat*. Even his great work, *Electricity*, though it seems to bristle with formulæ, contains but few which are altogether unnecessary. Compare it, in this respect, with the best of more recent works on the same advanced portions of the subject.

In M. Poincaré's work, however, all this is changed. Over and over again, in the frankest manner (see, for instance, pp. xvi, 176), he confesses that he lays himself open to the charge of introducing unnecessary mathematics :—and there are many other places where, probably thinking such a confession would be too palpably superfluous, he does not feel constrained to make it. This feature of his work, at least, is sure to render it acceptable to one limited but imposing body, the *Examiners for the Mathematical Tripos* (*Part II.*).

M. Poincaré not only ranks very high indeed among pure mathematicians but has done much excellent and singularly original work in applied mathematics :—all the more therefore should he be warned to bear in mind the words of Shakespeare

> "Oh ! it is excellent
> "To have a giant's strength ; but it is tyrannous
> "To use it like a giant."

From the physical point of view, however, there is much more than this to be said. For mathematical analysis, like arithmetic, should never be appealed to in a physical inquiry till unaided thought has done its utmost. Then, and not till then, is the investigator in a position rightly to embody his difficulty in the language of symbols, with a clear understanding of what is demanded from their potent assistance. The violation of this rule is very frequent in M. Poincaré's work, and is one main cause of its quite unnecessary bulk. Solutions of important problems, which are avowedly imperfect because based on untenable hypotheses (see, for instance, §§ 284–286), are not useful to a student, even as a warning :—they are much more likely to create confusion, especially when a complete solution, based upon full experimental data and careful thought, can be immediately afterwards placed before him. If something is really desired, in addition to the complete solution of any problem, the proper course is to prefix to the complete treatment one or more exact solutions of simple cases. This course is almost certain to be useful to the student. The whole of M. Poincaré's work savours of the consciousness of mathematical power :—and exhibits a lavish, almost a reckless, use of it. Todhunter's favourite phrase, when one of his pupils happened to use processes more formidable than the subject required, was "'Hm :—breaking a fly on the wheel !" He would have had frequent occasion to use it during a perusal of this volume. An excellent instance of the dangerous results of this lavish display of mathematical skill occurs at pp. 137–38, the greater part of which (*as printed*) consists of a mass of error of which no one, certainly, would accuse M Poincaré. The cause must therefore be traced to the unnecessary display of dexterity with which, after obtaining the equation

$$Q_2/Q_1 = 1 - Af(T_1, T_2),$$

where the *order* of the suffixes is evidently of paramount importance, M. Poincaré proceeded to say "Nous pouvons donc écrire

$$Q_1/Q_2 = \phi(T_1, T_2)."$$

But his unfortunate printer, not prepared for such a *tour de force*, very naturally repeated the Q_2/Q_1 of the first equation, with the result of wholly falsifying all that follows. On the other hand, we must fully recognize that, when more formidable analysis is really required (as, for instance, in the treatment of v. Helmholtz's monocyclic and polycyclic systems), M. Poincaré seems to feel so thoroughly at home as to criticize with freedom.

One test of the soundness of an author, writing on Thermodynamics, is his treatment of temperature, and his introduction of absolute temperature. M. Poincaré gets over this part of his work very expeditiously. In §§ 15–17 temperature, *t*, is conventionally defined as in the Centigrade thermometer by means of the volume of a given quantity of mercury; or by any continuous function of that volume which increases along with it. Next (§ 22) absolute temperature, T, is defined, provisionally and with a caution, as $273 + t$; from the (so-called) laws of Mariotte and Gay-Lussac. Then, finally (§ 118), absolute temperature is virtually defined afresh as the reciprocal of Carnot's function. [We say *virtually*, as we use the term in the sense defined by Thomson. M. Poincaré's *Fonction de Carnot* is a different thing.] But there seems to be no hint given as to the results of experiments made expressly to compare these two definitions. Nothing, for instance, in this connection at all events, is said about the long-continued early experimental work of Joule and Thomson, which justified them in basing the measurement of absolute temperature on Carnot's function.

In saying this, however, we must most explicitly disclaim any intention of charging M. Poincaré with even a trace of that sometimes merely invidious, sometimes purely Chauvinistic, spirit which has done so much to embitter discussions of the history of the subject. On the contrary, we consider that he gives far too little prominence to the really extraordinary merits of his own countryman Sadi Carnot. He writes not as a partisan but rather as one to whom the history of the subject is a matter of all but complete indifference. So far, in fact, does he carry this that the name of Mayer, which frequently occurs, seems to be spelled incorrectly on by far the greater number of these occasions! He makes, however, one very striking historical statement (§ 95):—

"Clausius . . . lui donna le nom de *Principe de Carnot*, "bien qu'il l'eût énoncé sans avoir connaissance des "travaux de Sadi Carnot."

Still, one naturally expects to find, in a Treatise such as this, some little allusion at least to Thermodynamic Motivity; to its waste, the Dissipation of Energy; and to the rest of those important early results of Sir W. Thomson, which have had such immense influence on the development of the subject. We look in vain for any mention of Rankine or of his Thermodynamic Function; though we have enough, and to spare, of it under its later *alias* of Entropy. The word dissipation does indeed occur, for we are told in the Introduction that the *Principe de Carnot* is "*la dissipation de l'entropie*."

We find Bunsen and Mousson cited, with regard to the effect of pressure upon melting points, almost before a word is said of James Thomson; and, when that word does come, it wholly fails to exhibit the real nature or value of the great advance he made.

Andrews again, *à propos* of the critical point, and his splendid work on the isothermals of carbonic acid, comes in for the barest mention only *after* a long discussion of those very curves, and of the equations suggested for them by Van der Waals, Clausius, and Sarrau:—though his work was the acknowledged origin of their attempts.

The reason for all this is, as before hinted, that M. Poincaré has, in this work, chosen to play almost exclusively the part of the pure technical analyst; instead of that of the profound thinker, though he is perfectly competent to do that also when he pleases. And, in his assumed capacity, he quite naturally looks with indifference, if not with absolute contempt, on the work of the lowly experimenter. Yet, in strange contradiction to this, and still more in contradiction to his ascription of the Conservation of Energy to Mayer, he says of that principle:— "personne n'ignore que c'est un fait expérimental."

Even the elaborate thermo-electric experiments of Sir W. Thomson, Magnus, &c., are altogether ignored. What else can we gather from passages like the following?

(§ 287) "Sir W. Thomson admet qu'il existe une "force electromotrice au contact de deux portions d'un "même conducteur à des températures différentes; il "assimile donc ces deux portions à deux conducteurs "de nature différente, assimilation qui parait très vrai-"semblable."

(§ 291) ". . . si l'effet Thomson a pu être mis en "évidence par l'expérience, on n'a pu jusqu'ici constater "l'existence des forces electromotrices qui lui donnent "naissance."

Everyone who comes to this work of M. Poincaré fresh from the study of Clerk-Maxwell's little treatise (or of the early papers of Thomson, to which it owed much) will feel as if transferred to a totally new world. Let him look, for instance, at Maxwell's treatment of the Thermodynamic Relations, Intrinsic and Available Energy, &c., and then turn to pp. 148–150 of M. Poincaré's work. There he will find at least a large portion of these most important matters embodied in what it seems we are now to call the *Fonctions caractéristiques de M. Massieu!*

But the most unsatisfactory part of the whole work is, it seems to us, the entire ignoration of the true (*i.e.* the statistical) basis of the second Law of Thermodynamics. According to Clerk-Maxwell (NATURE, xvii. 278)

"The touch-stone of a treatise on Thermodynamics is "what is called the second law."

We need not quote the very clear statement which follows this, as it is probably accessible to all our readers. It certainly has not much resemblance to what will be found on the point in M. Poincaré's work:—so little, indeed, that if we were to judge by these two writings alone it would appear that, with the exception of the portion treated in the recent investigations of v. Helmholtz, the science had been retrograding, certainly not advancing, for the last twenty years. P. G. T.

INSECT PESTS.

Hand-book of the Destructive Insects of Victoria. By C. French, F.L.S., Government Entomologist. Part I. Prepared by Order of the Victorian Department of Agriculture. (Melbourne, 1891.)

THE appearance of this volume affords another proof, if any were required, of the wholesome activity, now noticeable in all progressive countries, directed towards the suppression of the insect pests of cultivated plants. One effect of this welcome energy has been a process of differentiation, whereby the attacks of insects upon crops, instead of being included in the comprehensive but somewhat incomprehensible term of "blight," have been separated one from another, more or less clearly defined, and, to a very useful extent, associated respectively with the ravages of certain specific insects. It is now possible for those to whom the subject is new to obtain a much clearer idea of the scope of agricultural entomology than was the case even as recently as five or six years ago. "The time has arrived," observes the author, "when, if we are to fight insect pests successfully, united action must be taken, and knowledge gained by constant vigilance, and by useful and carefully conducted experiments. Only thus can a better knowledge be obtained of the relations of insects to agriculture, viticulture, and horticulture."

About one-fifth of this volume of 150 pages is devoted to an introduction to entomology, a classification of insects, directions for collecting and preserving specimens of economic interest, the preservation of insect-destroying birds, and certain horticultural quarantine rules. The main part of the book is occupied with a discussion of fourteen of the most troublesome insect pests of apples, pears, apricots, and cherries in the colony of Victoria. These are illustrated by means of coloured plates, the excellence of which demands a word of approbation. The ever-growing facilities for international transport are, no doubt, partly responsible for the extent to which the insect pests of this country are identical with those of the Antipodes. In this connection it is worthy of note that at least five of the pests which are illustrated have acquired as unenviable a reputation in Britain as in Victoria. These are the woolly Aphis (or American blight), the codlin moth, the apple-bark scale, the red spider (an Arachnid), and the pear and cherry slug, which is the slimy, repulsive-looking, leaf-eating larva of one of the saw-flies. Of the fourteen pests enumerated, the Lepidoptera claim four, Coleoptera three, Homoptera two, Heteroptera two, Arachnoidea two, and Hymenoptera one.

The volume concludes with an instructive chapter upon insecticides and the means for applying them. Amongst the more noteworthy of the former are carbon bisulphide, Gishurst compound, hellebore powder, kerosene (petroleum), gas lime, London purple, Paris green, sulphur, and tobacco. A caution is given as to the use of certain so-called insecticides, such as ammonia and carbolic acid. Insecticides they undoubtedly are, but inasmuch as they injure the plant as well as kill its pests, they had better be left alone. Various kinds of apparatus for applying insecticides are described, and illustrated by means of twenty wood-cuts. The most efficient and one of the newest of these, the air-power distributor called the Strawsonizer—after its inventor, Mr. G. F. Strawson, an Englishman,—is adequately described and figured. Several useful nozzles and pumps are likewise noticed.

Mr. French has produced a volume of much practical value, and it may be hoped that he will maintain the same high standard in the subsequent parts. One appeal, however, may be made to the author—and not only to him but to all writers upon this subject,—and that is to append the name of the authority to the systematic name of each insect. Agricultural entomology is necessarily a subject of international interest, and much confusion arises—especially in connection with American writings—through an omission which might easily be remedied. The difficulties of synonymy are great enough, without gratuitously adding to them.

OUR BOOK SHELF.

Farm Crops. By John Wrightson, M.R.A.C., F.C.S. (London: Cassell and Company, Limited, 1891.)

THE author introduces this volume of upwards of 200 pages as "an honest attempt to place the large subject of crop cultivation before the minds of children"; and this is, reasonably enough, his plea for its being "penned in the plainest possible language." The work belongs to "Cassell's Agricultural Readers," and the several chapters deal with rotations of crops, the fallow, root crops, corn crops, grass crops, grasses, clovers and pasture plants, and the making and management of pastures.

Whether agriculture is a subject that can be at all satisfactorily treated, in a book of the type which a "reader" necessarily suggests, is a question that need not be discussed here. But it is abundantly evident that the problem has not been solved in the volume under notice. It is sprinkled with footnotes and tables, the latter being of as complicated a character as any which are usually found in agricultural treatises. Then, again, there are long quantitative lists of grass seeds recommended for use in laying land down to pasture, and these, it is to be feared, will be found both wearisome and unintelligible to the small boy who has to wade through them in the course of a "reading lesson." Indeed, the book is curiously unequal throughout, and it is apparent that the author would probably have done better had he not had to continually remind himself that he was writing a "reader" for children.

It is particularly desirable that, in a strictly elementary book, everything should be correct; but this is hardly the case with some of the illustrations. In Fig. 2, for example, the fruit of the cabbage is represented as dehiscing from above downwards, though this is not the behaviour of a siliqua in nature. On the other hand, the figures of grasses are exceedingly good.

The text is not free from errors. On p. 67 is described what will happen "if turnips braid (*sic*) too thickly." The use of systematic names will rather hinder the juvenile student than otherwise, unless special care is taken to render them correctly, which is not always the case. Occasionally, the fanciful element is in evidence, as when it is stated (p. 207): "Mowing is as old as Time itself; for has not Time been represented as carrying a scythe over his shoulder?"

"In future editions," it is said in the preface, "this little book may, no doubt, be further extended." It is questionable, however, whether the author would not more successfully meet the requirements of a "reader," of the kind which appears to be contemplated, by eliminating all such matters as do not fall easily into the course of a reading lesson. At present, it would seem as if the object had been to produce a "text-book" rather than a "reader."

Arithmetic for Schools. By Charles Smith. "Pitt Press Mathematical Series." (Cambridge: University Press, 1891.)

MR. CHARLES SMITH is such a well-known writer of mathematical works that we expected to find the present volume very commendable. In this we are not disappointed. The explanations of the fundamental principles and processes are treated with a clearness, conciseness, and completeness that make the book a delight to read, and although, as he says, "my aim has not been to introduce novelties," yet he has succeeded, in so far as we are able to predict, in placing before students a book not only of practical utility, but also of great educational value.

Stocks and shares, and such like transactions, have all been treated more in accordance with the methods of the present day than is usual in such treatises. There has also been inserted a chapter on foreign exchanges for the benefit of those preparing for examinations in commercial arithmetic. The examples are of a varied and useful nature, and are numerous and well chosen: each new principle or process is accompanied with one or two sets of them, while interpolated throughout are many to be worked out by those who wish to revise their back work as they proceed in the subject. Miscellaneous exercises to the number of 500, together with sets of examination papers, form also a useful addendum. W.

Journeys in Persia and Kurdistan. By Mrs. Bishop (Isabella L. Bird). Two Vols. With Portrait, Map, and Illustrations. (London: John Murray, 1891.)

THIS work consists of letters written in the course of the second half of journeys in the East which extended over a period of two years. The author had intended, in the event of their being published, to correct them by reference to notes made with much care. Of these notes she was robbed, and she refers to the loss as her "apology to the reader for errors which, without this misfortune, would not have occurred." Perhaps, however, the book is all the better for being presented essentially in the form in which it was originally written. The record of the writer's impressions has thus a directness, simplicity, and freshness of which it might to some extent have been deprived by elaborate revision. Mrs. Bishop does not profess to have written a book on Persia and Eastern Asia Minor. She has merely set down what she herself saw during her travels in those countries. But she has done this so well that ordinary readers are not likely to resent the slightness of her references to the administration of government, the religious and legal systems, the tenure of land, and the mode of taxation. The illustrations are very good, and add considerably to the interest of the narrative.

A First Book of Electricity and Magnetism. By W. Perren Maycock, M.Inst.E.E. (London: Whittaker and Co., 1891.)

THE scope of this work is limited to the syllabus of the elementary stage of the Science and Art Department. It is intended as an easy introduction to many of the text-books now in use, which, although termed elementary, are of rather too advanced a nature for some students to commence with; the author considering that they might be led to "take a greater interest in their work" by the help of such a book as he has put before us.

Throughout the three parts, which deal severally with magnetism, electro-kinetics, and electro-statics, the explanations are of a plain and simple nature, while the illustrations bring out clearly the various points which they are intended to exhibit. The information is based on the latest ideas; and interpolated in the text are many questions, the answers to which the student should write out before proceeding beyond them.

The book will be found really very useful for beginners, and will be to them a good introduction to higher works.

A Cyclopædia of Nature Teachings. With an Introduction, by Hugh Macmillan, LL.D., F.R.S.E. (London: Elliot Stock, 1892.)

THE compiler of this volume has brought together a large number of extracts from various authors, setting forth what profess to be "facts, observations, suggestions, illustrations, examples, and illustrative hints taken from all departments of inanimate nature." Here is the information offered to us about "the sun-controlled stars":—

"When stars, first created, start forth upon their vast circuits, not knowing their way, if they were conscious and sentient, they might feel hopeless of maintaining their revolutions and orbits, and might despair in the face of coming ages. But, without hands or arms, the sun holds them. Without cords or bands, the solar king drives them unharnessed on their mighty rounds without a single misstep, and will bring them in the end to their bound, without a single wanderer."

This sorry stuff is a fair specimen of a good many of the "Nature Teachings" presented in the "Cyclopædia." A more suitable title for the compilation would have been "Scientific Gush." The compiler does not always even give accurate titles to his extracts. A passage from one of Mr. Ruskin's writings has the strange heading, "The Star Mercury."

LETTERS TO THE EDITOR.

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

On the Attitudes of the Zebra during Sleep, and their Influence on the Protective Value of its Stripes.

NOWADAYS, when the colours of animals and their uses for the purposes of recognition and protection are forcing themselves upon the attention of all naturalists, it is not wonderful that an animal so conspicuously marked as the zebra should have commanded a large share of notice.

Much as it has been considered, however, I do not think we have yet learned all the lessons that it has to teach us.

That its bold and vivid stripes should be of immense service for recognition may be accepted as beyond dispute.

The statement of Mr. Francis Galton, that on a clear moonlit night these vivid stripes melt into invisibility, and to an eye not absolutely focussed to the animal itself, but to objects in its immediate vicinity, it is quite unseen, even when so near that its breathing can be heard distinctly, proves most indubitably their immense protective value. As he says, "If the black stripes were more numerous, it would be seen as a black mass; if white, then as a white one; but their protection is such as exactly to match the pale tint which arid ground possesses in the moonlight."

Primâ facie, this is hardly what one would have expected, but when pointed out by a competent and trustworthy observer, even a slight knowledge of the laws of light proves it to be true.

Let anyone notice at what a short distance a lady in a *galatæa* dress with broad stripes becomes invisible in the moonlight, and he will be at once convinced of the truth of Galton's remark.

Prof. Henry Drummond further says:—"When we look at the coat of a zebra, with its thunder-and-lightning pattern of black and white stripes, we should think such a conspicuous object designed to court, rather than elude, attention. But the effect in nature is just the opposite. The black and white somehow take away the sense of a solid body altogether, and the two colours seem to blend into the most inconspicuous grey, and at close quarters the effect is as of bars of light seen through the branches of shrubs. I have found myself in a forest gazing at what I supposed to be a solitary zebra, its presence betrayed by some motion due to my approach, and suddenly realized that I was surrounded by an entire herd, which was all invisible until they moved." By this I understand Prof. Drummond to refer to his observations *in the day-time*, as Mr. Galton speaks only of the moonlight.

One can readily see how the shadows of the branches in a tropical forest falling upon the zebras would so intermingle with the stripes of the animals as to add enormously to the difficulty of recognition by human eyes, and also, in the dim light of the forest (broken up as it is into bars of light and shade), by the eyes of their fierce and hungry foes as well.

A careful examination of the varied stripes of the zebra has forced upon my mind the conviction that they have a still deeper meaning and value than has hitherto been noticed and explained.

It is easy to see how the vertical bars may assimilate to the falling shadows in the noonday sun, and the diagonal stripes on the neck and hind-quarters to those cast by the declining day. But it is not so much in the day-time and during its waking hours that the zebra stands in such pressing need of concealment as at night, when it is compelled to rest. *Then*, when surrounded by eager and wakeful foes, it *does* require all the concealment it can get. Now, let us suppose the animal to be lying down, say partly on its side and partly on its belly, as horses very frequently do. What will be the effect of such an attitude upon the different stripes on various parts of the body? In the first place, the animal will thrust out its knees, and fold its fetlocks backwards under its body in such a manner that the horizontal bars on the fore-legs will become vertical.

At the same time it will push out in a backward direction, its haunches, and the hind-feet will be brought forward under or near its body, so that the diagonal stripes on the hind-quarters will be *drawn* so as to become much more vertical, and to correspond with the now vertical bars across the hind-legs, made vertical by the folded position of the limbs. In such an attitude—a perfectly natural and common one—all the stripes of the body will be vertical, or nearly so, especially if the zebra rests its head upon the ground, or its fore-legs, so as to bring the diagonal stripes of its neck into unison with all the rest. Supposing, then, that a coincidence in the general direction of the stripes is produced by such an attitude of the body during rest, is it too much to assume it to be an extension and refinement of those protective devices of Nature, extending to the sleeping zebra *the full amount of all the possible protective value of its stripes just at the very time when it needs it most*, so that in the clear tropical moonlight, when the shadows are only a little less distinct than in the day, it may be able to repose in something like safety and peace?

But, suppose the zebra rests, not always on its belly, as suggested, but now and then on its side, with its limbs outstretched. It is plain that the vertical, diagonal, and horizontal stripes would then be all more horizontal than anything else, *but pointing in different directions*, and would then so assimilate themselves with the crossed and varying directions of the shadows as to have the same practical effect in hiding the sleeping animal from its foes.

Under such a supposition (by no means an impossible one), it seems to me that those beautiful bars of brown and white surround the dormant zebra with a protection and a defence almost as secure as bars of iron or brass, leaving the foes with nothing but their sense of smell to guide them to their prey.

We have only to assume the folding up of the limbs, like the folding up of a two-foot rule, *until the marks on both sides correspond*, and we see at once the unification in the general direction of all the stripes of the body, which I cannot help believing has a very considerable protective value to the zebra.

However, if any enlightened and generous patron of science would kindly present to our College ("Owens," Manchester) a good stuffed specimen of a recumbent zebra in the attitude I have suggested, he would help considerably to settle a nice point in the matter of protective colouring, and give to the cause of scientific education a very welcome and appreciable aid.

December 21, 1891. H. W.

The Migration of the Lemming.

THERE are two questions which I should like to ask Mr. W. Duppa-Crotch touching his recent letter on the above subject (NATURE, December 31, p. 199); and for this purpose I had better begin by quoting a paragraph from my own discussion of the same subject, written close upon ten years ago:—

"Looking to Mr. Collett's large experience on the subject, as well as to the intrinsically probable nature of his views, I think we may most safely lend countenance to the latter. The most important point of difference between Mr. Crotch and Mr. Collett has reference to a question of fact. For while Mr. Crotch states that the migrations are made westwards without reference to the declivities of the country, Mr. Collett is emphatic in saying that '*the wanderings take place in the direction of the valleys*, and therefore can branch out from the plateaux in any direction.' If this is so, there is an end of Mr. Crotch's theory, and the only difficulty left to explain would be why, when the lemmings reach the sea, they still continue on their onward course to perish in their multitudes by drowning. The answer to this, however, is not far to seek. For their ordinary habits are such that when in their wanderings they come upon a stream or lake, they swim across it; and therefore when they come upon the coast line it is not surprising that they should behave in a similar manner, and, mistaking the sea for a large lake, swim persistently away from land with the view to reaching the opposite shore, till they succumb to fatigue and the waves. Therefore, pending further observations on the question of fact above alluded to, I cannot feel that the migration of the lemming furnishes any difficulty to the theory of evolution over and above that which is furnished by the larger and more important case of migration in general, to the consideration of which I shall now proceed" ("Mental Evolution in Animals," pp. 284–85).

Mr. Duppa-Crotch's theory thus alluded to—which constituted the most striking feature of his "rather lengthy paper before the Linnean Society," and which, he then wrote, "led me to spend two years in the Canaries and adjacent islands"—is, briefly, as follows:—

"I allude to the island or continent of Atlantis. . . . It is evident that land did exist in the North Atlantic Ocean at no very distant date. . . . Is it not then conceivable, and even probable, that, when a great part of Europe was submerged, and dry land connected Norway and Greenland, the lemmings acquired the habit of migrating westwards, for the same reasons which govern more familiar migrations? . . . It appears to me quite as likely that the impetus of migration towards this continent should be retained, as that a dog should turn round before lying down on a rug, merely because his ancestors found it necessary thus to hollow out a couch in the long grass" (Linn. Soc. Journ., vol. xiii. p. 30).

And, in a subsequent paper (*ibid.*, p. 157 *et seq.*), he combats the statement of Mr. Collett, "that these migrations follow the natural declivities of the country." Now, however, it appears that Mr. Collett turns out to be right as to the fundamental fact of the migrations not being westerly more than towards any other point of the compass; for Mr. Duppa-Crotch, in his letter to you, acknowledges that, in regard to this point, which he previously maintained against Mr. Collett, he "was betrayed into an error by trusting to common report and insufficient personal experience." Nevertheless, he still maintains that the lemmings in their migrations "do not follow the water-shed."

The questions, therefore, which I have to put are: (1) What are the grounds on which Mr. Duppa-Crotch continues to differ from Mr. Collett touching this minor point?; and (2) Does he still maintain his theory with regard to "the island or continent of Atlantis," since he has found himself in error upon the major point? GEORGE J. ROMANES.

Christ Church, Oxford, January 6.

Destruction of Immature Sea Fish.

IT might be supposed that the "importance of the subject" would have induced Mr. Walker, at all events, to examine Dr. Fulton's observations at first hand, before criticizing them (NATURE, December 24, 1891, p. 176), instead of confining himself to reading a review.

It may be pointed out that Dr. Fulton's computation of the number of young fish captured is intended to apply only to the Solway, as indeed may be gathered from your review, and being, not a matter of hearsay, as implied by Mr. Walker, but founded on an average of fifteen hauls extending over nine months of the year, is likely to be pretty near the mark.

In examining Mr. Walker's own computation, we find that he reckons six days' fishing to the week, instead of four, which is Dr. Fulton's estimate, based on local inquiry; and we may say that, if Mr. Walker has succeeded in utilizing every working day during any one year of his trawling career, he must have been singularly fortunate in his weather, or must have confined himself to very sheltered waters. I think it will be conceded that a calculation derived from actually counting the catch is more trustworthy than one derived from an observation (or was it only an estimate?) of weight. If, however, "10 cwt. of young flukes, . . . not one the size of half-a-crown," is really only the sixtieth part of a day's destruction in the Formby Channel, it is a wonder that there are any left.

A point emphasized in the review, but seemingly missed by Mr. Walker, is that the young fish are always promptly returned to the sea by the Solway shrimpers, and the fact that the industry flourishes in spite of the delay so caused shows that the destruction which ensues from the practices described by Mr. Walker is quite unnecessary. Dr. Fulton has experimentally proved that the proportion of young flat-fish of a certain size (say above an inch) that would not survive if returned to the sea is small, so that it is evident that Mr. Ascroft's "axiom that 90 per cent. of fish that come on board a boat is destroyed" holds good from no fault of the trawl itself, but simply from a discreditable carelessness on the part of the man.

Mr. Walker's experiences at the mouth of the Dee show that the shrimps and the young soles (species ?) have different habitats in that river, so that his suggestions as to the limitation of shrimp-trawling seem rather superfluous, since it may be supposed that the trawler would fish where he knew he could get shrimps, and not go out of his way to catch what he did not want. I have noticed myself on the west coast of Ireland that the minute post-larval flat-fish, smaller than those dealt with by Fulton, and which are undoubtedly killed by the meshes of the shrimp-trawl, were never taken on ground frequented by shrimps, where, indeed, as one may judge from the relations of the two forms in captivity, the weaker would have a poor chance of surviving.

Everyone will agree with Mr. Walker that it is most necessary to ascertain the habitat of the young fish at different times of the year, and to this end the energies of the Marine Biological Association in England, the Fishery Board in Scotland, and the Royal Dublin Society in Ireland, have been for some time directed; and the assistance that might be rendered by a series of observations by one possessing the experience and opportunities of Mr. Walker would be incalculable. Until, however, our knowledge on the subject is much more complete, I question the advantage of strewing boulders about the bottom of the sea. Even if they remained to accomplish their purpose of interfering with trawling, there is the danger that they would form an attractive shelter, not to the young flat-fish that stand in no need of it, but to some of their natural enemies.

Dublin, December 27, 1891. ERNEST W. L. HOLT.

A New Precessional Globe.

To facilitate the understanding of the effects of precession, I have made a new arrangement of the celestial globe. A globe mounted in the new way can give a representation of the starry heavens for every place on the earth, and for any date, both past and future.

The globe is fastened in a ring, so that it can be turned round an axis that goes through the poles of the ecliptic, but can also be fixed in any position by a pair of screws. The amount of turning is to be measured by a divided circle.

The ring above mentioned—which we will call ring I.—is movable in another ring (ring II.), round an axis, which forms a right angle with the axis formerly mentioned. The inclination between ring I. and ring II. can be measured by an index; it must equal the obliquity of the ecliptic.

Ring II. is fastened finally in a third and extreme ring (ring III.), so that it can be turned round an axis which forms an angle of 90° with the axis of ring II. Ring III. is mounted on a stand with a horizon-circle, so that its axis can be inclined at pleasure to the plane of the horizon-circle. The inclination may be read on a scale engraved on ring III.

To adjust the apparatus to show the firmament at any appointed place and time, one must place ring III. so that its inclination towards the horizon-circle equals the latitude of the place. Then ring II. must be turned so that its plane coincides with the plane of ring III. The angle between I. and II. must be equal to the obliquity of the ecliptic at the appointed time. Finally, the globe must be turned round the axis which goes through the poles of the ecliptic, till the point of the heaven, which is the celestial pole for the time appointed, comes under the axis round which ring II. turns in ring III. If the globe is then fastened in ring I., and ring I. in ring II., with screws, by turning the globe in ring III. one can see at a glance which stars are setting and rising, and which are always above the horizon.

By making Vega, for example, the celestial pole (14,000 A.D.), one can see immediately that for the latitude of London at that remote period, the Cross would be seen at the southern horizon, and that Sirius then did not rise at all. K. HAAS.

Vienna.

Simple Proof of Euclid II. 9 and 10.

IN NATURE of December 24 (p. 189) a simple proof of Euclid II. 9 and 10 is given, which it is stated is believed to be new. It may therefore be of interest to your readers to know that these proofs are given in an edition of Euclid which we have now in the press. As the author, Mr. Brent, is resident at Dunedin, New Zealand, we are unable to state whether he lays claim or not to any originality in respect to them: in any case, as he has been engaged in mathematical teaching for many years, these and similar proofs of other propositions in Euclid II. have clearly been more widely employed than has been supposed. PERCIVAL AND CO.

34 King Street, Covent Garden, London, January 4.

THE ALLEGED DISCOVERY OF A BACILLUS IN INFLUENZA.

FROM the behaviour of influenza as an epidemic, it seems not unreasonable to suppose that it may have as its cause a living and multiplying organism; and when influenza reappeared, after an interval of many years, in the latter part of 1889, and more especially since its communicability from person to person, formerly disputed, has come to be generally admitted, the public mind, medical and lay, has been in expectation of the announcement that a specific microbe had been discovered as the cause of the disease.

Even in diseases, however, of which the characters point most strongly to a parasitic microbe as their cause, the discovery of such an organism is by no means an easy matter. Thus, no micro-organism has as yet been identified as the cause of small-pox, although this disease is always more or less with us; breeds true; has distinct characters, and a definite localization on the skin; and propagates by a contagion which retains its activity for very long periods—circumstances which point to a specific organism as its cause, and might be thought to facilitate its discovery.

From *a priori* considerations we must suppose the properties of the hypothetical influenza microbe to be as follows. The diffusibility of the poison through the air shows that it must be very minute and readily suspended. For the same reason it must belong to the class of aërobic organisms, *i.e.* those for whose existence oxygen is necessary, or at any rate not hurtful. It must multiply with extreme rapidity. It must be capable of multiplying in the bodies, or secretions, of human beings; and probably also in some medium or media outside the human body—perhaps on damp ground-surfaces, or in confined air laden with dust and organic matter. One can hardly suppose it capable of multiplying in pure air, as it would lack pabulum; perhaps, as Dr. Symes Thompson suggests, particles of organic dust floating in the air may serve as rafts for it to live on. As, however, influenza prevails under the most opposite conditions of season, climate, and weather, our supposed microbe, if it can live in the air, must be able to flourish under a great range of temperatures and degrees of humidity. I am not aware of any instances of long retention of contagion, such as would lead us to postulate the possession by our microbe of resting spores. From these considerations we might have expected that it would be more likely to turn out to be a micrococcus than a bacillus.

From what is known of the pathology of some other diseases of microbic origin, as tetanus and diphtheria, it seems possible that the immediate cause of the symptoms of influenza may be the presence in the blood and tissues, not of the microbe itself, but of the poison manufactured by it. The microbe itself may disappear early in the case; but the poison formed by it pervades the whole body, and especially the nervous system, and produces profound and lasting effects. An early disappearance of the microbe in influenza would explain the failure to find it on *post-mortem* examination; death from influenza being usually the result of complications rather than of the primary disease. Influenza is infectious at an early stage of the disease; but it is not known how long the infectious condition may last: some cases point to its being infectious as late as the eighth day, and we must suppose that, as long as the disease is communicable, the microbe retains its vitality.

Evidently there is a power of resistance in the human body to the invasion of the microbe, varying in different persons, for not all who are exposed to the infection contract the disease; the resistance to it being weakened by depressing influences—as fatigue, and exposure to changes of temperature.

The resistance to the poison seems also to be overcome when the dose is large: a certain degree of concentration seems to be necessary in order for the disease to take on an epidemic form.

The pabulum for the microbe, or the number of susceptible persons, seems also to be soon exhausted; for the decline of an epidemic as regards the number of new cases is often almost as rapid as its increase. At the same time the immunity conferred by an attack of influenza is of short duration, for a person may suffer repeatedly from the disease; and the same holds as regards communities, for many localities have suffered repeated epidemics of influenza during the last few years; whereas an epidemic of one of the ordinary infectious diseases is usually succeeded by a long period of comparative freedom. These are some of the points which have to be taken account of in any theory of the causation of influenza.

During the past week the announcement has been made in the public press of the discovery by Dr. Pfeiffer, in the Royal Institute for Infectious Diseases at Berlin, of a bacillus which he looks upon as the cause of influenza.

It will be remembered that a similar announcement, made, in January 1890, by Dr. Jölles, of Vienna, was not confirmed. Since then various observers have discovered in the sputa and lungs of influenza patients, micro-organisms of one kind or another; but their statements are conflicting, and the forms met with are some of them at least known to occur in other diseases; so that the inference is that they were either accidentally present, or connected with secondary affections for which the attack of influenza had prepared the way. Whether Dr. Pfeiffer's discovery will be more successful in gaining acceptance remains to be seen; but the position of its author, and the alleged confirmation of his results by Dr. Koch, will no doubt secure for it a respectful consideration.

As Dr. Koch has pointed out, in order that the relation of a particular micro-organism to a particular disease, as cause and effect, may be considered satisfactorily proved, the following conditions must be complied with:—

(1) The micro-organism in question must be present in the secretions, blood, or diseased tissues of the subject of the disease.

(2) The micro-organisms in question must be isolated and cultivated—all other organisms being excluded—in suitable media outside the animal body, through several generations of cultures.

(3) The micro-organisms, thus cultivated, when introduced into the body of a healthy animal of a susceptible kind must be capable of producing in it the disease in question.

(4) In the animal in which the disease has thus been produced the same micro-organism must again be found.

It is stated that, for the investigation of the etiology of influenza, a *clinique* for influenza patients was opened in September last in the Royal Institute for Infectious Diseases, and that the result of the exhaustive examination of the cases was the discovery in the matter discharged from the patients' lungs of a bacillus found in no other cases of disease of the respiratory organs, and which, as the patient recovered, gradually disappeared. It is stated that the bacilli were cultivated to the fifth generation, and that, inoculated into monkeys and rabbits, they produced in every case the symptoms of influenza.

It is added that these results were confirmed by Dr. Koch, who further discovered the same bacillus in the blood of patients in the febrile stage of influenza.

An account of the discovery is promised in the *Deutsche medicinische Wochenschrift*, and will be awaited with interest. H. F. P.

ON THE MATTER THROWN UP DURING THE SUBMARINE ERUPTION NORTH-WEST OF PANTELLERIA, OCTOBER 1891.

We did not reach Pantelleria till November 5, ten days after the end of the eruption, but a certain number of specimens had been secured at the time by people who went out in boats. Dr. Errera, who helped us in other ways, kindly gave me some pieces of a bomb from his own collection; and others, among them a good-sized bomb, some 30 inches in its longest diameter, were obtained from the inhabitants. Out of a number of small pieces from different people, I did not see any that might not have formed some part of a mass such as this last, and I have no evidence that any other kind of material was erupted.

General, Structural, and Mineralogical Characters.

Riccò (*Comptes rendus*, November 25, 1891) says that some of the bombs had a diameter of 2 metres, and that the prevailing shape was an "ellipsoid of revolution." They were not only porous in texture, but contained large cavities, and floated for a time, but pieces taken separately are fairly heavy. Riccò mentions a specific gravity of 1·4 (perhaps for a bomb when unbroken). A 4-ounce piece of the coarser material from the inside displaced less than half its weight of water, giving me specific gravity 2·3.

What most struck the possessors of specimens was their coaly blackness. Nevertheless, there was on the outside of the bombs a distinctly brownish layer, an inch perhaps in thickness, which the eye, or better, the pocket lens, shows to be due to vesiculation of the transparent brown glass that here forms the ground mass. In certain places vesiculation has been carried so far that we have a *coarse*[1] type of the "thread lace scoria," described among others by Dana, from Hawaii (*Amer Journ. Sci.*, March 1888, p. 213, or his book, "Characteristics of Volcanoes," p. 163, 1890).

In the brown glass of this part sections show numerous narrow crystals of triclinic felspar, and in places olivine and magnetite, and probably a little augite.

Beneath this brownish layer may occur another, say half an inch thick, coarser and darker than the former; but which in sections can still be seen to be for the most part brown transparent glass, with the above-mentioned minerals in it.

We are thus led to a layer perhaps an inch or two thick,[2] coarsely spongy, black, of pitchstone lustre, which

[1] I find a prettier example of this structure on one side of a piece of scoria picked up last month near the base of the active cone of Vesuvius. It was partly covered by the brown dust ejected since the tapping of the lava on the side of the Atrio del Cavallo last summer. I do not know, therefore, when it was erupted. I find on this, as on scoria that I saw erupted in October 1889, a tendency to form Pele's hair (on a very small scale).

[2] Unfortunately, the only whole bomb that I saw went to pieces on the way to England. The point worth noticing is the difference in structure of different parts; and I give these rough measurements, taken from pieces in my posses-ion, merely to show the kind of dimensions with which we are dealing.

bounds the internal cavities of the bomb. Sections show that this inner material is largely crystalline. Perhaps one-third of its substance is composed of well-marked crystals of triclinic felspar, olivine, and augite, the rest being a black ground material, opaque in sections of ordinary thickness, except where relieved by micro-crystals of felspar.

Foerstner's Description of Specimens from Graham's Isle (Ferdinandea).

With the above it is interesting to compare Foerstner's account of the specimens from Graham's Isle which he examined (*Min. and Petr. Mitth.*, v., new series, 1883, pp. 388–96). I suppose specimens are scarce. He obtained three. That from Strasbourg consisted of light-gray lapilli, apparently altered by acid vapours. It differed much macroscopically from the other two. These lapilli contained magnetite and plagioclase.

The other two were as follows (I give an abstract of Foerstner's description):—

(1) Specimen in Museum at Naples was pumiceous and almost foamy, and had a brown ground mass with glassy lustre, in which crystals of plagioclase, olivine, and magnetite.

(2) Specimen from Palermo (collected by G. Gemmellaro) was black and vesicular, but in sections was very similar to (1). It appeared to be largely crystalline. Plagioclase most conspicuous, but also augite, olivine, and magnetite.

I have not seen the specimens, but the descriptions accord well with those given above for the outer and inner material of the recent bombs. As will be seen below, they also agree well enough chemically.

Description of certain Basic Scoriæ from the Island of Pantelleria.

I did not obtain specimens of the plagioclase-basalts from the Cuddie Monti and S. Marco, analyzed by Foerstner (see below), but I have basic scoriæ from different localities in the north-west part of the island. Specimens from Cuddie Brucciate, while differing in structure, agree mineralogically with the recent ejecta, having crystals of triclinic felspar, olivine, and augite, set in a glassy or opaque black ground, as the case may be.

Further, some very black and rough specimens, from a small patch of basic scoriæ north-east of the Bagno del Aqua, not only agree mineralogically, but are in texture not unlike the intermediate portion of the bomb described above.

A Comparison, as to Chemical Constitution, of the Products of the Recent Eruption with those of Graham's Island, and certain Lavas of Pantelleria, Etna, and Vesuvius.

In the following table the iron oxides are taken together. In the case of the Etna lava of 1865, the analyses by Fuchs and Silvestri disagree as to the proportions of FeO and Fe_2O_3.

The results in the first four columns are from a table in Foerstner's paper (*loc. cit.*). For the fifth column I have to thank Mr. Geo. H. Perry, who has made an analysis of part of the large mass above mentioned, and also Prof. Thorpe, F.R.S., who kindly permitted the work to be done in the laboratory of the Royal College of Science. Mr. Perry's analysis will be found in full below.

This table speaks for itself. There is in the recent bomb a little less silica and a little more alumina than in the specimens from Graham's Isle, Etna, and Pantelleria, while the percentages agree with those in the specimen from Vesuvius.

	Plagioclase-basalt, S. Marco, Pantelleria (Foerstner).	Plagioclase-basalt, Cuddie Monti, Pantelleria (Foerstner).	Plagioclase-basalt, Etna, 1865 (Or. Silvestri).	Plagioclase-basalt, Graham's Isle, 1831 (Foerstner).	Bomb from submarine eruption N.W. of Pantelleria, October 1891 (Geo. H. Perry).	Leucite-basalt, Vesuvius, 1867–68 (Fuchs).
SiO_2	49·87	49·35	49·95	49·24	46·40	46·94
Al_2O_3	14·80	15·71	18·75	19·06	21·84	21·35
Iron oxides	15·13	14·40	11·30	12·10	11·57	12·23
MnO	—	—	0·49	—	trace	trace
CaO	9·36	9·80	11·10	8·75	10·33	9·69
MgO	6·77	5·71	4·05	5·00	5·37	3·78
K_2O	0·68	1·31	0·70	1·19	1·69	5·57
Na_2O	2·81	2·96	3·71	3·89	3·27	1·62
Water	0·45	0·49	0·70	0·63	—	—
	99·87	99·73	100·75	99·86	100·47	101·18

We may note that Foerstner[1] describes a decrease in the amount of silica in the rocks erupted on Pantelleria itself during the later part of its history. Thus, the oldest rocks of the island are described by him as phonolites, liparites, and andesites, probably of Tertiary age, containing from 60–73 per cent. of SiO_2. Then, coming to the group of rocks which, as containing the mineral "cossyrite" (rather, *ænigmatite*) and much soda and iron, he distinguishes by the name of "Pantellerites" (which rocks form the greater part of the surface of the island), he finds that the older ones contain about 70 per cent. of silica, and the younger only 67 per cent., thus heralding the outburst of basic rocks (lavas and scoria) containing some 49–50 per cent. of silica (see table above), which form the most recent rocks of the island, and are confined to the north-west part of it.

That we should find a still further decrease of SiO_2 to 46·40 per cent. is, so far, interesting. I have not come across an analysis of any very recent lava of Etna to know whether the lava of that district shows any tendency in the same direction.

In conclusion, I must express my thanks to Prof. Judd, to whom I am indebted for reference to the authors quoted, and for loan of papers.

December 26, 1891. GERARD W. BUTLER.

ANALYSIS OF VOLCANIC BOMB, PANTELLERIA, OCTOBER 1891.

Percentage Composition of Washed Powder, dried at 120° C.

	1.	2.	Mean.
SiO_2	46·39	46·42	46·40
FeO	2·20	1·88	2·04
Fe_2O_3	9·53	9·53	9·53
Al_2O_3	21·77	21·91	21·84
MnO	mere trace	—	mere trace
CaO	10·31	10·36	10·33
MgO	5·35	5·39	5·37
K_2O	1·65	1·73	1·69
Na_2O	3·42	3·13	3·27
Loss on ignition	—	—	—
	100·62	100·35	100·47

As the powder was magnetic, Fe_2O_3 was probably combined with FeO to form Fe_3O_4. This would give—

FeO 7·55
Fe_3O_4 4·18

December 22, 1891. GEO. H. PERRY.

[1] "Nota preliminare sulla Geologia dell' Isola di Pantelleria" (with geological map), *Boll. Com. Geol. d'Ital.*, 1881.

THE SPECTRUM OF IRON AND THE PERIODIC LAW.

IN the course of a prolonged series of spectroscopic observations on iron containing $\frac{1}{10}$ carbon, ·08 sulphur, ·070 phosphorus, and about $\frac{4}{10}$ per cent. of manganese, and based on the previous investigations of Mr. Lockyer on the iron spectrum at varying temperatures, I noted some results summarized as follows:—

(1) Iron heated *in vacuo* evolves a vapour showing the H spectrum; in addition, other lines are sometimes visible.

(2) I have found that iron kept in a vacuum slowly evolves H at a temperature not exceeding 70°–80°; this continued for six months. Further, on applying heat, I have observed a condensed sublimate at the sealed cold end of the tube.

Heated iron known to contain small quantities of some of the more fusible metals evolves these bodies, and *vice versâ* absorbs them. Exhausted heated iron also absorbs H in the same way, and most rapidly at an intense heat approximating to fusion.

(3) On iron being heated in the blow-pipe flame through which the spark was passing, lines were detected in the flame apart from the iron.

(4) On heating iron electrodes, "varying the tension of the spark,[1] also the flame temperature," according to methods elsewhere given, I found it possible to obtain iron spectra, varying roughly in accordance with the heat of the flame and spark tension. Three nearly distinct spectra have been observed:—(1) Lowest heat, a nearly pure manganese spectrum. (2) Higher heat, manganese lines; other long lines appear, also the beginnings of a short-line spectrum. (3) Highest heat, a complete iron spectrum.

As regards the first spectrum, manganese has been identified by the ordinary method of chemical analysis. The second group of long lines the chemist would say were due to the presence of some body not identical with either iron or manganese, but this problematic body has not been identified or isolated; the proof is wanting, although it is a product, or function, of temperature, just as is the first or manganese spectrum. This spectrum may be due to dissociation of iron, and not to the vaporization of a foreign constituent. It is probable that iron can be roughly split up into two bodies, one of which is more volatile than the other, and that the relative quantity of each present may not always be the same. At any rate, it appears that by the simple heating of crude iron its composition may be sensibly modified, and that, even at a temperature as low as 70°–80°, slow dissociation is going on, manifested by the evolution of hydrogen; and this continues, the rate of dissociation apparently broadly corresponding to the heat applied. It follows that in actual practice the chemical composition of iron may thus be altered, such changes being probably so minute as to escape recognition.

These researches were made with the sole object of utilizing the spectroscope as an aid to the ordinary chemical analysis of iron, my previous experience having taught me that an extension of the usual methods was imperatively required. It was thought that by the spectroscopic method some body or bodies as yet unrecognized might be found; in other words, I searched for so-called impurities with but scant success.

Finally, I was forced to admit that I had exhausted the purely analytical part of the inquiry, and must seek for the solution of the many discrepancies observed in the behaviour of iron and steel, and not comparable with its chemical composition as determined by ordinary analysis. Nothing was left for further study, with the exception of the metal itself. It may be remarked, however, that *absolutely* pure metal could not be obtained; manganese, for instance, seems always present, even after repeated purifications.

[1] Suggested by Mr. Lockyer.

This led to a study of the periodic law as enunciated by Mr. Crookes in his address on the genesis of the elements. He advances the rational hypothesis that atoms are formed from the original protyle or fire mist; next, by a series of atomic condensations, due to successive coolings, the elements are formed. Mr. Lockyer, by somewhat different methods of research, appears to have come to the same conclusion—viz. that temperature governs all; and tells us, "as the result of a long series of spectroscopic observations," that an element is a very complex thing, broken up—at higher temperatures—into simpler things.

Mr. Crookes, by a careful study of the periodic law, supplemented by spectroscopic work, shows how elements may be built up. Mr. Lockyer, pursuing the opposite method, viz. by a study of the breaking up of the so-called elements, and registering the results by means of the spectroscope, appears to have *experimentally* proved the same thing.

It is quite obvious that an absolutely pure element can only exist at a given temperature; any deviation from this —the critical temperature—must favour partial dissociation, and in this way it undergoes changes which may veil its true atomic weight. As Mr. Crookes puts it, "of a given mass of atoms, only a few may have the true atomic weight, the others slightly varying from it." Granting a variation of atomic weight in the element for the same reason, there may be a shifting of its spectral lines. I submit also that the discrepancies in the position of certain spectral lines may be due to divergence from the critical temperature, and not observational errors.[1]

There appears, therefore, to be no necessity for the use of such phrases as chemical affinity, cohesive force, &c.: heat energy and the universal law of gravitation seem the only factors controlling the genesis of the elements—can we also say the genesis of known chemical compounds?

We cannot well say how far the physical properties of such a metal as iron are modified by temperature variations; yet we have seen that something like dissociation is going on at 70°–80°, and that at a moderate heat this is accentuated; whilst at high temperatures the spectrum of iron affords ample proof that such is the case. Experiments have been made showing that even at the bare fusion-point of iron matter is volatilized; and at the abnormally high temperature of the Bessemer blow— "melting up lumps of cold steel plunged in, and weighing 2 or more cwt, like wax"—it is admitted that iron as such is vaporized. It seems therefore, on the whole, that even a stable body like iron, when heated, gives results according with the periodic law; and as regards other bodies, from ice upwards, we do not need to be informed that evaporation (dissociation) is constantly going on.

It may not, however, be so well known that "on heating some of the more fusible metals in a vacuum," it is possible to obtain almost invisible vapours, some of which iron occludes or absorbs just as it does the gases hydrogen and possibly carbon monoxide.

Referring to the No. 2 spectrum indicating the probable existence of an intermediate body betwixt iron and manganese, not yet isolated, but which, nevertheless, is a product or function of the temperature, just as manganese is; the supposition that this body is a constituent of iron acquires force from the fact that recently it has been shown that iron may be capable of assuming two forms— the one termed α, or soft iron; the other β, or hard iron.

[1] Or, possibly, at a given temperature a vapour may be evolved from one body so nearly approximating in composition to that of another, the latter not necessarily at the same temperature, as to be almost undistinguishable from the other by the ordinary method of micrometric measurement. The same difficulty in another form occurs in ordinary chemical work; bodies are so closely allied in some instances as to render their separation and identification very difficult.

Consequently, the physical properties of the metal are modified in accordance with the relative proportions of each present.

It is thought that pure iron may contain both α and β iron; but it is certain that when alloyed with other bodies—more especially carbon—these allotropic changes of iron become very marked. In this connection the author noted long ago that the carbon-iron alloys were more liable to change, and more sensitive to variations of temperature, than iron alloyed with other bodies; and, as the results of experience given, he goes so far as to advocate the substitution of other than carbon-iron alloy, in the following words:—

"For the production of steel in large masses suitable for ship and boiler plates, rails, &c., the traditional rules of the old school of steel-casters cannot well be applied.

"What is desired is a strong ductile material, capable of resisting sudden shock or impact, and sudden or extreme changes in temperature—a material as insensible as may be to all influence except that due to fair wear. This material—*i.e.* low carbon, Bessemer, or Siemens steel—has almost superseded wrought-iron, and yet is not always to be relied upon. Under certain ill-understood conditions this metal sometimes behaves in a manner which has not been satisfactorily explained.

"Must we infer that carbon may be the culprit, and that the carbon-iron alloy is more sensitive to external influences, and more liable to molecular changes, than other iron alloys free from carbon?[1]

"It is quite possible that further study and experiment may result in the production of an iron alloy, capable alike of being forged or cast in amorphous masses free from any tendency to hardness or temper."

Osmond's researches have deservedly attracted great attention, and, in conjunction with the work of Prof. Ball and Prof. Roberts-Austen, have on the whole been approved and accepted by men of science.

With the aid of the Le Chatelier's pyrometer, the critical points of temperature, *i.e.* the points at which molecular changes take place, have been determined. The whole series of these masterly researches cannot here be given in detail; but after careful consideration the writer thinks they go far to prove that the undoubted molecular changes which take place when iron is heated simply represent marked periods of dissociation. That, broadly speaking, the results are in accord with the periodic law; with the spectroscopic work of Mr. Lockyer, and the researches of Mr. Crookes, together with the author's research on the behaviour of iron at varying temperatures; to say nothing of the work of other chemists all pointing in the same direction. As before said, the physical properties of iron are a function of temperature; indeed, one is fain to say that the absolute elementary body can only exist as such at a given temperature; at any other, it cannot, strictly speaking, be that body.

Appreciable dissociation can, however, only be noted at comparatively wide intervals of temperature; minor changes must, of course, be beyond recognition to our senses. It is possible that the first beginning, so to speak, of dissociation may be detected with the spectroscope; but unless carefully worked, the first spectroscopic indications of dissociation are not altogether trustworthy. The temperature of the spark and also the arc is subject to irregularities not easily controlled; and unless worked by the experienced spectroscopist, the results are apt to be unsatisfactory.

It is remarkable that many eminent chemists reject the spectroscope as a means of research, and prefer other methods. Others, again, consider that these methods of procedure fail to differentiate minute differences, which yet substantially exist. The method of spectrum analysis, however, seems capable of registering reactions beyond the scope of ordinary analysis. In fact, the instrument may be said to afford the same aid to the analyst in enabling him to note infinitesimal chemical changes or reactions, as the microscope affords for the discrimination and classification of microscopic objects.

On the whole, the results of a long series of patient investigations show that pure iron is probably a very complex body (as regards the commercial metal the microscopic researches of Sorby go to prove that it clearly is not, as usually assumed, a homogeneous body, but rather a heterogeneous one), extremely sensitive to external influences modified by the presence of minute proportions of other bodies; these latter, according to Prof. Roberts-Austen, governing its physical properties in accordance with their atomic volume as compared with that of iron, and in accord with the periodic law. It is evident that it is not enough to give merely the simple percentage of carbon, sulphur, &c., in iron; the relative mass (as compared with iron) of the foreign ingredient must also be noted, and thus only can the *absolute* percentage composition be determined. Practical results appear to confirm those attained in theory.

The writer, when all these researches were not even thought of, in some notes on the working of steel, gathered from his own practice and confirmed by that of others, considered that the heat at which the steel was manipulated played a very important part, for the following reasons:—

Many discrepancies have been noted in the behaviour of steel—the results of the tests applied not at all corresponding to what might have been expected from its chemical composition. For instance, steel containing traces of silicon, ·17 per cent. carbon, ·06 of sulphur, ·07 phosphorus, ·40 per cent. manganese, stood a tensile strain of 27 to 30 tons per square inch; other samples of the same composition showed an increase of 31 to 35 per square inch, and under these latter conditions the carbon had to be reduced ·12 per cent. to stand the normal test of 27 to 30 tensile strength.

The cause of this sudden change was not satisfactorily explained. I think a plausible explanation of these differences, which are of constant occurrence, may be traced to differences in temperature, and, strictly speaking, a steel of given chemical composition must be worked at a corresponding temperature to insure good results. Some clue to the temperature required may, however, be obtained. The fusion point of steel varies with the amount of other matter alloyed with the pure iron. All concerned in the manipulation of steel are well aware that hot or cold rolling makes a great difference in quality, and that the critical welding-point of the metal is confined to a narrow limit of heat; it is often a matter of great practical difficulty to decide upon the most suitable temperature necessary for good work. It is well known that steel may be seriously damaged either by under or over heating. In the first instance the steel may be too hard to bear rolling, or even if passed through it may not be sufficiently plastic to yield readily to pressure. We may in this case assume that minute cracks or flaws occur which cause a corresponding deterioration in strength. On the other hand, it is well known that if steel be over-heated it falls to pieces on further manipulation. The reason is apparent—it is approaching to a semi-fluid condition, and therefore cannot be rolled out. It may be, therefore, that for the successful working of steel it is not enough to rely simply on chemical analysis.

The foregoing seems to indicate that steel must be worked at a certain fixed, but as yet unknown, temperature below its fusion-point; at which heat the flow of

[1] Practically, we know that it is so; only pure carbon-iron alloys can be tempered and hardened with facility, the presence of other bodies tending to neutralize this effect; or, more plainly, the steel-smith terms it bad steel, which cannot be tempered or hardened properly.

heated metal undergoing compression and elongation is such as to insure good practical results.

It also follows that if the heat between these points can be ascertained, it may *only* be necessary to ascertain the fusion-point of any given steel, from which the working temperature can be determined, for the welding heat will obviously be a constant of temperature below the fusion-point of the steel sample, and it is probable that the discrepancies so often observable are simply due to deviations from the critical temperature required for welding and rolling purposes.

The welding or rolling heat should correspond to the fusion-point of steel, which is governed mainly by the amount of carbon it may contain, and possibly other elements may play a part in affecting the final result.

Finally, as the results of purely practical experience, the writer has been led to think that the term impurity, as applied to the mixed foreign elements present in iron, "is simply a conventional one, applicable only under certain rigid conditions of temperature combined with manipulation"; and these must be present in fixed quantities, bearing uniformly the same ratio to each other. It follows that under other conditions of temperature and manipulation a product possessing the same physical properties might be produced from a material sensibly differing in composition from that quoted above.

It is well known that those solely engaged in the manufacture of iron and steel have, "independent of the teachings of science," long ago come to the conclusion that iron undergoes unaccountable changes. It is asserted that ordinary chemical analyses afford no explanation of the observed phenomena; further research is insisted upon. To use their own words, they ask "What is iron? In our practice something often happens to iron of which your analyses afford no explanation." It is to be hoped that recent research has partly solved the problem; and that, by a further study of the metal itself, some clue may be found indicating more clearly than at present that iron is either a true chemical compound, or, if not, subject to allotropic modifications.

Practically, it does not seem to matter which, as, to quote the words of Dr. Gore, "every substance becomes a more or less different substance at every different temperature" (*Phil. Mag.*, May 1890).

JOHN PARRY.

THE GROWTH OF THE PILCHARD OR SARDINE.

IT was long since proved that the pilchard of the south-west coasts of England and the south coast of Ireland is the same species of fish as the sardine of the Atlantic coasts of France and Portugal, and of the Mediterranean. But there are apparent differences in the sizes and habits of these fish in different regions, of which the explanation has only recently been sought. The life-history of the species has been studied during the past few years with great care by several naturalists at various points of the coasts along which its habitat extends; and as a result of these researches, the extent to which its local peculiarities are real or only apparent is gradually being ascertained. Thus Marion at Marseilles has established the facts that the Mediterranean sardine in that neighbourhood spawns chiefly in February and March, but that the spawning period extends from December to May, that the adult fish does not exceed 18 cm. in length, and that the smallest sexually mature individuals are 15 cm. long. The majority of the pilchards caught by drift-nets on the south coasts of Devon and Cornwall are from 20 to 25 cm. in length, while those which I have seen in the ripe condition were 23 to 25 cm. Thus it is clear that the Mediterranean sardine, at any rate in the Gulf of Lions, is in its adult state a much smaller fish than the Cornish pilchard, although no structural differences have yet been described which would separate the two as local races or varieties.

The well-known French sardine, such as we see it preserved in oil in tins, is also a small fish. The sardine fishery and the sardine-preserving industry in France are carried on along the south coast of Brittany from La Rochelle to Brest. The great majority of the sardines caught there are fish from 13 to 16 cm. in length. Considering the short distance between Cornwall and Brittany, it might be suspected that these fish are not full grown; and Prof. Pouchet, Director of the Zoological Laboratory at Concarneau, tells us in his Reports that these sardines are young fish which have not yet reached sexual maturity. In fact, full-grown sardines of the same size as typical Cornish pilchards are also caught on the Breton coast, and are locally distinguished as "*sardines de dérive*," the small fish used for tinning being called "*sardines de rogue*." The adult sardines are captured principally in winter, the *sardines de rogue* in summer. The question therefore arises whether small pilchards of the same size as the *sardines de rogue* of the French coast occur on the coasts of Cornwall, and if not, why not. During the four years I have been at the Plymouth Laboratory I have never heard of any such fish being caught by the fishermen. Not long ago I asked Mr. Dunn, who has been engaged in the Cornish pilchard trade the greater part of his life, if he had ever seen any pilchards of the same size as French sardines, and he said he never had. He is connected with the factory at Mevagissey, where adult pilchards are prepared in oil in tins in the same way as French sardines, and he told me that some years ago the owners of the factory took steps to ascertain whether pilchards of small size could be captured near Mevagissey. A seine of the kind used by the French fishermen was procured from France, and several trials were made with it; but instead of half-grown pilchards of the required size, it captured only very young specimens 2 or 3 inches long. The recent capture, therefore, in nets belonging to the Marine Biological Association, of young pilchards similar in size to the French *sardines de rogue* is a matter of some interest and importance. The discovery also adds considerably to our knowledge of the growth and history of the pilchard.

Some months ago the Director of the Plymouth Laboratory was instructed to procure a fleet of small-meshed drift-nets for the purpose of catching anchovies, in order to ascertain at what seasons and positions and in what abundance these fish appeared off Plymouth. These nets are five in number, each being 60 fathoms in length; the mesh is about ½ inch square, or 70 meshes to the yard. They were shot a few miles outside Plymouth Breakwater on November 3, 4, 5, and 6, and on each occasion the chief part of the catch consisted of pilchards measuring 13 to 16·5 cm. in length. The rest of the catch consisted of a few full-grown pilchards, a few young mackerel, a few sprats, and sometimes a few anchovies. On each occasion there was a considerable difference in size between the smallest of the large pilchards and the largest of the small. The spawning period of the pilchard off Plymouth extends from the beginning of June to the beginning of November—five months—and may possibly be prolonged a little beyond these limits. Now all the available evidence tends to show that even the smallest of the young pilchards above mentioned, 13 cm. in length, could not have reached that size if hatched the same year, even if they were derived from eggs shed in May. For in the latter case they would be only a little more than five months old. Meyer found that herrings at five months were only 6 to 7 cm. long, and Marion states that the sardine at Marseilles is 7 cm. long at the same age. It might be argued that the Atlantic pilchard grows faster than the Mediterranean sardine, but it can scarcely grow so much faster as to reach 13 cm. in five months. It is pretty certain, therefore, that these young sardines were derived from the previous year's spawning, and were between twelve and seventeen months old, probably thirteen to fifteen months. This being the case, the young pilchards hatched the same year ought to have been discoverable. Day states, doubtless on Mr. Dunn's authority, that young pilchards are first seen in September, 3 or 4 inches long—that is, 7·5 to 10 cm. Mr. Dunn himself tells me that the young pilchards about this size regularly occur off this coast in autumn, and that he has seen them taken in seines and in the stomachs of whiting. I found young pilchards myself in the stomachs of the young mackerel taken in the anchovy nets at the dates above mentioned, and in full-grown mackerel examined at the same time. These young pilchards measured 6 to 9 cm., and were doubtless derived from spawn shed the previous summer. It is, of course, possible that the pilchards measuring 13 to 16·5 cm. in length at the beginning of November were derived from spawn shed rather late in the spawning season of the previous year, and that their age was nearer twelve than seventeen months. But the above facts indicate clearly that the pilchard does not reach adult size in one year, and is not capable of spawning until it is two years old, while the larger spawners are probably three years old.

If we compare the data and inferences just given with the facts concerning the sardine of the French coast recorded by Pouchet, we find that the data agree and the inferences are confirmed. Pouchet, it is true, denies that the eggs of the sardine are pelagic, and has not defined the spawning period. But he tells us that he has only seen eggs approaching maturity in fish taken in April and May, when the fishing for *sardines de dérive* ceases, and that for *sardines de rogue* commences. There can therefore be no doubt that near Concarneau the sardine spawns in the months following May. Pouchet's records of the fish captured are somewhat difficult to interpret. He publishes in his Reports the records kept by the manufacturers, in which the size of the fish is registered according to the number required to fill a tin of a certain size. Two processes of calculation have to be carried out in order to get approximately the length of these fish. Having made these calculations, we find that at Concarneau in 1888, in June, the *sardines de rogue* were 12·5 to 14 cm. long; in July, 13 to 14·3 cm.; in August and September about the same; in October, for the most part 15 or 16 cm., though some were still taken of 13 to 14 cm. In some of his reports Pouchet gives the dimensions according to actual measurement of two or three sardines taken nearly every day throughout the season, but nowhere does he give the range of sizes of the total number of fish taken on one day. Thus in the year 1888 he obtained sardines of 10 to 11·5 cm. in March, 11 to 14 cm. in April, 15 cm. in May, 13 to 15 cm. in June, 13 to 16 cm. in July, 13 to 14 cm. in September, 14 to 18 cm. in October. On the whole, the *sardine de rogue* gets larger towards the end of the season, though it is obvious that the shoals in a given place replace one another, so that fish taken in September at Concarneau may be of the same age and size as others taken in June. This phenomenon is a necessary consequence of the extended spawning period of the species. But I think there can be no doubt that the *sardines de rogue* caught in such numbers along the coast of Finisterre in summer are yearling fish, which in the following summer reach maturity at a length of 20 to 22 cm. There is one consideration which may give rise to a doubt as to the general validity of this conclusion. According to Pouchet, sardines 15·7 cm. long are taken at the end of May: would not these reach a length of 19 or 20 cm., and be capable of spawning, by the end of October, when the spawning period for the year is not yet terminated? This question cannot be definitely answered in the negative at present. I will merely point out that the increment of length corresponding to the same increment of weight becomes smaller as the fish grows larger. Thus at 13 cm. a sardine weighs about 15 grammes; at 16 cm. about 30 gms., an increase of 15 gms.; at 19 cm. it weighs about 60 gms., an increase of 30 gms.

If, as the above considerations indicate, the sardine of the Cornish and French coasts reaches a length of 13 to 16 cm. at one year of age, it is surprising that the Mediterranean sardine should reach the same length at the same age, since its maximum length is so much less than that of the more northern fish. But Marion finds that the sardine at Marseilles grows at the rate of 1 cm. per month, starting from a length of 3 cm. at one month old. Thus, according to his table of growth, the sardines hatched in December are 14 cm. long in the following December. I cannot help thinking that Marion has over-estimated the rate of growth, but it may prove that the fish reaches maturity more quickly in the Mediterranean, although it does not grow so large. Marion has conclusively shown that the spawning period at Marseilles extends from December to May, instead of from May to October.

J. T. CUNNINGHAM.

SCIENCE IN JAPAN.[1]

THE growth of modern science in Japan is one of the most interesting phenomena connected with the history of civilization. The Japanese, and the Magyars of Hungary, are the only peoples of other than Aryan stock who have founded Universities and taken part in the development of the historical and physical sciences. The University of Buda-Pesth dates from the fifteenth century, and at the present moment its large staff of eminent Professors contains but few names which are not distinctively those of Magyar nationality. The University of Tokyo was founded in the year 1868 by the union of the Tokyo Daigaku and the Kobu Daigakko. It has more than seven hundred students, and comprises a College of Law, with eleven Professors, of whom one only is a European; a College of Medicine, with sixteen Professors, all native Japanese; a College of Engineering, with eighteen Professors, three of whom bear English names; a College of Literature, with ten Professors, of whom two are Englishmen and two Germans; a College of Science, with fifteen Professors, amongst whom one—a chemist—is English, the rest being Japanese.

The present volume bears testimony to the high qualifications and serious work which distinguish the Japanese Professors and their assistants in the College of Science of Tokyo. It contains seven memoirs on biological subjects—a branch of study for which the Japanese have proved themselves during the last fifteen years to have a special and indeed a remarkable aptitude. The names of Mitsukuri, Ishikawa, Iijima, and Watase, not to mention others, are known and esteemed in every laboratory in Europe and America where the study of embryology and comparative anatomy is cultivated.

The list of papers in the present volume is as follows:—(1) The fœtal membranes of the Chelonia, by K. Mitsukuri, with ten plates; (2) The development of Araneina, by K. Kishinouye, with six plates; (3) Observations on fresh-water Polyzoa, by A. Oka, with four plates; (4) On *Diplozoon nipponicum*, n.sp., by Seitaro Goto, with three plates; (5) A new species of Hymenomycetous Fungus injurious to the mulberry-tree, by Nobujiro Tanaka, with four plates; (6) Notes on the irritability of the stigma, by M. Mujoshi, with two plates; (7) Notes on the development of the suprarenal bodies in the mouse, by Masamaro Inaba, with two plates.

Some of the authors of these admirable papers bear the title "Rigakushi," whilst Prof. Mitsukuri alone is styled

[1] "The Journal of the College of Science, Imperial University, Japan," vol. iv., Part 1. (Tokyo, Japan, 1891.)

"Rigakuhakushi." All the memoirs above named are valuable contributions to science, and are profusely illustrated by lithographic plates, which compare favourably with the best European work. Prof. Mitsukuri's memoir on Chelonian development is the most important; it forms a continuation of a memoir on the germinal layers of the Chelonia, published by him in conjunction with Mr. Ishikawa in 1887 in the *Quarterly Journal of Microscopical Science*.

English-speaking naturalists may congratulate themselves on the fact that the English language is chosen by our Japanese *confrères* as their medium of publication: English, indeed, appears to be the official language of the Imperial University of Tokyo throughout. Whilst the Russian Government encourages its scientific *protégés* to withdraw themselves more and more from European intercourse by publishing their investigations in the Russian language, the Far East steps gladly into the place among civilized nations vacated by the long-suffering subjects of the Czar. E. RAY LANKESTER.

EVIDENCE OF A WING IN DINORNIS.

IN 1889, Mr. A. Hamilton, of the Otago University, submitted to me some of the Moa bones he had exhumed from a swamp near Te Aute, in the North Island of this colony. Among them there were several very diminutive scapulo-coracoids and sterna, which I hope soon to figure and describe. Among the former was one which presented a small but distinct hollow in the situation where the glenoid cavity occurs in the winged Ratitæ. I made a sketch at the time, and exhibited the bone at one of the meetings of the Philosophical Institute of Canterbury. Though satisfied in my own mind that this hollow did represent a humerus articulation, I have been unable to find confirmation of its existence in any other scapulo-coracoid among the Moa collections I have examined. Among the bones, however, which I lately dug up from a peaty hollow near Oamaru, in the South Island, I have found a large scapulo-coracoid presenting a deep, well-marked depression, with a beautifully smooth and polished concavity, which leaves no room for doubt that it has

Scapulo-coracoid of *Dinornis* sp., showing the glenoid cavity.

been a functional glenoid cavity for a humerus possessing a head not less substantial at least than that in the Cassowaries. The accompanying drawing (half the natural size), made by camera lucida, will convey better than a description the form and position of the depression. Proximally to the cavity, and separated from it by a smooth ridge, there is a shallow impression (not seen in the figure), as if it were an antitrochanter for some tuberosity on the humerus. The coracoidal termination of the bone fits perfectly into a deep and rounded depression in a sternum obtained at the same time and place as the scapulo-coracoid, belonging to *Dinornis maximus* of Owen. Prof. T. J. Parker has proved that the *Apterygidæ* are undoubtedly descended from birds that could fly: the finding of so unmistakable a glenoid cavity in the present bone confirms the generalization for the Dinornithidæ. HENRY O. FORBES.

Canterbury Museum, Christchurch, N.Z.,
November 4, 1891.

NOTES.

THE medals and funds to be given at the anniversary meeting of the Geological Society, on February 19, have been awarded as follows:—The Wollaston Medal to Baron Ferdinand von Richthofen; the Murchison Medal to Prof. A. H. Green, F.R.S.; and the Lyell Medal to Mr. George H. Morton; the balance of the proceeds of the Wollaston Fund to Mr. O. A. Derby; that of the Murchison Fund to Mr. B. Thompson; that of the Lyell Fund to Mr. E. A. Walford and Mr. J. W. Gregory; and a portion of the Barlow-Jameson Fund to Prof. C. Mayer-Eymar.

PROF. WILLIAMSON, F.R.S., has been elected a corresponding member of the Imperial Academy of Sciences, St. Petersburg.

THE Belgian Academy is preparing to celebrate the fiftieth anniversary of M. Van Beneden's membership. He is the Professor of Natural Sciences at the University of Louvain.

THE private or preliminary installation of the Duke of Devonshire as Chancellor of the University of Cambridge, in succession to his father, took place at Devonshire House on Tuesday. An admirable speech was delivered by the new Chancellor in reply to addresses by the Vice-Chancellor and the Public Orator Speaking of the University of Cambridge as it was it was in his undergraduate days, he said that the University did not at that time present in so attractive a form as she did now that instruc, tion in the study of history, constitutional law, political economy and natural sciences, which perhaps, at the present day, formed the best preparation for one who intended to aspire to take part in the management of the affairs of his country. He believed that the estimation in which high education was held had been so greatly enhanced that the Universities had nothing to fear from attacks of cupidity, envy, hostility, or ill-will. The worst they had now to apprehend was excessive zeal on the part of those who, with the best intentions, but perhaps with insufficient knowledge and experience, sought to extend more widely and more generally their influence and their usefulness. The University of Cambridge had been steadily increasing its influence and responsibility. In an expanse so wide as that covered by science and learning, the time would never come when new fields would not be open for everyone. Most of what had been done was due to the devotion and ability of their own members—men whose names were more familiar to those present than they were to himself, so that it would be invidious for him to attempt to specify them. The progress of the Cambridge University in the future, as in the past, must be mainly its own work. The time might come when their ever-extending labours—labours undertaken in response to the growing wants of the community—might be received with even wider national recognition than they had hitherto been. So far as it might be in his power, in the office to which they had done him the honour to call him, to serve as one of the links which bound the University to the great body of the people whom she existed to serve and instruct, that service, imperfect as it might be, would be cheerfully given.

THE nineteenth annual dinner of the old students of the Royal School of Mines was held at the Holborn Restaurant on Tuesday. Mr. H. Bauerman occupied the chair, Sir G. Stokes and Sir Lyon Playfair being among the guests. Responding to the toast, "The Mining and Metallurgical Industries," proposed by the Chairman, Prof. Roberts-Austen spoke of the value of metallurgical science. In illustration of its importance, he said that, if the thousands of tons of steel in the Forth Bridge had contained two-tenths less of carbon, the material would have been worthless, that thousands of tons of copper would be useless if it contained a trace of bismuth, and that the eighty millions sterling of gold coin which Sir C. Fremantle had been responsible for would have crumbled away if it had contained one-tenth per cent. of lead. Sir Lyon Playfair, responding for the past professors, in the course of his speech remarked, "We are looking to the promise of the Government hat increased accommodation will be given by the erection of new buildings behind the British Museum at South Kensington. A public man is of no use unless he can look ahead and see the wants of the future. I can take this credit to myself, that for many years I have seen the need of your expansion, and, having some influence in the destiny of the vacant land at South Kensington, I always resisted granting any land opposite the College of Science that might prevent the natural growth of the science institutions at South Kensington. But there was a greater man than myself, the Chancellor of the Exchequer, who very nearly succeeded in grabbing that land for an art gallery. I hope that project is at an end, and that the land long destined for the growth of science will only be applied to that purpose."

Prof. Victor Horsley, F.R.S., will, on Tuesday next (January 19), give the first of a course of twelve lectures, at the Royal Institution, on the brain. Prof. J. A. Fleming will on Saturday (January 23) give the first of a course of three lectures on the induction coil and alternate current transformer. The Friday evening meetings will begin on January 22, when the Right Hon. Lord Rayleigh, F.R.S., will give a discourse on the composition of water.

The Council of the Royal Meteorological Society have arranged to hold at 25 Great George Street, S.W., from March 15 to 18 an exhibition of instruments, charts, maps, and photographs relating to climatology. The Exhibition Committee invite the co-operation of all who may be able and willing to help them, as they are anxious to obtain as large a collection as possible of such exhibits. They will be glad to show any new meteorological instruments or apparatus invented or first constructed since last March, as well as photographs and drawings possessing meteorological interest.

Medical science in France has lost one of its most prominent representatives in Prof. Richet, who died on December 30, 1891. He was seventy-five years of age. M. Richet was a member of the Academy of Sciences, and in 1879 acted as President of the Academy of Medicine.

The death of Dr. Ferdinand von Roemer, Professor of Geology and Palæontology in the University of Breslau, is much regretted by all students of geological science. He was in his seventy-fourth year, and proposed to celebrate his jubilee as Professor on May 10, 1892.

We regret to have to record the death, on the 5th inst., of pneumonia, after a very short illness, of Dr. Albert J. Bernays, Lecturer on Chemistry at St. Thomas's Hospital. He was the author of several works of great value to medical students: "Household Chemistry," "Lectures on Agricultural Chemistry," "First Lines in Chemistry," "Notes for Students in Chemistry," &c.

The rich collection of dried mosses formed by the late Prof. S. O. Lindberg has been acquired by the Botanical Museum of the University of Helsingfors.

Dr. H. Jagor, the well-known ethnologist, is about to proceed to Saigon, and will visit Cambodia and Tonquin. Dr. Jagor recently spent some time in Java, renewing the impressions which he formed nearly thirty-five years ago on his first extensive scientific tour through the countries of the Far East. His book on the Philippines is still a work of great value.

The question of removing the Madras Observatory to a station in the Pulneys or Neilgherries is occupying the attention of the Governments of India and Madras. The transfer is recommended in order to obtain an atmosphere with the minimum of cloud. If this project is carried out, solar observations will be conducted there instead of at Dehra in the North-West Provinces. The Meteorological Department has arranged for a trial of observations in 1892, at Kodai Kanan, in the Pulneys, and Kotaigiri, in the Neilgherries.

It is stated that the Japanese Budget for the next fiscal year includes an appropriation for the construction of meteorological observatories in all the prefectures not yet provided with such establishments. Should the Parliament approve this item, the Empire will be completely covered with a network of observatories.

The Pilot Chart of the North Atlantic Ocean, in its review of December 1891, notes that along the American coast the month began with cool pleasant weather, accompanying a strong anticyclone that hung persistently about Hatteras for several days, giving northerly winds and clear weather off the Atlantic coast and as far south as the Caribbean Sea, and warm south-easterly and southerly winds in the Gulf of Mexico. On the Atlantic, however, December opened with very stormy weather, prevailing throughout almost the entire region from Bermuda to Rockall and the Bay of Biscay. One hurricane was central about 700 miles north-east from Bermuda, and another storm—one of great extent and severity—central about lat. 58° N., long. 25° W. On December 6 and 7 fresh to strong southerly winds prevailed off the American Atlantic coast, whilst a norther set in over the Gulf of Mexico, attending the approach from the westward of an anticyclone that caused northerly gales in the Gulf Stream region and as far south as the Caribbean Sea on the 8th and 9th, with persistent northerly winds and cold weather until the 14th. Various storms reached the Atlantic from the Gulf of St. Lawrence. No ice was reported south of the latitude of Cape Race. There was very little fog, none having been reported until toward the end of the month. On the 22nd a large fog bank extended from about Sable Island to Sandy Hook, accompanying an anticyclone. Reference is made by the Pilot Chart to "the extremely dense fog that overhung London from the 22nd to the 26th."

It is perhaps not generally known that the Annual Reports relating to H.M. colonial possessions frequently contain meteorological observations in addition to other useful information. We extract the following particulars from the Annual Report for the Leeward Islands for 1890. From the records of the temperature, pressure, and rainfall at the Government Laboratory, Antigua, the hottest month there, during that year, was September, with an average maximum temperature of 88°. The absolute maximum was 91°, in June, and the minimum 62°, in April. The average rainfall at 45 stations in the island was 33 inches, and was very much below the usual amount. There were several slight shocks of earthquake during the year, but no damage was done.

In the *Repertorium für Meteorologie* (vol. xiv. No. 10), M. E. Berg discusses the frequency and geographical distribution of heavy daily rainfalls in European Russia, excepting Finland and the Caucasus. The observations refer to the years 1886–90, a rather short period; but in previous years there were not sufficient stations for such an investigation. The paper deals exclusively with falls of between 1·4 and 3 inches, distributed according to months, for the various Governments of the Empire. The results show that the frequency of heavy falls is subject to considerable fluctuation from year to year. The regions of greatest frequency occur on the south-east coast of the Crimea and the extreme south-west of the Empire; on the eastern side of the Dnieper, the region extending to Smolensk and further northwards is also subject to very heavy falls. The northern limit of daily falls of over 3 inches, so far as relates to Central Russia, is the Government of Moscow. The yearly range of frequency reaches a maximum in summer, and, except in the south-eastern districts, the frequency in autumn is greater than in spring. In July and August the great falls extend over very large districts, and at other seasons are generally regulated by the course of the barometric depressions. The following is the average yearly frequency of the heavy falls for the whole Empire, arranged according to seasons: winter, 0·8; spring, 14·3; summer, 106·4; autumn, 20·8. The maximum amount which fell in any day was over 8 inches, in Bessarabia.

THE floating of the particles of cloud or fog, Herr von Frank, of Graz, seeks to explain (*Met. Zeit.*), by the presence of an envelope of aqueous vapour. As an approximate average value for the diameter of droplet with envelope he gives 0·7 mm. Supposing one cubic metre of cloud to hold 3 grammes of water, there would be an interval of 0·2 mm. between the envelopes. When clouds pass over the sun, the shadows of objects are perceptibly lengthened when the darkening occurs, and the author attributes this to refraction by the vapour envelopes. Again, it is difficult to see how water droplets in the form of cloud or fog could exist at such various temperatures, did not the vapour envelopes, as bad conductors of heat (compare Leidenfrost's drops), guard the droplets to some extent from evaporating and freezing. The minute particles must soon be dissipated by the sun's rays, if they were not in a kind of spheroidal state. This heating expands the envelopes, so that the cloud tends to rise; and various phenomena in Nature may be thus explained (*e.g.* the rise of mist in Alpine valleys). Once more, liquid droplets have been observed (by Assmann) floating in air of − 10° C. On meeting a solid body these froze to ice-lumps without crystalline structure. Here, according to Herr von Frank, the vapour-envelopes prevent freezing, till they are ruptured by the solid; the droplet thus loses the bad conductor of heat which protected it, and solidifies so quickly that no crystals can form. The author supposes that with much aqueous vapour in the air, larger drops form, the clouds floating lower; with less aqueous vapour, the drops are smaller and the clouds higher; the thickness of envelope, however, being the same for large and small drops under like conditions of temperature and pressure.

ON January 5 slight shocks of earthquake were felt at Verona, Peschiera on the Lago di Garda, Illasi, Parma, Modena, and Chiavari; and on January 6 slight shocks were felt at Rochester, New York. A telegram from Athens, dated January 11, states that several severe shocks of earthquake, accompanied by subterranean noises, had been felt in Thessaly, especially in the neighbourhood of Larissa.

ON January 11 a fresh stream of lava was issuing from the base of the great cone of Mount Vesuvius on the northern side.

MR. HERBERT JONES, to whom has been intrusted the charge of the animal and vegetable remains found at Silchester during the excavations last year, writes to the *Times* that all the bones which are sufficiently perfect will be carefully measured for comparison with those of modern animals and with bones found on other ancient sites. This examination is yet very far from complete, but Mr. Jones is inclined to think that the remains of the red deer are those of animals considerably larger than are common at the present day. The roe deer appears to have been of about the ordinary size. The bones of the ox, of which the only variety met with is apparently *Bos longifrons*, and those of the sheep are very small; also the horses' bones, two varieties of which are present in the collection. It is probable that the horses were of about the size of Exmoor or New Forest ponies, the cattle much like the Kerry or Brittany breeds, and the sheep similar to those now found on the island of St. Kilda. These results are quite tentative, but Mr. Jones points out that so far as they go they confirm the deductions made by Lieut.-General Pitt-Rivers, F.R.S., from the animal remains found by him at his excavations of a Romano-British village, near Rushmore, on the borders of Wilts and Dorset.

LAST week we referred to a "new herbarium pest" to which Dr. C. V. Riley calls attention in *Insect Life*. Writing on the subject in the *Gardener's Chronicle*, Mr. R. McLachlan points out that an insect of similar habit has been known in Europe for nearly a century. In 1798, Fabricius described a moth, now known as *Acidalia herbariata*, and says of it, "Habitat in herbariis folia plantarum exsiccatarum exedens, Mus. Dom. Bosc." This moth has occasionally been found in England, and has been recorded as infesting herbalists' shops; it has been found nearly all over Europe, and usually in herbaria. A complete account of its transformations by Dr. Heylaerts is given in the *Annales de la Société Entomologique de Belgique* (tom. xxi. pp. 1 to 8, 1878).

MESSRS. PRATT AND SON, Brighton, state in the current number of the *Zoologist* that they have recently set up a specimen of the spotted eagle which was shot at the Sudbourne Hall Estate, Wickham Market, Suffolk, and sent to them for preservation. It proved on dissection to be a male, and its stomach contained the remains of a water rat and a partridge. It was killed on November 4. Another bird had been seen in it company, and was no doubt the one caught at Colchester, as recorded by Mr. H. Laver in the *Zoologist*. The bird sent to Messrs. Pratt and Son was in perfect plumage, beautifully spotted, and evidently in its second year; it weighed 3½ pounds.

THE U.S. Commission of Fish and Fisheries has issued a full and very interesting Report on the fisheries of the Great Lakes. The review is based mainly on data obtained in 1885. While commercial fishing is the chief and practically the only subject considered, the importance of pleasure-fishing on the lakes has been incidentally referred to. Although there are no statistics to show the amount of fish caught by sportsmen and other pleasure-seekers, it is known that the quantity and value of the fish so taken are very considerable. Mr. J. W. Collins estimates, from his own observations, that no less than 10,000 dollars' worth of fish is taken every year from the breakwater at Chicago by men, women, and children who go there in summer for a day's "outing."

PROF. PUTNAM has received 20,000 dollars from a Connecticut gentleman, whose name is withheld, to enable him to search in South America for objects of anthropological interest, to be exhibited at the Chicago Exposition. A part of the exhibit in Prof. Putnam's department will be a fine collection of cliff-dwellers' relics, gathered by the Rev. C. H. Green in Colorado, Utah, New Mexico, and Arizona.

MUCH interest has been excited in New York by the use of electricity in a representation of "Julius Cæsar" which is being given in that city by the Meiningen company. The thunderstorm in the third scene of the first act is said by *Electricity* to be the finest achievement of the kind ever seen in New York. The lightning effects are "exceptionally lurid and realistic."

THE Report of the President of the Johns Hopkins University for 1891 has been issued, and all who are interested in the higher education in the United States will be glad to learn from it that the attendance of students was larger than it had been in any previous year, while their quality was satisfactory. The number of graduates also showed a marked increase. The President notes that electrical engineering has received especial attention, "at a considerable though still inadequate outlay."

IN a paper entitled "The Navajo Belt-Weaver," published by the Smithsonian Institution, Dr. Shufeldt gives an excellent account of weaving as practised by the Navajos. While living in the north-western part of New Mexico, he was able to watch native weavers preparing their beautiful blankets, belts, and sashes; and on one occasion he was fortunate enough to have an opportunity of photographing an Indian woman while engaged in weaving a belt. The reproduction of the photograph is interesting, and is said by Dr. Shufeldt to show the entire scene well. Curves are never found in the figure patterns on the belts or blankets, but horizontal stripes, diagonals, and the lozenge are interwoven with a variety that appears to be almost endless in the matter of design. The leading colours used are red, brilliant orange yellow, a blue, and by combination a green, and, finally, black, white, and grey.

MR. W. T. ROBERTSON gives in the October number of the *Agricultural Gazette of New South Wales* a clear and interesting account of the cultivation and manufacture of tea. The object of the paper is to supply the farmers of New South Wales with information which they may be able to turn to practical advantage. Mr. Robertson does not think that the colony can ever manufacture sufficiently large quantities of tea to put it in a position to compete with China, India, and Ceylon. He sees no reason, however, why the industry should not be conducted on a modest scale. A farmer with children could utilize their labour in the plucking and the light work in manufacture, while the heavier he could undertake himself. If the owner had, say, an acre under cultivation, it would probably bring him in 300 pounds of made tea per annum—enough for his own consumption, with a surplus which he could dispose of at a good profit.

M. PAUL TOPINARD contributes to the new number of *L'Anthropologie* a most interesting paper on the transformation of the animal skull into a human skull. The process may be explained, he thinks, by the influence, direct and indirect, due to the enlargement of the brain. There is also a paper, by M. G. de Lapouge, on various prehistoric skulls from the collection of M. Puech, of Montpellier; and Dr. R. Collignon brings together some facts relating to the colour of the eyes and hair of the Japanese.

A WORK on the great earthquake of Japan, by Prof. John Milne and Prof. W. K. Burton, is now in the press at Tokyo. It will be illustrated by 25 large photo-plates. For the sake of comparison, there will be two plates showing on a small scale the effects of earthquakes in Italy and other countries. All the plates are to be on the finest quality of Japanese paper.

THE prospectus is issued of a *Forstlichnaturwissenschaftliche Zeitschrift*, an organ for laboratories of forest-botany, forest-zoology, forest-chemistry, agriculture, and meteorology. It is to appear monthly in Munich, under the editorship of Dr. Carl Freiherr von Tubeuf; the first number is announced for the current month.

MM. ROUY AND FOUCAUD expect to publish the first fascicle of their new *Flore de France* in the course of the coming year.

MR. ELLIOT STOCK has published a fourth edition of Mr. H. W. S. Worsley-Benison's "Nature's Fairy-Land."

PART 39 of Cassell's "New Popular Educator" has been published. It includes, besides many illustrations in the text, a coloured plate representing the Great Hall, Karnac.

FURTHER details of his experiments upon the colour and spectrum of free gaseous fluorine are contributed by M. Moissan to the January number of the *Annales de Chimie et de Physique*. The apparatus employed was, of necessity, constructed of platinum, and M. Moissan prefaces his description of it with an account of a few later observations upon the action of fluorine on platinum. He finds that fluorine may be stored for days in his vessels of platinum without the slightest action occurring, provided the precautions which he has previously described are taken to remove the last traces of hydrofluoric acid vapour from the gas. Moreover, even at 100° fluorine was found incapable of effecting the least alteration in a spiral of platinum wire immersed in the heated gas. It is not until a temperature superior to 400° is attained that corrosion commences, and the platinum vessel requires heating to low redness before rapid action occurs.

IN order to ascertain whether fluorine, like other members of the family of halogens, was possessed of a distinctive colour, a tube of platinum, one metre long and two centimetres diameter, was procured. The two ends of this tube were closed by disks of faultlessly clear and colourless fluor-spar, a commodity of great rarity. Near the ends were inserted narrow side-tubes of platinum for the entrance and exit of the fluorine; the ends of these side-tubes were closed by small, tightly-fitting stoppers, also of platinum. The whole apparatus held about 200 cubic centimetres of gas. In performing the experiment, pure fluorine was allowed to stream through the apparatus until a crystal of silicon held at the end of the exit-tube burst into flame. The stoppers were then inserted, and the colour of the inclosed gas examined against a white background. For the sake of comparison a similar observation was made with a blackened glass tube, closed at the ends with plate-glass disks, and filled first with air and afterwards with chlorine. The colour of fluorine is then seen to be somewhat paler than that of chlorine, and decidedly more yellow—just what one would expect from the position of fluorine at the head of the halogen family group.

THE experiments made with the view of determining the spectrum of fluorine were carried out in the following manner. A beautiful little piece of platinum apparatus was constructed, consisting of a wide tube, brightly polished inside and supported vertically. It was closed at each end by a platinum cap, through each of which passed a stout electrode rod. Each rod was in turn connected with one of the wires from a Ruhmkorff coil, worked by six Bunsen cells. Two pairs of these rods, which served for the passing of the spark, were employed alternately, one pair made of platinum and the other of gold, so that the lines due to the terminals could be eliminated. In order to permit the spectroscopic observation of the spark, a short horizontal tube of the same diameter was attached at the middle of the vertical tube, opposite to the two terminals; the open front end of this horizontal tube was closed with a window of perfectly colourless fluor-spar. Narrow entrance and exit tubes were also attached near the ends of the vertical tube in order to enable the apparatus to be filled with any gas at pleasure. The spectrum given by passing the spark between platinum terminals in an atmosphere of nitrogen was first observed; then the nitrogen was displaced by fluorine, and the spark again passed and observed. The two observations were then repeated with terminals of gold. The positions of the lines in the spectrum of fluorine thus obtained were finally confirmed by observations of the dissociation spectra of hydrofluoric acid and the gaseous fluorides of silicon, carbon, and phosphorus. The results show that the spectrum of fluorine consists of thirteen bright red lines, whose positions have previously been given in a preliminary note by M. Moissan, and which will be found in NATURE, vol. xliv. p. 623.

THE additions to the Zoological Society's Gardens during the past week include a Toque Monkey (*Macacus pileatus* ♀) from Ceylon, presented by Mr. John Bell; a Vervet Monkey (*Cercopithecus lalandii* ♂) from South Africa, presented by Mr. R. J. White; a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, presented by Mr. J. Buckingham; a White-tailed Sea Eagle (*Haliaëtus albicilla*) from Asia Minor, presented by Sir H. F. de Trafford, Bart., F.Z.S.

OUR ASTRONOMICAL COLUMN.

STONYHURST DRAWINGS OF SUN-SPOTS AND FACULÆ.—A little more light on the relation of faculæ to spots is contained in a paper communicated by the Rev. Walter Sidgreaves to the Royal Astronomical Society in December 1891. None of the drawings of solar phenomena made at Stonyhurst under the late Father Perry's direction afforded a clear instance of faculæ preceding the birth of a spot. Neither was there any positive evidence of the birth of a spot before the appearance of faculæ; while every spot of importance was attended from the beginning with at least a small surrounding of faculæ. No absolute priority of one or the other could therefore be regarded as proved. During the minimum of 1889, however, Father Sidgreaves observed two cases in which faculæ undoubtedly appeared before any trace of a spot could be detected. "On June 29, a small patch of faculæ was sketched near the eastern limb, in latitude $-40^{\circ}\cdot5$, and in longitude 252°. There was no trace of a spot in the neighbourhood, and neither spot nor faculæ had been seen near the position for years. On the following day a small round spot appeared in latitude $-40^{\circ}\cdot3$, and longitude $252^{\circ}\cdot2$—that is, in the midst of the faculæ, the faculæ on this day being visible only just close round the spot." A similar development was recorded at the end of July, in latitude -22°, and longitude 155°. Both the faculæ and spots were new, and clearly distinguished; hence, so far as these observations are concerned, their evidence clearly indicates that the birth of some spots is preceded by the appearance of faculæ.

SOME APPARENTLY VARIABLE NEBULÆ.—Mr. Lewis Swift, in his ninth catalogue of new nebulæ discovered at the Warner Observatory (*Astr. Nach.*, 3004), noted his inability to re-find a nebula previously seen in R.A. 3h. 36m. os., Decl. $95^{\circ}\ 2'\cdot1$. A further examination of the region led this observer to suspect that the object formerly located in the position given must have been a comet (*Astr. Nach.*, 3014). Dr. Dreyer has looked up the observations of nebulæ in the region in question, and the information thus obtained leads him to conclude that the object is most probably a variable nebula (*Monthly Notices*, December 1891). The nebula appears to have been visible in 1827, 1848, 1850, 1851, 1856, and 1889, while it was not seen in 1785, 1855, 1864, 1865, 1872, 1875, 1877, and 1890, although it was specially looked for on two or three of these occasions. The two nebulæ *h* 229 and *h* 882, which Prof. Winnecke found were periodically variable (and his observations were supported by later ones made by other observers), are believed by Dr. Dreyer to owe their apparent fluctuations of light to disturbing atmospheric influences. *h* 1452 is a similar diffused nebula with slight condensation, which Sir John Herschel suspected to be variable. But in this case, also, conclusive evidence of variability is wanting.

THE CRYSTAL PALACE ELECTRICAL EXHIBITION.

THE Electrical Exhibition at the Crystal Palace was opened on Saturday last. It is an Exhibition of great interest, not only to electricians but to the public, and should do much to enlighten ordinary visitors as to the methods and results of electrical science. At the present stage we need refer only to some parts of the display. When the Exhibition is complete, we shall give a fuller account of the principal exhibits.

Much attention will, of course, be devoted to the section containing the generating machinery. Every important type of generating apparatus is shown in this department. Among the large exhibits is a 350 horse-power Davey, Paxman engine, capable of driving a powerful Kapp dynamo; and Messrs. Crompton and Co. exhibit a dynamo combined with a Willans engine of 200 horse-power—the dynamo being capable of running nearly 4000 8 candle-power glow lamps. There are many gas-engines, some of which are shown by Messrs. Crossley Brothers, the original proprietors of the Otto gas-engine. Other exhibitors are the British Gas Engine Company, with cycle engines; Messrs. Dick Kerr and Co., with the Griffin gas-engine; Messrs. J. E. H. Andrew and Co., with the Stockport gas-engine; and Messrs. Day and Co., with a new form of gas-engine. All of these engines are used to drive dynamos of various makers.

A most interesting exhibit is sent by the Postmaster-General, who displays a complete set of telegraphic apparatus. A large projector or search-light is shown by Messrs. Crompton and Co., who also exhibit, among other things, an electric crane capable of hoisting about a ton. No fewer than 10,000 glow lamps in one group are shown on a wire screen by the Edison-Swan Company, and arc lights, poles, regulators, and samples of submarine cables are displayed by Messrs. Siemens Brothers. A model of an electric launch built for use on the Thames is included among the exhibits of Messrs. Woodhouse and Rawson; and a full-sized electric tram-car is shown by the Brush Electrical Engineering Company, who have also in the Exhibition various dynamos, arc lamps, and other objects.

The exhibits in connection with telephony cannot fail to attract notice, and will do more than any amount of verbal explanation to make its principles intelligible. The National Telephone Company are arranging rooms where London operatic and other performances may be heard by visitors on payment of a small fee; and two stands belonging to the Consolidated Telephone Company, one in the nave, and another in the gallery, are connected by telephone.

Messrs. Croggon and Co. show lightning conductors of the latest type applied to a model church, in connection with which a peal of bells are rung by electricity from a keyboard. Various styles of fittings for domestic electric lighting are displayed in a series of rooms in the galleries; and these will no doubt attract very general attention. The Medical Battery Company show well how electricity is applied in various departments of medical practice.

The Exhibition has been organized with so much care, and on so great a scale, that it is sure to be widely appreciated.

THE SMITHSONIAN INSTITUTION.

PROF. S. P. LANGLEY, Secretary of the Smithsonian Institution, has submitted to the Board of Regents his Report for the year ended June 30, 1891. It includes, among other things, an account of the work placed by Congress under the charge of the Institution in the National Museum, the Bureau of Ethnology, and the National Zoological Park.

As in a previous Report, Prof. Langley refers to the fact that owing to the changing value of money the purchasing power of the Smithsonian Fund, in the language of a Committee of the Regents, "while nominally fixed, is growing actually less year by year, and of less and less importance in the work it accomplishes with reference to the immense extension of the country since the Government accepted the trust"; and he urges that the fund should be enlarged, "if only to represent the original position of its finances relatively to those of the country and institutions of learning." If we may judge from the general tone of the Report, the required increase is more likely to be obtained from private benefactors than from the Government. Quite lately, as we recorded at the time, the Institution obtained from Mr. Thomas G. Hodgkins, of Setauket, Long Island, a handsome donation of 200,000 dollars.

By reducing expenses in other directions, the Institution has been able to revert to its early practice of aiding investigators carrying on original research. Among the special grants may be named that of 500 dollars to Prof. A. A. Michelson, of Clark University, for continuing his important work upon a universal standard of measure founded on the wave-length of light; also a sum of 600 dollars placed at the disposal of Prof. E. W. Morley, to procure a special apparatus for determinations of the density of oxygen and hydrogen, an investigation requiring extreme precision and delicacy of manipulation, and promising results of wide application; while a sum of 200 dollars was placed at the disposal of Dr. Wolcott Gibbs, for investigations at his laboratory in Newport upon chemical compounds.

To Prof. E. S. Holden, Director of the Lick Observatory, California, a grant of 200 dollars was made, to assist in perfecting his apparatus for securing photographs of the moon. The results of his studies in this field Prof. Holden has offered to place at the disposal of the Smithsonian Institution for publication at some future day, should it seem desirable.

Prof. Pickering, Director of the Harvard Observatory, has also placed at the disposal of the Institution for publication a very valuable series of photographs of the moon, which have been secured at the Harvard Observatory, and which will be supplemented by photographs to be taken at the Harvard Observatory high-altitude station in the mountains of Peru.

The Director of the Paris Observatory, Admiral Mouchez, has likewise promised his co-operation in securing lunar photographs of the highest degree of excellence now attainable.

With the aid of these three prominent Observatories, which have given especial attention to the subject of lunar photography, it is proposed to prepare a volume representing upon a large scale the best results that can be secured, thus placing on record a detailed description of the lunar surface, the value of which for comparison with observations and photographs of the future can scarcely be over-estimated.

In furtherance of the plan for the establishment of standard sizes of screws and of diameters of tubing, &c., for astronomical and physical apparatus—a subject which has received the attention of Committees of the National Academy of Science, as also of the American Association for the Advancement of Science—a few standards have been tentatively adopted, and copies of these are attainable by all interested in securing uniformity in this class of work.

No memoir was added to the Smithsonian "Contributions to Knowledge" during the year, but a paper presenting an account of new experiments in aëro-dynamics by Prof. Langley was in course of preparation. These investigations were made at private charge, but it is in accordance with a policy long ago counselled by the Board of Regents that they should be published in a volume of the Institution's "Contributions."

A statement relating to the establishment of an Astro-physical Observatory as a part of the Smithsonian Institution has already appeared in NATURE (vol. xliv. p. 254). With regard to this Observatory, Prof. Langley recalls the fact that preparations for it had been made by the late Secretary, Prof. Baird. A special interest was taken in the proposed Astro-physical Observatory by the late Dr. J. H. Kidder, formerly Curator of Exchanges in the Smithsonian Institution, and the sum of 5000 dollars was received from his executors for this purpose. A like sum of 5000 dollars was presented personally to the Secretary by Dr. Alexander Graham Bell for prosecuting physical investigations, and particularly those upon radiant energy; and this sum was, with the consent and approval of the donor, placed to the credit of the Smithsonian Institution upon the same footing as the Kidder bequest. Congress was asked to appropriate 10,000 dollars for annual maintenance, and this sum was granted, and became available on July 1 last.

Speaking of the National Museum, Prof. Langley notes that at the close of the fiscal year the present building had been occupied one decade, and that during that period the total number of specimens of all kinds catalogued and ready for exhibition or study had increased from about 193,000 to more than 3,000,000. This rate of growth, as he says, is "probably unprecedented in the history of Museums." The development of the collections has not, however, proceeded "in such a symmetrical and consistent manner as is essential to the necessities of the work"; and such is the competition for "material," that the Museum is often unable to hold its own, not only with foreign Governments and with local Museums in other American cities, but even with private collectors. More space and a larger staff of curators are urgently needed.

Some interesting statements are made with regard to the work of the Bureau of Ethnology. At the close of the last fiscal year, specific exploration of the mound area by the United States ceased, except so far as it was found necessary to correct errors and supply omissions. A large part of the results of the work of several past years is in print, though not yet issued. A plan of general archæological field work has been practically initiated by a systematic exploration of the tide-water regions of the District of Columbia, Maryland, Virginia, and the Ohio Valley, which determined among other points of interest that the implication of great antiquity to forms of stone implements of America which have hitherto been classed with European palæoliths in age as well as in fabrication has not been substantiated by the ascertained facts.

Careful exploration of the Verde Valley in Arizona followed that before made of other parts of the large south-western region of the United States in which the presence of many extensive ruins has given rise to fanciful theories. The data as classified and discussed have shown that the hypothesis of a vanished race enjoying high civilization, which has been proposed to account for the architecture of the ruined structures is unnecessary.

The attention already given to Indian languages has been continued, in recognition of the fact that some of them are fast passing beyond the possibility of record and study, and that the ethnic classification of all of the Indian tribes can be made accurate only through the determination of their linguistic divisions and connections. The studies upon aboriginal mythology and religious practices have also been continued, with special attention to the ghost dances and "Messiah religion," which have produced important consequences bearing upon the problem of proper national dealing with the Indians. Official misconception of their religious philosophy, which has been forcedly transfigured by the absorption of Christianity so as to present more apparent than actual antagonism to civilization, has occasioned needless loss of life and treasure.

With regard to the National Zoological Park, Prof. Langley says the primary object for which Congress was asked to establish it was to secure the preservation of those American animals that are already nearly extinct, and this object it was thought would be best attained by the establishment of a large inclosure in which such animals could be kept in a seclusion as nearly as possible like that of their native haunts. Congress has been so unwilling to provide the necessary funds that the Smithsonian Institution has found it hard to realize the original design. Nevertheless, the development of the Park proceeded steadily during the year, as few changes as possible being made in its natural features. Trees have been planted in different parts, in some places for ornament, in others to secure the proper seclusion of animals; and a considerable area of open land has been prepared for lawn and pasture grounds. Near what is for the present the principal entrance is a disused quarry, from which arise precipitous cliffs and bold rocky ledges. It seemed particularly well fitted for the construction of dens and yards for bears. A series of caverns has been blasted in the rock and inclosed by a stout iron fence. Within the fence are large and commodious yards, in which have been constructed bathing pools, with water flowing constantly from a large spring outside the Park. The result has been a place admirably adapted for the health and general welfare of the animals, as well as a most picturesque and striking feature.

Already the establishment of a National Zoological Park under the management and guidance of the Smithsonian Institution has attracted the attention of similar institutions and of naturalists in other countries, and liberal offers of gifts and exchanges have been made.

From Sumatra, from the islands of the Pacific, from the shores of Alaska, and from American national parks, have come offers of gifts or terms of purchase, but it has been necessary to defer acceptance of all these offers owing to lack of funds even to pay for transportation.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, December 17, 1891.—Dr. W. H. Perkin, F.R.S., Vice-President, in the chair.—The following papers were read:—The composition of cooked vegetables, by Miss K. J. Williams. The vegetables examined after cooking were the artichoke (Jerusalem), broad bean, haricot bean, beetroot, cabbage, carrot, cauliflower, celery, cucumber, lettuce, mushroom, onion (Spanish), parsnip, pea (green), potato, radish, salsafy, scarlet-runner, sea-kale, spinach, tomato, turnip, and vegetable marrow. Ultimate analyses of the cooked vegetables were made, and their heats of combustion determined. The woody fibre, cellulose, fat, and the carbohydrates convertible into glucose were also estimated.—Metallic hydrosulphides, by S. E. Linder and H. Picton. The authors have investigated the sulphides of copper, mercury, arsenic, antimony, cadmium, zinc, bismuth, silver, indium, and gold; and find that, with the single exception of bismuth, all these metals form hydrosulphides of a more or less complicated character. These compounds, when treated with acids, in most cases lose part of their sulphuretted hydrogen, and form still more complicated hydrosulphides. Copper forms a soluble hydrosulphide possessing the composition $7CuS,H_2S$; this, on treatment with acetic acid in presence of excess of sulphuretted hydrogen, yields a substance of the composition $9CuS,H_2S$; if no excess of sulphuretted hydrogen be present, the compound $22CuS,H_2S$ is obtained. Hydrochloric acid produces still further condensation. Mercuric sulphide forms products approximately represented by the formulæ $31HgS,H_2S$ and $62HgS,H_2S$. The latter formula represents the substance obtained in presence of acid, and is a very stable substance. Zinc sulphide solution obtained from the hydroxide contains about 14 per cent. excess of sulphur as sulphuretted hydrogen; in presence of acetic acid a product represented approximately by the formula $12ZnS,H_2S$ is obtained. The authors consider that their results support the conclusion that the metallic sulphides are in most cases polymerides of very high molecular weight.—The physical constitution of some sulphide solutions, by H. Picton. The author has specially examined the solutions of mercuric, antimonious, and arsenious sulphides, and finds that in each case the sulphide is present in the form of very finely divided particles. In the "solution" of mercuric sulphide particles are visible under the microscope with a magnifying power of 1000 diameters, and are not diffusible even in the absence of a membrane. Arsenious sulphide may exist in "solution" in three distinct types of subdivision. In the first solution, the particles are just visible. In the second, the particles are smaller but not diffusible, and scatter and polarize a beam of light sent through the solution. The third solution is diffusible in the absence of a membrane, but the optical behaviour shows that particles really exist in the solution.—Solution and pseudo-solution, Part I., by H. Picton and S. E. Linder. The authors consider that there is a continuous series of grades of solutions passing without break from a crystallizable solution to one containing the substance in a state of fine subdivision. They regard the very finely divided particles in the lower grades of solutions—colloid solutions—as large molecular aggregates retaining many of their molecular properties. On passing up through the different grades of solution, the particles become smaller, and the forces holding them in solution become more definitely those of chemical attraction. A new property is described, which holds for a large range of solutions extending from pseudo-solutions to crystallizable solutions. This property consists in the repulsion of the dissolved substance as a whole from one of the electrodes of a battery immersed in the solution. Thus, in the case of colloidal arsenic sulphide, the sulphide aggregates are repelled from the negative electrode; they are also repelled, though much less strongly, from the positive electrode. An exactly similar phenomenon is observed in the case of the crystallizable colouring-matter Magdala-red when dissolved in absolute alcohol, the repulsion being, however, from the positive electrode, no perceptible repulsion from the negative electrode being observable. This property is of much interest in itself, but also as exhibiting similarities between the different grades of solution.—The charge proceeding in an acidified solution of sodium thiosulphate when the products are retained within the system, by A. Colefax. The action of acids on sodium thiosulphate was investigated by allowing the action to proceed for a known time, then titrating with standard iodine solution, and subsequently determining the amount of acidity of the solution. The author concludes that the change proceeding in an acidified solution of sodium thiosulphate, when the products, viz. sulphurous acid and sulphur, are retained in the system, is a reversible one, a limit being reached a certain time from the time of acidification. The value of this limit is affected by the state of concentration, the ratio of the mass of acid relatively to the sodium thiosulphate, the nature of the acidifying acid, and the temperature. Sulphurous acid cannot prevent the decomposition of thiosulphuric acid. The presence of both products of the change in the system seems essential to the attainment of a limit value, for sulphurous acid, when initially free in the system at the time of acidification, has but little influence upon the values expressing the extent of the chemical change. A higher temperature favours the interaction of sulphurous acid and hydrogen and sodium thiosulphates; but this is a secondary change, which proceeds at lower temperatures with extreme slowness. Spring's statement that sodium trithionate is formed by the interaction of iodine, sodium sulphite, and sodium thiosulphate, seems to be wrong: the author finds that on adding a solution of these two salts to one of iodine no sodium trithionate is produced; the sodium sulphite is completely oxidized to sulphate.—The action of sulphurous acid on flowers of sulphur, by A. Colefax. Contrary to the statement of Debus, sulphurous acid acts on flowers of sulphur at the ordinary temperature, producing thiosulphuric acid and a polythionic acid, probably trithionic acid; no pentathionic acid was found. The action occurs even in the dark, and proceeds much more rapidly at a temperature of 80°–90°. Water has no action on flowers of sulphur, either at ordinary temperatures or at this higher temperature.—The α and β modifications of chlorobenzene hexachloride, by F. E. Matthews. A mixture of these two substances with oily products is obtained by passing chlorine gas through chlorobenzene in presence of dilute caustic soda. They are both colourless crystalline substances, which on heating, either alone or with alcoholic potash, give a quantitative yield of 1 : 3 : 4 : 5 tetrachlorobenzene. The β modification of chlorobenzene hexachloride, $C_6H_5Cl_7$, melts at about 260°, and is more stable and less volatile with steam than the α compound, which melts at about 146°.—The sulphochlorides of the isomeric dibromonaphthalenes, by H. E. Armstrong and E. C. Rossiter. The sulphochlorides of five of the dibromonaphthalenes have been investigated. It is to be noted that, while the dibromonaphthalenes all have higher melting-points than the corresponding dichloro-derivatives, no such relation holds between the sulphochlorides of corresponding dichloro- and dibromonaphthalenes.—The action of alcohols on sulphonic chlorides as a means of producing ethereal salts of sulphonic acids, by H. E. Armstrong and E. C. Rossiter. The authors find that the ethereal salts of several but not all of the dibromonaphthalenesulphochlorides may be prepared by simply boiling them with dehydrated alcohol.—The action of bromine on α and β bromonaphthalene, by H. E. Armstrong and E. C. Rossiter. The authors have succeeded in resolving into its constituents the mixture of dibromonaphthalenes obtained on brominating naphthalene with two molecular proportions of bromine.—The action of bromine on a mixture of ortho- and paranitro-α-acenaphthalide, by H. E. Armstrong and E. C. Rossiter. When a mixture of ortho- and paranitro-acenaphthalides is brominated, the ortho-compound, not the para-, as previously supposed, is alone attacked.—Camphrone, a product of the action of dehydrating agents on camphor, by H. E. Armstrong and F. S. Kipping. Several chemists have described camphorone, $C_9H_{14}O$, as a product of the action of sulphuric acid on camphor; the properties of this substance, however, as given by different chemists, show great variations. The authors, on preparing the substance and purifying it by means of its hydrazone, find its composition to be, not $C_9H_{14}O$, but probably $C_{10}H_{12}O$.—Metaxylenesulphonic acids, Part II., by G. T. Moody. When acetmetaxylid (1 : 3 : 4) is sulphonated, metaxylidinesulphonic acid ($Me_2 : NH_2 : SO_3H$ = 1 : 3 : 4 : 6) is obtained in slender needles soluble in water. On diazotizing, and boiling with alcohol, it yields ethoxymetaxylenesulphonic acid; if the diazo-compound be boiled with hydrobromic acid, the corresponding bromoxylene-sulphonic acid is obtained in slender needles. The salts of the above acids are described.—The action of propylene bromide on the sodium derivatives of ethylic acetoacetate and ethylic benzoylacetate, by W. H. Perkin, Jun., and J. Stenhouse. The preparation and properties of the ethyl salts of acetylmethyltrimethylenecarboxylic acid, methyldiacetyldiadipic acid, and benzoylmethyltrimethylenecarboxylic acid, and their derivatives, are described.—Derivatives of tetramethylene, by W. H. Perkin, Jun., and W. Sinclair. The authors have prepared the monobromo-derivative of tetramethylenecarboxylic acid. Its hydroxy-, acetoxy-, and ethoxy-acids are also described, together with tetramethylene, methyl, and ethyl ketones and their reduction products.

Geological Society, December 23, 1891.—W. H. Hudleston, F.R.S., Vice-President, in the chair.—The following communications were read:—On part of the pelvis of *Polacanthus*, by R. Lydekker.—On the gravels on the south of the Thames from Guildford to Newbury, by Horace W. Monckton. The author stated that the greater part of the hill-gravel in the district referred to belonged to the Southern Drift of Prof. Prestwich, and that the valley-gravels for the most part consisted of material derived from the Southern Drift. Small patches of Westleton Shingle and Glacial Gravel occurred near Reading and Twyford. He divided the Southern Drift into three classes:—(1) Upper Hale type, characterized by the abundance of small quartz pebbles and the scarcity of chert. (2) Chobham Ridges type, with abundance both of small quartz pebbles and chert. (3) Silchester type; quartz scarce, and chert very rare or altogether absent. He described the localities at which these types occurred and their limits of distribution, and then referred to the Glacial Gravels of the Tilehurst plateau, which he believed to have been deposited before the excavation of the valley of the Thames between Reading and Goring. The author then dealt with the valley-gravels, which he believed to be mainly derived from the hill-gravels of the immediate neighbourhood, and showed how the various types of hill-gravel had contributed materials for the valley-gravels. He explained that, with the possible exception of the Westleton Shingle, he entirely rejected the theory of marine action in connection with the formation of these gravels, and thought that the Glacial Gravels were probably for the most part due to floods during melting of large quantities of ice. The remaining gravels, he believed, had been spread out by water in valleys; as denudation proceeded, the gravel, by protecting the ground upon which it lay, came to stand out as the capping of the plateaux and hills; as the gravel itself was denuded, the materials were carried to lower levels, forming new gravels; and this process has been repeated up to the present time. He explained that Prof. Rupert Jones and Dr. Irving had already adopted this theory in part, but that he differed from them in the entire exclusion of marine action. After the reading of this paper there was a discussion, in which the Chairman, Mr. W. Whitaker, Dr. Hicks, Mr. R. S. Herries, Prof. Grenville Cole, and Mr. Monckton took part.—The Bagshot Beds of Bagshot Heath, by Horace W. Monckton.

PARIS.

Academy of Sciences, January 4.—M. Duchartre in the chair.—On an abnormal mode of propagation of waves, by M. H. Poincaré.—Remarks on the mechanism of the fixation of nitrogen by the soil and plants, *à propos* of a reply by MM. Schlœsing and Laurent, by MM. Arm. Gautier and R. Drouin. —Note on the late Herr Kronecker, by M. Hermite. This is an obituary notice on Herr Kronecker, the renowned mathematician, who died at Berlin on December 29, 1891, after a short illness.—On electro-capillary phenomena and differences of potential produced by contact, by M. Gouy. In order to obtain some new information as to contact force, the author has measured the surface tensions of more or less polarized liquid amalgams, in comparison with mercury. The first experiments were made with amalgams containing 1/1000 part of zinc, cadmium, lead, tin, bismuth, silver, and gold. And the results lead to the provisional statement that in a system consisting of non-polarized mercury, acidulated water, and an amalgam of 1/1000 more or less polarized, the superficial tension of the amalgam is a function of the apparent difference of potential between the amalgam and the mercury.—The direct combination of nitrogen with the alkaline-earthy metals, by M. Maquenne. The metals employed have been used under the form of electrolytic amalgams. They unite rapidly with nitrogen when heated in a current of that gas, in the absence of carbon and its compounds; there is thus no intermediate formation of a metallic carbide. The ease with which the combination takes place may lead to a new interpretation of the synthesis of alkaline-earthy cyanides by the simultaneous action of nitrogen and carbon on the corresponding bases.—Nitration of hydrocarbons of the methane series, by M. Konovaloff. The normal hydrocarbons of the methane series may be nitrated by weak nitric acid, and give as principal products secondary nitro compounds. The yields are relatively good, and the method may be used to prepare secondary nitro-paraffins. Corresponding amines and ketones are obtained by reduction of these products.—On the embryogeny of *Sagitta*, by M. S. Jourdain.—Influences of electric discharge during thunderstorms on apparatus registering terrestrial magnetism, by M. Em. Marchand. An examination of the tracings drawn by the registering magnetometers at Lyons Observatory since 1887, and the records of thunderstorms, establish a connection between lightning discharge and magnetic disturbances which has been frequently noted. Seventy-three lightning discharges had their time of occurrence and approximate distance recorded during the last five years. Forty of these were accompanied by well-marked disturbances of the declination curve; in fifteen cases the oscillatory movements were slight, but could be easily found when the time of discharge was known; thirteen cases were doubtful; and in five cases absolutely no trace of an abnormal oscillation could be detected. No simple relation appears to exist between the distance of the discharge and the amplitude of the oscillation they produce. Some very violent thunder-claps have only been accompanied by slight magnetic perturbations, whilst others, far more feeble and distant, have produced very large ones.—On the absolute values of the magnetic elements on January 1, 1892, by M. Th. Moureaux. The following are the values at the Parc Saint-Maur Observatory, deduced from the mean of the horary observations obtained on December 31, 1891, and January 1, 1892, and referred to the absolute measures made on December 27, 29, and 31, and on January 2:—

Elements.	Absolute values on January 1, 1892.	Secular variation in 1891.
Declination	15° 30′·7	−5′·2
Inclination	65° 9′·0	−1′·6
Horizontal force ...	0·19580	+0·00026
Vertical force	0·42278	+0·00006
Total force	0·46592	+0·00016

—On the soundings of the Bourget Lake, and some other lakes in the Alps and the Jura, by M. A. Delebecque.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Elements of Agriculture: Dr. W. Fream (Murray).—Annuaire, 1892, par le Bureau des Longitudes, Paris (Gauthier-Villars).—Monograph of the British Cicadæ, Part 8: G. B. Buckton (Macmillan).—Richard Wiseman: Surgeon-General Sir T. Longmore (Longmans).—U.S. Commission of Fish and Fisheries; Part xv., Report of the Commissioner for 1887 (Washington)—Observations made at the Blue Hill Meteorological Observatory, Mass., U.S.A., in the Year 1890 (Camb., Mass., Wilson).—Nature's Fairy-Land: H. W. S. Worsley-Benison; 4th edition (E. Stock).—A Cyclopædia of Nature Teachings (E. Stock).—A Treatise on the Ligation of the Great Arteries in Continuity: C. A. Ballance and W. Edmunds (Macmillan).—Rand, McNally, and Co.'s Indexed County and Railroad Pocket Maps and Shippers' Guides of Connecticut, Massachusetts, Pennsylvania, and Washington (Stanford).—Guide to the Examinations in Magnetism and Electricity, and Answers to Questions: W. J. Harrison (Blackie).—The Universal Atlas, Part 10 (Cassell).

PAMPHLET.—The Evolution of Mind in Man: H. B. Medlicott (Kegan Paul).

SERIALS.—Bulletin of the N.Y. Mathematical Society, vol. i., Nos. 2 and 3 (New York).—Journal of the Asiatic Society of Bengal, vol. lix., Part 2, 1890; Supplement No. 2 (Calcutta).—La Nuova Scienza, vol. vi. fasc. v. (Todi, Umbria).—Journal of the College of Science, Imperial University of Japan, vol. iv. Part 2 (Tōkyō).—Zeitschrift für wissenschaftliche Zoologie, liii. Band, 2 Heft (Williams and Norgate).—Notes from the Leyden Museum, vol. xiii. Nos. 3 and 4 (Williams and Norgate).—The Record of Technical and Secondary Education, No. 2 (Macmillan).—Journal of Physiology, vol. xii., Nos. 5 and 6 (Cambridge).—Journal of the Royal Microscopical Society, December (Williams and Norgate).

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