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FOOD AND ITS FUNCTIONS.

Food and its Functions: a Text-book for Students of Cookery. By James Knight, M.A., B.Sc., F.C.S., F.G.S., &c. Pp. viii + 282. (London: Blackie and Son, Ltd., 1895.)

AS a scientific work bearing upon the culinary art, "Food and its Functions," from the pen of Mr. James Knight, of Glasgow, must form a welcome addition to that branch of literature. The work is described as "a text-book for students of cookery," and the author further explains in his preface that it is an expansion of a course of lectures on dietetics, which he was privileged to deliver to the students in training at the Glasgow Schools of Cookery, and that it aims at supplying such students with a complete manual of the theoretical part of their curriculum. Of the scientific soundness and great value of this book to a considerable section of the educated classes there can be no question, but when we consider its merits as a text-book for students of cookery, we are forced to inquire what sort of students? If for such as desire to become teachers of practical cooking, and have therefore to acquire a certain amount of knowledge of the chemistry of the art and the values of foods from a scientific standpoint, then much of Mr. Knight's information and careful reasoning will certainly be useful. Still more valuable should the book be to the nursing sisterhood of the United Kingdom; and to many medical practitioners also, who have to prescribe food as well as medicine for the sick, and might perhaps be a little more closely acquainted with that part of their responsibilities. But to the ordinary learner of the business of a cook, who wants to practise rather than to preach or advise, we much fear that "Food and its Functions" cannot but be too abstruse and overladen with dry scientific details. The theoretical instruction of cookery classes, the students of which are merely seeking to become proficient workwomen, cannot, we think, speaking from experience, be too carefully pruned down, and put into words that can easily be "understanded of the people." A few simple chemical facts in regard to the different culinary processes, a few touching food-stuffs, with a judiciously condensed explanation of the dietary value of the latter, are very desirable, and may be inculcated with some degree of hopefulness. But if the rubicon of moderation be crossed, the teacher's effort is but lost labour. Not one in fifty can really follow or remember it, and the lesson falls verily upon stony ground. For this cause we are constrained to hold in question the advisability of over-instructing the instructors. A little knowledge is a dangerous thing, as we all know, and it is, moreover, a fruitful source of vanity. When the holder of a brand-new diploma—crammed with fine words—proceeds to teach, what a temptation there must be to let some of them loose, especially before an audience unable to detect inaccuracies! But when he or she, veneered with a little anatomical smattering by the aid of Mr. Knight's text-book, proceeds to chalk out on the blackboard diagrams of the alimentary canal, the stomach, the contents of the chest and abdomen, the thoracic duct and lymphatic vessels, with a few words concerning "Bernard's theory of Glycogenesis," and Pavy's view of the same, how learned the board-school-girls, or evening continuation class (who, between ourselves, want to know how to make "toad-in-the-hole") will think her, and how frightened they will be at her awful disclosures as to the secrets of their interior economies! But to be serious, while granting to the full the undoubted importance of Mr. Knight's section on the physiology of digestion to the purely theoretical student, and its value in the hands of the trained nurse, who ought, be it added, to be equally well trained in sick cookery, we cannot admit that it is necessary, or indeed advisable, for ordinary cookery classes; neither can we agree with him when he says that "it is impossible to secure the rational treatment of food without at least a slight acquaintance with" its "subsequent course within the body itself."

Having thus endeavoured to indicate the classes of readers who ought to benefit by Mr. Knight's three scientific sections, and the class for whom we consider them inapplicable, save in so far as a few simple facts to be found in the first two are concerned, we return with no little satisfaction to "parts iv. and v.," in which a goodly store of information is to be found, which ought to be appreciated not only by mere students of cookery, but by every one interested in the question of diet in relation to health, and the still more difficult one of foods best adapted to persons suffering from various forms of illness. In the former section, "Foods in detail," we find explanatory notes as to the chemical properties and dietetic value of dairy produce, eggs, animal food, fish, cereals, legumes, root-vegetables, green-stuff, fungi, fruits, accessories and condiments, beverages, alcoholic drinks, wines, ale and cider, with aërated and mineral waters. The culinary methods which are best suited to many of these, in view to their preparation for food, are adverted to, and the important question of the digestibility of each not lost sight of. The first three lessons in part v., "Dietetics," are of general interest, and ought to be studied by every housewife, for in them will be found the advice, already alluded to, touching dietary scales, diet in relation to infancy, adolescence and age, and referring to food in times of sickness, with special models to meet the cases of standard complaints.

In his last lesson regarding cookery methods, the author certainly betrays a want of practical knowledge. But this, in consideration of the excellence of his scientific instruction, may perhaps be excused. He treats of roasting and boiling with accuracy, but he is hardly correct in advocating broiling by gas *below* the flame in supersession of the time-honoured practice *over* glowing coals. "The value of the grill," says Sir Henry Thompson in allusion to that method, "is nowhere better understood than in England," and we certainly doubt whether any other way of treating a chop or steak will be accepted in the City of London, so celebrated for its grill-rooms. We do not mean to say that meat may not be done in the manner indicated by Mr. Knight, but we maintain that it can never "taste of the fire," to borrow a well-known phrase, as a chop does when well broiled over a clear fire. Nor do we concur with him, Count Rumford's dictum notwithstanding, regarding oven-roasting. Even if every trace of the oven taint be absent, no piece of meat can be properly and constantly basted by this process, which means that it cannot possess the best qualities produced by proper roasting. The *rôtisseur*, whom Brillat Savarin considered to be like the poet "born not made," was skilful with the spit, and certainly no oven-roasted bird can approach one cooked in that manner. Mr. Knight becomes confused in regard to the frying processes. To dry-fry, the French word *sauter* is alone applicable; to wet-fry, the term is *frire*. By the former, the thing fried is supposed to be tossed or "made to leap," hence *sauter;* by the latter, it is boiled in seething fat or oil—not in a *sauté*-pan, which is too shallow, but in a *friture*-pan or frying-kettle. Clarified beef suet or prime fat is superior to oil for many things; it does not heat so rapidly, nor does it boil over as the latter is prone to do. The object of stewing is not to extract all the nutritive juices of food. On the contrary, in all the best examples of the process, those juices are sealed up to begin with as much as possible, by blanching in the case of white meat, or dry frying (the *faire revenir* of French cookery) in that of brown. After blanching, white meat is refreshed, and then laid on a couch of vegetables covered with broth and very gently stewed; while after having been seized, brown meat is moistened with warm broth just brought to the boil once, and then simmered gently till done. Of braising there are several processes, white meat being done in one way, brown in another. The *faire revenir* process is carried out in regard to the latter, and this is now also done in the case of *bœuf à la mode*—"mettez-la," says Dubois, "dans une braisière ou casserole longue avec du lard fondu; faites-la revenir sur un feu modéré jusqu'à ce qu'elle soit bien saisie et colorée: mouillez alors la viande." Lastly, with reference to soups, we should call a perfect *consommé* the finest rather than the "richest" form of soup; the latter term would be better applied to bisques, thick turtle, and all to which eggs, butter and cream are added. These few slips however are, as we have said, excusable on the part of an author who has given so much valuable information in the major portion of his work. In recommending it to all educated readers who are interested in the subject, we would say to those who may desire to use it in their instruction of the illiterate—do not lose sight of the fact that over-elaboration of the scientific and theoretical aspect of cookery may tend to the somewhat perfunctory teaching of its practical side. For this reason, as far as teaching in board-schools and evening continuation classes is concerned, let sound practical instruction be the main point, with just sufficient of theoretical teaching to explain the scientific reasons which render this, that, and the other step necessary in the different methods of cooking, and why various food-stuffs differ in nourishing value.

THE STUDY OF FUNGI.

Introduction to the Study of Fungi, their Organography, Classification, and Distribution; for the use of Collectors. By M. C. Cooke, M.A., LL.D., A.L.S. Pp. iv.+360. (London: Adam and Charles Black, 1895.)

AS a terminal group, the Fungi possess but little interest for those whose aim is to gain an insight into the general scheme of evolution of the plant-world. On the other hand, it may safely be asserted, without fear of contradiction, that no group of plants has better repaid the investigations of the specialist, as illustrated by the brilliant discoveries of De Bary, Brefeld, Ward, and others. The important part played by parasitic fungi in connection with numerous plant and animal diseases has of late years also attracted considerable attention, and with the exception of Great Britain, almost every civilised country in the world has one or more institutions specially devoted to the investigation of this branch of the subject. Another branch of the study deals with the classification or systematic arrangement of fungi, the importance of which can only be realised when it is known that above forty thousand described species have to be dealt with in such a manner that their specific individuality, affinities, location in the scheme of classification, and distribution, may be easily accessible to workers in other branches of the study. In the work under consideration, the author has given the amount of morphological information he considers necessary for the systematist to possess, at the same time indicating the additions to our knowledge resulting from the investigation of the life-history of individual species; but it is in the sections devoted to classification and distribution that Dr. Cooke appears at his best, and here we find embodied the matured experience gained during the author's connection with Kew, where he had charge of the unrivalled collection of fungi, with its thousands of type specimens, in addition to the opportunities of examining numerous collections, received at different periods, from every quarter of the globe. In the chapter on classification, Brefeld's researches are analysed, and his proposed system of classification given in a tabular form. Saccardo's arrangement of the fungi is also thoroughly explained and criticised, as "it will doubtless come into universal use where expedients are valued rather for their utility than their consistency." The above quotation refers to the elevation of the Friesian sub-genera of the Agaricini to generic rank by Saccardo; and, while admitting that there is an apparent trifling with a preconceived conception of generic value in elevating to the same level, the sub-genera and genera of the same author, more especially when the genera are so broad, as in the Friesian system; yet perhaps in these days utility is of more value than consistency in a purely systematic work, the real value of which depends on the ease with which the organisms of which it treats can be recognised, and this can usually be more readily accomplished by the use of artificial methods than by adhering strictly to a supposed uniform standard of relationship, at all events so far as species and genera are concerned.

The author advocates the continued use of the term *spore* for the reproductive body of the Basidiomycetes, and *sporidium* for that of the Ascomycetes; with this we cannot agree, considering *basidiospore* for the former, and *ascospore* for the latter as conveying more definite information, and further, freeing the subject from the very vague term spore.

We cannot accept either of the following statements, which certainly should be qualified in a future edition of the book. "Of the 9600 known species of Hymenomycetal Fungi, really parasitic species are almost, if not wholly unknown." "All the parasites on living leaves which are not of insect origin, are Fungi." *Agaricus melleus* and many species of *Polyporus* are too well known as parasites, and in the tropics coriaceous leaves of evergreen plants are victims to the attacks of parasitic lichens and algæ; lichens are mentioned, as the author holds to his previous view, that these are entirely distinct from fungi, giving a summary of his views on this subject.

We should look elsewhere in vain for anything approaching the amount of information contained in the section devoted to the geographical distribution of fungi, a chapter which indicates not only what has been done, but also what remains to be done.

A noteworthy feature of the book is the full bibliography given at the end of each chapter, treating of the special subject dealt with. There is also a glossary explaining the scientific terms adopted. The index might with advantage have been fuller. The numerous illustrations have in most instances done service before, but nevertheless serve to elucidate the text; and on the whole it may be said that no one aspiring to the study of fungi from the systematic standpoint, can afford to ignore the present work.

GEO. MASSEE.

OUR BOOK SHELF.

Rambles in Japan, the Land of the Rising Sun. By H. B. Tristram, D.D., LL.D., F.R.S. With forty-five illustrations by Edward Whymper, from sketches and photographs. (London: The Religious Tract Society, 1895.)

CANON TRISTRAM has done well in putting together this record of a visit to Japan, which, although not "recent" when measured by the rapidity of the present march of Japanese history, occurred only a few years ago. The object of the visit was mainly to study the working of Christian missions on the spot; and this is a welcome fact, because it ensures an audience for what the author has to say, who cannot but profit greatly from the acute observations and calm judgments which he records. While making no pretensions to scientific treatment, Canon Tristram's book is to the average run of tourist twaddle on Japan, as a good novel is to a "penny dreadful." It is truthful, well-written, and inspires confidence. Under the guidance of his daughter, who as a missionary had acquired the Japanese language, Dr. Tristram visited some parts of the islands remote from the tourist-track, although all well-known to European residents in Japan. His instincts as a field-naturalist kept him on the alert for all that was to be seen of animal and plant life; and although we fear the precipitancy with which he yielded to temptation in the matter of ivory-carvings and rare china, must have told on his natural history collections, he seems to have brought back a good many plants, insects and birds.

A great number of interesting facts and phenomena are touched upon. The wonderful results of fancy gardening in Tokyo in dwarfing and grafting, seem to culminate in a maple-tree with seven large branches, the foliage of each having a different tint, varying from copper-colour to greenish-white. The art of the Japanese in domesticating such sensitive birds as robins, titmice and warblers, is cited as an instance of the great sympathy for nature which distinguishes the Japanese. Dr. Tristram found that the localities of many of the birds, brought to the seaports for sale, were wrongly described on the labels which were affixed in Europe, and he instances one case in which a species found only in the forests of Nikko, from 3000 to 8000 feet above the sea, had its habitat given as Yokohama. The author is inclined to rank Fujisan second in beauty to the Peak of Tenerife, and he remarks that no Japanese artist would think of painting this much-portrayed mountain from nature, but always from the paintings of the "old masters" of Japanese art. Richly wooded as Japan is, the universality of the use of charcoal as a domestic fuel has necessitated special forest-legislation, based on the strict system of re-planting practised in Germany. Although Dr. Tristram necessarily depended much on second-hand information, he avoids the familiar pitfalls of the uneducated writer, and but for a printer's error in the population of Nagoya, there seems little wanting in the way of accuracy.

The illustrations add greatly to the interest of the book; but while all of them are worthy of the name they bear, it is almost with a feeling of shock that one reads "Whymper" on several ordinary half-tone process blocks.

A Manual of Botany. By Prof. J. Reynolds Green, F.R.S., Sc.D., F.L.S. Vol. I. Morphology and Anatomy. Pp. x + 398. (London: J. and A. Churchill, 1895.)

PROF. GREEN has set himself a difficult task in attempting to put new wine into old bottles. Bentley's book, on which the present work is based, was admirable in its time, but to-day it strikes one as being somewhat inflexible both in style and ideas. It is true that in the volume before us there is a great deal of very useful information, which is put better and more clearly than elsewhere; in fact some of the subjects are so well treated, that we cannot help regretting that Prof. Green did not see his way to give us an altogether original work.

We notice, however, with regret, that the morphology of the inflorescence is here somewhat hazy, and it seems a pity that Eichler and Gray were not more closely followed, since their views, especially those advanced by the former, are certainly the most philosophical, as well as the most lucid and comprehensive of any which have as yet been put forward. The treatment accorded to the stele does not strike us very favourably; the student may be well forgiven if he abandons all attempts to understand the complex and apparently irreconcilable ideas embodied in the expressions "monostely" and "polystely" respectively.

The position of the axis should have been marked in the floral diagrams, as without it, one fails to recognise the correct orientation of the parts of the flower. This need is the more obvious in cases where the actual position of the axis varies in figures on the same page, as in Figs. 248 and 250, in which it falls above and at the side respectively.

But notwithstanding these faults, the book provides, on the whole, a clear and comprehensive account of the structure of plants.

Rope Driving. By John F. Flather, Ph.B., M.M.E. Pp. 230, and figs. 92. (New York: John Wiley and Sons. London: Chapman and Hall, Limited, 1895.)

THIS is a handy little book on the transmission of power by means of rope gearing; it contains a large amount of sound information on the various arrangements of driving gear, and their design, the best speeds at which ropes should be run, and the tension to which they should be exposed. The reasons of decay and means of preservation of ropes are succinctly dealt with; as also are the relative advantages of cotton and manilla hemp ropes when worked under different conditions. The book is certainly worthy of a place in any technical library, as the subject is one which is daily engaging increased attention, affecting as it does the efficient driving of mills, factories, and electric installations, and the transmission of motive power to places more or less isolated from its source.

LETTERS TO THE EDITOR.

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

The Cause of an Ice Age.

SEVERAL letters from Sir Henry Howorth, Dr. Hobson, Mr. Culverwell, and Prof. Darwin, having appeared in NATURE relating to my little book on the "Cause of an Ice Age," I shall be glad if you will allow me to make a few remarks on the matter. In his first letter, Sir Henry Howorth thinks I have omitted to give Wiener the credit which was justly his due. Subsequent letters by Dr. Hobson and Sir Henry Howorth may be held to have cleared up this matter; still there is a point which has escaped Sir Henry Howorth's attention, and I therefore refer to it again.

The facts are as follows. When I first began to work at the Ice Age I arrived independently, as any mathematician might easily have done, at a theorem by no means difficult, which seemed to me of importance in connection with the subject of geological climates. I had never seen this theorem before; had I done so I should, of course, have properly acknowledged its prior discovery.

Soon after the publication of my book, Prof. Darwin kindly pointed out to me that the mathematical theorem in question had been already given by Wiener. Thereupon I did all that it seemed possible to do. I called attention to Wiener's priority at once by a letter to NATURE, which appeared on February 18, 1892, and I also mentioned his priority both in the preface and the text of the second edition of the "Cause of an Ice Age," which was published in 1892. Sir Henry Howorth, when he wrote his recent letters in which he thought I had not rendered justice to Wiener, could not, I am sure, have known all the facts as above stated.

Mr. Culverwell thinks that I was wrong in attributing a certain opinion to Croll, and I quite admit that this charge might once have been correct. The fact is, I had been mistaken in the meaning I read into a passage in Croll's "Climate and Time," p. 56. But I think if Mr. Culverwell had known the circumstances, he would hardly have considered it necessary to raise this question again. On the appearance of the first edition of my book, the mistake I had made was kindly pointed out by Mr Monck, as well as by Mr. Noble, and I think by others; and I accordingly amended the second edition. In the *Geological Magazine* for February 1895, p 58, Mr. Culverwell appeals to me to correct certain passages relating to this point which he puts into italics from the first edition. My excellent friend had not the slightest notion that these passages had been already corrected in the second edition, published two years before his paper.

I must, however, say that on looking over my book again in connection with this correspondence, I consider that some of the references I have made to this particular point might be further amended. If, however, Sir Henry Howorth still thinks that I have at any time regarded Croll's work otherwise than with due respect, I would like to remind him of the words in both editions, p. 112, in which I said:—

"I was greatly struck by this work ('Climate and Time') when I first read it many years ago. Subsequent acquaintance with this volume, and also with his second work ('Climate and Cosmology'), has only increased my respect for the author's scientific sagacity, and my admiration for the patience and the skill with which he has collected and marshalled the evidence for the theory that he has urged so forcibly."

I have studied with much interest and profit the investigations made by Mr. Culverwell in connection with the astronomical theory of the Ice Age, and I may be permitted to say how glad I am that so excellent a mathematician and physicist should have had his attention drawn to this subject. I may, however, take this opportunity to explain why I have had to remain unconverted by certain of his arguments, notwithstanding that they have carried conviction to Sir Henry Howorth and Prof. Darwin.

In his earlier paper in the *Geological Magazine* for January 1895, p. 9, Mr. Culverwell has demonstrated that the direct sunheat received on any parallel at the time of greatest eccentricity, is the same as that now received on the parallel not more than three or four degrees north. This seems to me not only a novel, but also a very instructive result, and is in any case a valuable contribution to the theory. Mr. Culverwell, however, goes on to deduce from this that the climatic change in England between the present time and the time of the greatest eccentricity, would be no greater than the present climatic difference between Yorkshire and Cornwall, and hence he concludes that the astronomical theory is incompetent to account for the Ice Age. Prof. Darwin seems to think that this argument is unanswerable; I hope he will forgive me if I say that here my dissent begins. I think the facts cited do not warrant the inference which Mr. Culverwell would draw from them. With due respect to Mr. Culverwell, I would say that he seems at this point to have quite forgotten that the actual temperature in a region depends not merely upon the sun-heat there received, but also upon the transference of heat across the boundaries of that region. He takes the actual temperatures of Yorkshire and Cornwall; but what his argument would really require is a totally different thing. It would be the temperatures of those counties if each of them were perennially surrounded by a wall extending to the top of the atmosphere, and adiabatic to all heat except direct solar radiation.

This point is so important that I must put it in a somewhat different manner. It is certain that the actual climatic gradient from the equator to the pole is very different from what that gradient would have been if each parallel of latitude had marked the course of an adiabatic barricade such that no heat transference *via* earth, air or water could take place from zone to zone. In the latter case I quite admit that the mean temperature due to the sun-heat received on any zone would be actually the mean temperature of that zone, but the same is not true of the actual climatic gradient as we have it in nature For, on account of heat transference, the mean temperature of a zone is by no means the same thing as the mean temperature due to the sunbeams received by that zone.

May I say that I think the fallacy throughout this part of Mr. Culverwell's argument arises from his overlooking the distinction between the actual gradient and the adiabatic gradient. There may be but little difference between the mean temperatures of a zone through Yorkshire, and a zone through Cornwall; but this does not prove, as Mr. Culverwell's theory requires, that there would be but little difference between a mean temperature due solely to the direct sun-heat falling on the zone through Yorkshire, and a mean temperature due solely to the direct sun-heat falling on the zone through Cornwall. This inference would only be sound if all parallels were adiabatic. This they certainly are not.

I do not question that the difference between present temperatures and the temperatures at the time of highest eccentricity might be fairly represented by the difference between the temperature due to the sun-heat received in the latitude of Yorkshire, and the sun-heat received in the latitude of Cornwall. What I do question are the grounds on which Mr. Culverwell maintains that this latter difference (and therefore the former one) is so insignificant as to discredit the astronomical theory of the Ice Age.

I have thus explained in what respect Mr. Culverwell's investigation involves assumptions which are in my opinion unsound. I am accordingly to this extent unable to accept the conclusions at which he has arrived. ROBERT S. BALL.

Observatory, Cambridge, January 2.

THE letter of Prof. G. H. Darwin in your last issue states very clearly the argument on which Mr. Culverwell and himself rely as affording a demonstration of the inadequacy of the astronomical theory. It now seems opportune, therefore, to lay before your readers the general considerations which lead me to the conclusion that the whole argument they rest upon is unsound; and, further, that Sir Robert Ball's ratio of 63 to 37, representing the ratios of sun-heat received by each hemisphere in summer and winter respectively, is (contrary to Prof. Darwin's view) an important factor in any adequate discussion of the problem.

Accepting Prof. Darwin's estimate that the difference in the amount of sun-heat received in our latitudes during high and low eccentricity, would only give to Yorkshire the amount received by London or *vice versa*, I entirely demur to his statement that this would be also a measure of the amount of change in the climates of these places To do so is to assume that the climate of a place, as regards the amount and distribution of its temperature, is determined by one factor only—the amount of sun-heat it receives.

How very erroneous is this assumption, may be shown by the contrasted climates of places on the east and west sides of the Atlantic, due to the influence of both ocean-currents and prevalent winds; but even more strikingly by a comparison (which I made in my "Tropical Nature") between certain tropical and temperate climates. In Java, about 8° south of the equator, the altitude of the noonday sun in June is about 58½°, while at London during the same month it is 62°, the length of the day at the same time being 5½ hours greater with us. The sun-heat received in London must therefore be *considerably greater* than that received in Java, and, according to the rule that the *amount* of sun-heat determines temperature, London should then have the warmest climate. The fact, however, is that our mean temperature in June is more than 20° lower than that of Java and our mean highest temperature about 18° lower, a result due, as I have shown, to a variety of causes, of which the temperature of the atmosphere in all surrounding areas, the action of aqueous vapour in reducing the loss by radiation, and the accumulation of heat in the soil, are probably the most important. These facts prove, I think, that the amount of heat received by the whole hemisphere, through its influence on both oceanic and aerial currents, must be taken account of in estimating temperatures under different phases of eccentricity; and that any determination of the amounts of sun-heat received at particular latitudes, considered by themselves, are necessarily misleading and must usually indicate a difference of climate far below the truth.

But there is another consideration of even more importance which entirely invalidates the arguments of those who, like Mr. Culverwell and Prof. Darwin, treat the problem as one to be determined by a simple mathematical calculation of amounts of sun-heat received on the same area at different times. This is, the remarkable difference in the behaviour of air and liquid water on the one hand and snow and ice on the other, as regards climate; the former from their great mobility tending to the diffusion of heat, the latter by its comparative immobility to the accumulation and perpetuation of cold. Without this power of accumulation perpetual snow on tropical and temperate mountains, and glaciers in hot sub-alpine valleys and at only 705 feet above the sea-level in latitude 43° 35′ south in New Zealand, would be impossible. In either of these cases, if an elevation of about a thousand feet should double the area of the snow fields, which might easily be the case, the outflowing glaciers would be greatly increased in magnitude and might either descend to much lower levels or spread out over large areas of the lowlands—and all this without any change whatever in the total amount of sun-heat received by the countries in which they occur.[1]

For some years past there has been a persistent attack by astronomers and physicists on the explanation of the glacial epoch put forth by Croll and adopted with some modifications by many students of glacial phenomena. But as these writers have all treated the problem as a question of the direct effect of the amount of sun-heat received at different epochs in corresponding latitudes, completely ignoring the great distributing and accumulating agencies which are always and everywhere in action, their theoretical conclusions appear to us to be entirely beside the question. We have to deal with a highly complicated problem in physical meteorology, which cannot be solved by an appeal to the well-known facts of the amounts of sun-heat received, any more than can the June climates of London and Batavia or the general climates of Ireland and Manitoba or Terra-del-Fuego (in about the same latitude) be explained from similar data. The great merit of Croll was, that he fully realised the complexity of the problem; that he took account of the various relations and reactions of the oceanic and aerial currents, and the physical characteristics of air and water, snow and ice; and that he showed how these causes reacted on each other so that the winds and ocean currents of one hemisphere might have an influence on the accumulation of snow and ice in the other. Whatever errors he may have made in matters of detail, his method was undoubtedly a sound one, and it is because so many recent writers on the subject have wholly ignored his method without even attempting to prove that it is erroneous, that their views appear to us to be both retrograde and scientifically unsound.

ALFRED R. WALLACE.

[1] This remarkable property and its effects are explained in some detail in my "Island Life," p. 131 (second edition), under the heading "Properties of Air and Water, Snow and Ice, in Relation to Climate," and in the four following sections.

The Dying out of Naturalists.

THE dying out of the distinguished school of "naturalists" which this country once produced, and which culminated in Darwin, is a fact which scarcely admits of dispute. I am informed on good authority that it has not escaped the notice of the French scientific world.

I drew attention to it in the address which I delivered to the new Botanical Section of the British Association at Ipswich. I rather described the phenomenon than attempted to explain its causes. But what I said has brought me many interesting communications. It has been suggested to me that as far as botany is concerned, I have much myself to be responsible for. It may be so. But this I may say, that in entering the laboratory I did so with the natural history spirit. I only looked at interesting things with a closer vision. So, if I may go to the other end of the scale, did Darwin when he made use of all the newer appliances of biological research in his later work.

Nothing, it seems to me, is more difficult than to trace to their right causes the springs of human endeavour. Its results are familiar to us, because we live amongst them. We are so prone to assume "motives" off-hand for any human action that we see about us, that nothing seems easier than to explain any new departure that comes in our way. But the process is almost certainly superficial, and the real causes of a social change which breaks upon us suddenly have in all probability been of slow growth, and do not at the moment either reveal themselves or readily lend themselves to analysis.

A friend, a well-known naturalist, gives me his explanation. I suppress his name, as I have not his permission to quote it; but I think what he says is worth printing, as affording ground for reflection. Whether the cause he assigns is or is not well founded, I confess I do not know.

But generalising from experience I can say this: all distinguished naturalists whom I have known have gone ahead in defiance of any and every obstacle. Looking back upon their lives, it was as if fate had conditioned them. It was once said to me that if one ever came across a possible artist of merit, the right thing to do would be to offer him every discouragement. If he had real genius he would transcend his ordeals; if he had not, the world would not be appreciably the poorer if he was quenched.

But I must discriminate. English naturalists of the generation which is now passing away have belonged to two groups. Some have been born to wealth, some to poverty. Class prejudice was against the one; means of livelihood against the other. The richer disciples of our art seem now to have gone irretrievably, and to have no successors. The poorer have changed their tone; they tend to treat science as a career like the Civil Service. They approach those who have any hand in the matter in an extremely business-like spirit. I do not blame them. But this is not the *métier* of the scientific hero. Nor in their memory shall we assemble to found a national memorial or raise a statue.

What is the force that now-a-days quenches the old enthusiasm? My correspondent says that it is the schools, and here is his story. I believe that, at any rate, what he says is the outcome of sincere conviction, or I would not publish it.

"I am pleased to see your remarks upon the dying out of the study of systematic botany, and I see in other papers, too, attention called to this and the diminution of field naturalists. One starts one's natural history usually on these lines when a boy—or, rather, used to—but I noticed things had altered much when I visited my old school last winter. In my day we had lots of naturalist boys; we knew all the localities for insects, plants, shells, &c. Now hardly any one knows anything of the country beyond the playing fields. The 'skipper field,' famous for skipper butterflies; the heath, with its localities for all kinds of insects and plants, are absolutely unknown. The great object of education appears to be to have every boy competing for something absolutely useless to him in later life. They were practising cricket or other games, or cramming for exams. all the while. This remarkable system begins, the masters of this and other schools told me, at about eight years old. There is no time to learn to think or observe. The boys must beat some other school in tennis or football, or must beat some one else in the history of the Punic Wars. Science was taught, but much in the same way. They were neither taught, nor did they get a chance of teaching themselves, any natural history. What the result of this will be it is difficult to foresee, but it certainly accounts a good deal for the diminution in systematists and field-naturalists."

W. T. THISELTON-DYER.

Royal Gardens, Kew, December 27, 1895.

Pendulum Observations in the Northern and Southern Hemispheres.

THE figure of the earth has been determined by three independent methods of investigation. (1) By abstract mathematical calculation of the form which such a body as the earth, rotating as it does, would assume when plastic. (2) By careful measurements of arcs on meridian lines in different latitudes. (3) By pendulum experiments, which have indicated a gradual increase of the force of gravity from the equator towards the poles.

These three methods, after necessary corrections have been applied, correspond so nearly in their results that probably we have ascertained the true ellipticity of our earth as nearly as is possible considering the irregularities of its surface. But there is one point in connection with pendulum experiments which, although it cannot have escaped notice, has not been treated of, as far as I am aware, in any work on astronomy or geodesy, viz. that all the pendulum experiments hitherto made in the southern hemisphere indicate that the force of the earth's attraction is less in that hemisphere than in the northern. The great navigator, Captain Cook, was the first, I believe, to notice this phenomenon in connection with an excellent pendulum clock which he carried with him. He noticed that this clock always went slower at places in the southern hemisphere than it did in the northern hemisphere; but he did not pursue the question.

In November 1893, Dr. John Murray read a paper on Antarctic research before the Royal Geographical Society, and in the appendix to that paper is a communication from Dr. Neumayer, of the Hamburgh Naval Observatory, giving a table of the results of pendulum experiments hitherto made in the southern hemisphere. In the annexed table I have made use of Dr. Neumayer's collected information, reducing his values of the length of pendulum beating seconds, given in metres, to the corresponding values of the accelerating force of gravity in foot seconds, and I have added, from other sources available to me here, the corresponding values of g at places in nearly similar north latitudes. By comparison it will be seen that the force of gravity in the northern hemisphere exceeds that in the southern hemisphere, in latitudes between 38° and 62°, by a mean of about ·010. In Dr. Neumayer's table, experiments in the southern hemisphere are recorded as far as lat. 33° 2′ 5″ S. (Valparaiso), but I have not been able to obtain here any records in similar latitudes in the northern hemisphere. In the northern hemisphere experiments have been made at Hammerfest 70° 40′ north latitude, and at Spitzbergen 79° 49′ 54″ north latitude; but no corresponding experiments have yet been made in Antarctic regions.

Taking, however, the values of g at Edinburgh and at Cape Horn, in very nearly the same latitudes, 55° north and south, viz. 32·204 and 32·194, and assuming that these values will not vary greatly in their difference at the poles; by a simple calculation we find that the centre of gravity of the earth is approximately $\frac{3}{10}$ths of a mile north of the plane of the equator. It would appear from this that in astronomical observations depending on zenith distances, and consequently on the direction of the plumb-line, not only must corrections be made for the ellipticity of the earth, but also for the true position of the centre of gravity of the earth, which at the equator must deflect the plumb-line about 15″ from the true vertical.

It is a deeply interesting question whether astronomical observations can be, or have been, made to verify the results obtained by the pendulum.

Geographically it is a subject which may approximately be investigated by comparing the masses of dry land now standing above the sea-level in the northern and southern hemispheres; the excess of dry land in the northern hemisphere, at present, being the probable cause of shift of the centre of gravity of the earth northwards.

In mathematical astronomy it presents an extremely difficult but highly important problem, viz. what effect this position of the centre of gravity of the earth has upon the gyratory motion, producing the precession of the equinoxes, which is caused by the attractions of the sun and moon on the equatorial protuberance.

If, as seems probable, a shift in the position of the centre of gravity of the earth north or south of the plane of the equator must produce a shift also in the direction of the axis of gyration, many perplexing geological problems as to varying climates in the same part of the world during different epochs in the world's past history would be at least partially elucidated. There is ample evidence of very widely-extended earth movements of elevation and depression in the past; these must have varied the balance of the earth, and if a change in the balance produces also a change in the direction of the axis of gyration, a change in climate follows as a matter of course.

It is a problem requiring mathematical genius and skill of the highest order for its solution; but it can be hardly denied that it is of very great scientific interest that it should be correctly solved.

Finally, I would wish to draw attention to the importance of accurate pendulum experiments being made in the highest southern latitudes attainable by the Antarctic research parties which are either now being organised, or will, it is hoped, eventually be despatched by the British Government.

Place.	N. lat.	Value of g. ft.sec.	Diff.	Value of g.ft. sec.	S. lat.	Place.
Washington, U.S.A.	38° 54′	32·1558	·013	32·142	37° 49′ 9″	Melbourne.
Paris	48° 50′	32·183	·009	32·174	49° 8′ 9″	Kerguelen Island.
			·011	32·182	51° 31′ 7″	Falkland Is. No. 1.
				32·178	51° 35′ 3″	Falkland Is. No. 2.
Greenwich ...	51° 29′	32·191		32·180		Mean of Nos. 1 and 2.
Belfast ...	54° 36′	32·199	·008	32·191	54° 31′	S. Georgia
Edinburgh ...	55° 27′	32·204	·010	32·1936	55° 51′ 3″	Cape Horn.
N. Shetlands	60° 45′	32·217				
Interpolated ... (at the rate of ·00275 per degree)	62° 45′	32·222	·010	32·212	62° 56′ 2″	S. Shetlands.

N.B.—The difference in the values of g between Washington and Melbourne, if corrected for difference in latitude, would become ·011. Similarly that between Paris and Kerguelen Island would become ·010. The variation in the difference at 54°. $\frac{31}{36}$ south and north latitudes may be due to some local attraction or some inaccuracy in observation.

Wellington, New Zealand, November 12, 1895. H. S. SCHAW.

The Metric System.

IT may not be within the recollection of your readers, and very unlikely to be so in that of the British public, that so far back as 1870–71 the Government of India, in the Governor-General's Council, passed an Act to introduce the metric system into the British dominions in India. However, as all Acts passed by that Government and its Council require the prior sanction of the Secretary of State for India in Council, the measure failed to take its place on the Statute Book of the Empire. His Grace the Duke of Argyle was at that time at the India Office, and it is a matter for much regret that he did not see fit to approve of the measure. That the Government of India did not expect that the Act would be vetoed, is proved by the fact of its having adopted the system in the State Railway Branch of the Public Works Department, then but recently formed. Sir Guildford Molesworth, K.C.I.E., then Consulting Engineer to the Government of India for Railways, published a series of type drawings dimensioned in the metric system. The Government further adopted the metre as the gauge of the narrow-gauge system then introduced for the first time by them. All the platform and other weighing machines sent out were so arranged as to weigh in kilogrammes, tons, and maunds. Had the wise policy of the late Lord Mayo been then approved of, the English commercial and scientific public would not now be clamouring for its adoption in the mother-country, as its great advantages would be patent to all.

In Ceylon the decimal system has been applied to the rupee, and I have not heard any complaints of inconvenience having arisen from such adoption.

Cannot a further agitation be started, to move the Government of England to take steps in the coming session to make a start, at least, in the matter? It might be notified that, for all Government contracts, no other system would be entertained after January 1, 1898. This in itself would give a huge impetus to the movement. F. G. BROOK-FOX.

West Kensington, W., December 26, 1895.

The Habits of the Cuckoo.

IN connection with the interesting article in NATURE of Dec. 26, 1895, on the habits of the common cuckoo, it may be of interest to some of your readers to record the following observations, which afford further evidence in support of the contention that the cuckoo occasionally lays its egg before carrying it to the nest in which it is to be deposited.

A few seasons ago, a pair of robins built in the ivy covering the walls of our house. It was cunningly concealed, about five feet from the ground, in a hollow formed between the wall and the interlacing stems of the ivy. The nest was successfully finished, and four or five eggs were laid. One day, in the early hours of the afternoon, the loud notes of a female cuckoo attracted our attention. Almost immediately afterwards we saw the bird on one of the branches of a large yew-tree growing close to the corner of the house where the nest, was placed, and one of our party exclaimed, "Oh! it is holding something in its beak." It seemed in no way disturbed by the close proximity of the house and its inhabitants, and, after a moment's pause, flew down and disappeared behind the angle of the wall. It then quickly reappeared and flew away, making a considerable noise. We immediately went to the nest, and found the cuckoo's egg together with the robin's. The entrance to the robin's nest, and the entire hollow where it lay, was far too small to admit so large a bird as the cuckoo; the short time, also, that the bird was there, presumably points to the fact that it carried its egg thither and simply placed it in the nest.

Some years before, much the same thing occurred in the same garden. In this instance the robin's nest was in a hole in a bank, which was also too small to easily admit the cuckoo. The parent robins were seen furiously attacking the larger bird, who was forced to beat a retreat. But it had already deposited its egg in the robin's nest, where we found it immediately afterwards.

London, December 29, 1895. ANNIE LEY.

A Luminous Centipede.

WAS not the insect seen by Miss Rose Haig Thomas (see NATURE, p. 131) a specimen of the Myriapod *Scolopendra electrica*, or *Geophilus electricus*, a well-known luminous insect whose light is but rarely seen owing to the insect living underground and in manure heaps? It is, however, the only luminous British species. I have but once seen one crawling abroad at night, but I know the insect well. It may be readily captured in the daytime. The light is bright and the colour is the same as that of the glow-worm. According to my observation both sexes are luminous, and the light is not peculiar to the summer season, as is that of the British glow-worm, hence the meeting of the sexes can scarcely be the object of the luminous prevision.

Worcester, December 20, 1895. J. LLOYD BOZWARD.

IT is impossible to give an unqualified reply in the negative to Mr. Lloyd Bozward's question; but for reasons stated in the note appended to Miss Rose Haig Thomas's communication, I see no grounds for doubting that the specimen she observed was an example of *Linotænia crassipes*, and not of *Geophilus electricus* (= *Scolopendra electrica*, Linn.). So far as my experience goes, the latter is very scarce in the south of England. It must be borne in mind, however, that there is no safety in the assumption that every luminous centipede found in this country is certainly referable either to one or the other of these two species. As a matter of fact, the family *Geophilidæ* is represented in England by at least a dozen species, belonging to five genera, and it is possible that all of them possess the property of phosphorescence. Perhaps it is not surprising that persons unacquainted with these facts jump to the conclusion that every luminous centipede they see must be co-specific with the one to which Linnæus gave the name *electricus*. This is so far from being the case, that not one of the many specimens that have been brought of late years to the British Museum, on account of its luminosity, has proved to be an example of this species. No doubt, however, there is much that might be learnt on this subject by the careful preservation of specimens, with particulars as to date, locality, &c., and I need hardly add that I shall be very pleased to identify any examples that are sent or brought to me at the British Museum for that purpose.

British Museum, Cromwell Road, S.W. R. I. POCOCK.

A Lecture Experiment on the Nodes of a Bell.

THE following modification of Chladni's method makes an interesting lecture experiment, and shows the nodal lines of a bell far more sharply and easily than any process already described of which I am aware. For the bell, use a cylindrical glass crystallising pan (say nine or ten inches diameter and four to six inches deep, but almost any size will do), and stand it, rim upwards, on three india-rubber corks. Some light-coloured powder, such as flowers of sulphur, is mixed with soapy water and smeared over the concave surface. The mixture should be quite watery, and can be applied by pouring a little into the bell, which is then tilted as much as possible and rotated round its axis. With one hand inside the bell, press it down firmly on the corks, and excite the rim with a bow. It is best to make double contact with the bow at two opposite points on the rim, and a succession of rapid strokes will produce strong vibrations, the powder meanwhile shooting upwards in arch-like curves, till it collects in four or six distinct vertical lines, easily visible at a distance if held against something black. Using a smaller vessel, smeared only half-way round, no doubt the whole process could be optically projected. G. OSBORN.

The Leys School, Cambridge.

The Critical Temperature of Hydrogen.

IF my allusion to the absence of "fresh experiments" in Dr. Natanson's work is not sufficient acknowledgment of its purely theoretical nature, a reference to my original abstract in the Physical Society's *Proceedings* will, I feel sure, correct any false impression that has arisen in the author's mind on that point. My note was in no way intended as a criticism or expression of opinion.) But the Cracow *Bulletin* paper was certainly calculated to give any reader the idea that Dr. Natanson was the only worker besides Olszewski who had attempted to calculate the critical temperature of hydrogen, and, to prevent misunderstanding, a reference to Wroblewski's previous work seemed desirable. As Dr. Natanson still appears to pass over the long and laborious experiments on which the latter investigation was based, and to be unaware that the whole object was to get the critical constants, &c., *from the application of Van der Waals' theory* (which had previously given chemists an accurate knowledge of such data in the case of oxygen, nitrogen, and marsh-gas *before the gases had been actually liquefied*), I must refer *him* to Wroblewski's memoir. Further, it might interest him to consult a paper by Prof. Dewar in the *Philosophical Magazine* for September, 1884, which discusses the critical constants of hydrogen based on the experimental facts known at that time.

G. H. BRYAN.

THE SPERM WHALE AND ITS FOOD.

THE services which H.S.H. the Prince of Monaco has rendered to the science of oceanography, during the last ten or twelve years, are familiar to every one interested in that department of research. First in the small schooner *Hirondelle*, with no power but the strong arms of his Breton crew, and later, in the large and perfectly equipped auxiliary steam yacht *Princesse Alice*, there is no branch of the science which has not been enriched by his enlightened enterprise and his unwearied perseverance. It may be interesting to the readers of NATURE to know something of what was achieved in the summer cruise of 1895 in the waters of the North Atlantic, chiefly in the vicinity of the Azores. The dredging and other deep-sea operations conducted on board the yacht herself were very successful, and produced an abundant harvest. The most interesting result of the cruise, however, was due to the lucky chance of a cachalot or sperm whale being pursued by the whalefishers of Terceira, and killed almost under the bows of the *Princesse Alice*, and to the prompt measures taken by the Prince to utilise this rare opportunity, the importance of which for science he immediately and intuitively perceived. The preliminary reports of the investigation of the material thus collected by the Prince, in collaboration with the Portuguese whalers, go to show that an almost entirely new and unsuspected animal kingdom has been opened to the zoologist.

A general account of the nature of the results has just been given, under the title "Prise d'un Cachalot," to the Société des Naturalistes, at its meeting in the amphitheatre of the Museum of the Jardin des Plantes, on December 24; and two communications were made, on December 30, to the Academy of Sciences by the Prince, of which one was from Prof. Joubain, of Rennes, dealing especially with the specimens of gigantic cephalopods obtained. It will be convenient to give the proceedings of the yacht, during and after the capture of the cachalot, in the form of an abstract of the Prince's own communications, and to deal with the specific details of the animals collected, in the form of an abstract of Prof. Joubain's paper.

Proceedings of the Yacht.

On July 18 of last year, about nine o'clock in the morning, I observed, while engaged in operations in the deep water to the south of the island of Terceira, two boats leave the coast under sail, and about half an hour later two other boats proceeded in the same direction from another point. It was evident that they were not bound on an ordinary fishing expedition, and I quickly perceived that they were in pursuit of a school of sperm whales or cachalots; and I finished with the greatest speed the work in hand, in order to be able to take full advantage of the rare occasion of being able to assist at the capture of one of these interesting animals, should such be the result of the exertions of the whalers. About eleven o'clock I observed a whale spouting at a distance of about two miles, and I perceived that one of the whalers was approaching it cautiously. I was careful to remain at the same distance, in order not to run the risk of interfering with the whaler, and I closely followed all the manœuvres. The officer or coxswain of the boat stood erect in the stern, steering the boat with an oar. The harponeer stood in the bows, and I distinctly saw him strike the whale. I then approached the group at full speed, while the other whalers dispersed in pursuit of other members of the school. When I had arrived within one or two hundred metres, the cachalot had already towed the whaler attached to it by the harpoon, and the whole length of this line, to a considerable distance, and the harponeer had just succeeded in giving the animal the thrust of the lance, which terminates the struggle if skilfully delivered. The spray thrown out by the animal had become pink, and soon became quite red, while a pool of blood extended itself more and more on the surface of the water around. The *Princesse Alice* was lying at about one hundred metres from the animal when it turned slowly round, lashed out with its tail, and then came straight for the yacht at a speed of ten or twelve knots. As there are many records of whaling ships having been sunk by the cachalot under similar circumstances, it will not be wondered at if I confess to having experienced some anxiety during the approach of the whale, and when powerless to avoid it. Just, however, at the moment when I expected the shock, the whale sounded, passed under the keel without touching it, and reappeared on the other side in the agony of death. The rescue of the yacht from certain damage, if not from destruction, would have been impossible had the life of the whale been spared for a little longer. The cachalot was now floating alongside, with its head at a distance of about fifteen metres from the rudder, when its jaws opened and allowed several objects to escape, which I quickly recognised as cephalopods; but, notwithstanding the speed with which a boat was got away, in order to secure these animals, of the inestimable value of which I had already a presentiment, I perceived that they had begun to sink. On the spur of the moment, I started the engines very slow astern, and the coveted remains circulated slowly in the vortices produced by the propeller until they were secured by the boat.

The vessel now floated in a sea of blood of some acres in extent, and the whalers fixed one of our hawsers to the head of the dead animal; for they had gladly accepted my offer to tow it to El Negrito, where they have their installation for harvesting the oil from the whales that they are lucky enough to catch. The towing operation was not an easy one. The tail, acting as a rudder, caused the animal to swerve so violently from one side to another, that it was necessary to desist from the attempt to tow it head foremost, and to shift the tow-rope to the tail, after which the operation was completed without difficulty. The creek, which was the final destination of the whale, was not a suitable place for the yacht to remain; so, after landing the zoologists, MM. Richard and Lallier, and the artist, M. Borel, she left for the anchorage of Angra, while these gentlemen remained to assist at the breaking-up of the whale, with all the materials necessary for preserving the interesting matter which it promised to furnish.

For four days, under a burning sun, the whalers worked at removing the blubber and transferring it to the neighbouring house, where it was boiled down. At the same time they endeavoured to assist me in every way in securing the portions of the animal which interested me, more especially the brain. But the work was so difficult that it was only at the end of the fourth day that the skull was penetrated, and then the brain was found in a too advanced state of decomposition to be of use for preservation. It was impossible to approach the brain sooner, except by sacrificing the spermaceti, of which the volume was more than a cubic metre, and the commercial value very great. For half a day several men stood up to their middles in the cavity of the head which contains the spermaceti, and ladled it out. It must be remembered that the whale, which was stranded at high water, could only be worked at after the tide had ebbed considerably.

A large number of parasites were collected from the stomach, the digestive organs, the blubber, and the skin of the animal. M. Richard discovered on the lips of the whale certain round impressions, which he identified as the marks of the suckers of the great cephalopods. One can imagine the struggles of the giants which take place deep under the surface of the ocean. Notwithstanding his activity the cephalopod is seized by the cachalot, who, by means of the formidable teeth of the lower jaw, and the corresponding recesses in the upper jaw, holds the body of the animal without hope of escape. The cephalopod, in its defence, envelopes the face and head of the whale with the crown of its tentacles, the suckers of which leave deep impressions on its lips, and other parts where they have fastened. Meantime the cachalot makes efforts to swallow the portion of the cephalopod of which it has really taken possession, with the effect that the part of comparatively small calibre connecting the body with the head gives way; the body is swallowed, and the head dies and either drops off, or is eaten by the whale.

Zoological Details from Professor Joubain's Paper.

The sperm whale or cachalot (*Physeter macrocephalus*, Lacepède), caught on July 18, 1895, measured 13·7 metres in length. While in the act of death, it ejected several large cephalopods which it had only just swallowed, as was evident from their perfect state of preservation. Amongst them were three large specimens, each over one metre in length, of a species, probably new, of the little-known but interesting genus *Histioteuthis*. The bodies of two other immense cephalopods were collected at the same time. When the stomach of the cachalot was opened, it was found filled with a quantity, estimated at over one hundred kilogrammes, of the partially digested débris of these cephalopods, all of them of enormous size. Amongst this débris may be noticed the crown and tentacles of a cephalopod, the body of which could not be found, belonging probably to the genus *Cucioteuthis*, hitherto known only by a few fragments. The muscular arms, which, though much shrunk and contracted by the preserving liquid, are as thick as those of a man, were covered with great suckers, each armed with a sharp claw, as powerful as those of the larger carnivora. More than one hundred of these suckers remain adhering to the arms.

The bodies of the two great cephalopods constitute one of the most interesting novelties of the scientific cruise of H.S.H. the Prince of Monaco. Their structure and their appearance are so different from all that is known amongst these animals, that it is impossible to place them in any species, genus, or family of this order. I propose for them the name of *Lepidoteuthis Grimaldii*, hoping that the discovery of complete specimens may permit of their affinities being more perfectly defined. One of these animals, half digested, is useless for study; the other, though headless, is much better preserved. It is a female, of which the body or visceral sac, after prolonged immersion in formol and alcohol, still measures 90 centimetres in length, from which it may be concluded that the length of the complete animal would exceed two metres. The surface of the sac is covered with large, solid, rhomboidal scales, arranged spirally like those of a pine cone. The fin (*nageoire*) is very powerful, and forms one half of the length of the body. It is not furnished with scales.

The stomach of the cachalot contained, besides, another cephalopod of large size, provided with a large fin, the skin of which enclosed certain photogenic organs. The head is wanting, so that it is impossible to affirm with certainty that it belongs to a new species, which is made very probable by the form of the body. Finally, the stomach of the cachalot contained a large number of beaks and rays or plumes, the difficultly digestible residue of former repasts.

The cachalot which was killed by the whalers of Terceira, almost under the keel of the *Princesse Alice*, seems as if it had been guided, in the pursuit of its food, by a desire to devour nothing but animals which, up to the present, are completely unknown, and in addition are of the highest importance for the morphology of the cephalopods. These cephalopods are all powerful swimmers, and very muscular. They appear to belong to the fauna of the deep intermediate waters, which is almost completely unknown, at least as regards the larger animals. They never come to the surface, nor do they lie on the bottom of the sea. Their great agility enables them to avoid every attempt to take them by nets; and it would appear that, for the present, the only means of capturing these interesting and gigantic animals is to commission a bigger giant to undertake the task, and to kill him in his turn when he has performed the service.

Accordingly, it is his Highness's intention for next season, either to add to the already very complete fittings of the *Princesse Alice* those of a sperm whaler, or to attach to her a special whaling tender. It need hardly be added, that the further working up of the unique material already collected is being pushed forward with the greatest energy, and the results will be awaited with interest and impatience.

J. Y. BUCHANAN.

NOTES.

MEN of science need no reminder that, however they may be separated by political or racial differences, they are united in the promotion of natural knowledge. Scientific academies and societies in every part of the world delight to admit foreign investigators into fellowship, and to show publicly, by various marks of appreciation, their regard for contributions to known facts of nature, and for assistance in interpreting those already garnered. But though these international amenities are common enough in the world of science, it is but rarely that the Government of one nation does honour to the distinguished men in another. We therefore notice with keen satisfaction that the French Government has just decorated a number of foreign investigators, in connection with the recent centenary of the Institute. Prof. Max Müller has been appointed Commander of the Legion of Honour, and Lord Rayleigh and Prof. Ramsay have been created Officers. The broad feeling that prompted these awards was the same as that which led the French Government to strike special medals to commemorate the late Dr. Hind's discovery of asteroids, and Janssen and Lockyer's method of observing solar prominences in full sunshine; and, more recently, it inspired the Paris Municipal Council to make arrangements for erecting a statue of Newton in Paris. In sharp contrast to the delicate compliments which the French Government and people pay to British science is the insularity which regulates the distribution of those honours that the British Government have at their disposal. So few and so belated, indeed, are the honours conferred upon men of science in our own country, that it is almost vain to think that her Majesty's advisers will one day have the magnanimity to do honour to investigators of other nations. We cherish the hope that the New Year decorations just given to British men of science by France will induce our own Government to return the courtesy.

M. BERTRAND AND M. BERTHELOT, Secrétaires Perpétuels of the Paris Academy of Sciences, have been made Grand Officers of the Legion of Honour. M. Maspero, the distinguished Egyptologist, has been appointed Commander, while Dr. Duclaux, Director of the Pasteur Institute, and MM. Grimaux and Moissan, the eminent chemists, have been created Officers of the same Order. Thus does France honour those who have established their claim "rightly to be great."

PROF. MARK W. HARRINGTON, late Chief of the United States Weather Bureau, and now President of the University of Washington, proposes to establish in the University a department of Terrestrial Physics and Geography, and he would be glad if authors and publishers would send to the University publications relating to these subjects.

A SOCIETY was legally registered in Paris a few days ago, having for its object the propagation of Pasteur's methods in medical treatment. The Administrative Council consists of MM. Duclaux, J. B. Pasteur, Roux, and Radot. The present capital of the Society is £400, in one hundred shares of £4 each, all of which have been taken up.

WHILE all interested in geology will rejoice at the recognition of the services to science and the State rendered by Sir Joseph Prestwich, they will regret to learn he is still in an extremely weak state of health and confined to his bed. Although he has regained a little strength, his convalescence must of necessity be slow.

PROF. SOLLAS, F.R.S., will leave in March for Sydney, to take charge of an expedition that is being despatched to make deep borings in a coral atoll. The scheme, which is supported by a strong scientific committee, has been financed by the Royal Society to the extent of £800; and the Government are placing a gunboat at the disposal of the party, to convey them from Sydney to Funifuti, in the Central Pacific, which has been selected as the scene of operations.

DR. DONALDSON SMITH read an interesting paper at the Geographical Society's meeting, last Monday, on his recent journey from Somaliland to Lake Rudolf. He told the story of the adventures of his expedition during the performance of this feat. The results of the journey are of great scientific importance. Dr. Smith has prepared a useful map, based on careful astronomical observations, of the region to the north and north-east of Lakes Rudolf and Stephanie, which has not hitherto been explored. He has also carried a chain of observations across the Borana country, between the Juba and Lake Rudolf. The collections proved of exceptional interest; in Somaliland, Dr. Smith has discovered an avifauna which is most closely allied to that of the Cape. This is in harmony with some other available evidence, and suggests a former immigration into East Africa from land now submerged beneath the Indian Ocean. He has found in the Borana country a fossil which proves the occurrence of Lower Oolitic rocks there; and thus shows the line of connection between the Jurassic beds of Mombasa with those of Shoa and Somaliland. He has also had exceptional opportunities of study of a dwarf tribe, first reported by Harris in 1844, members of which have only been seen twice previously. Dr. Smith's study of the hydrography of the region around Lake Stephanie has thrown light on the famous controversy as to the course of the Omo, though his observations do not settle it.

THE fact that calcium carbide is now obtainable commercially has been ingeniously applied by M. G. Trouvé for the purposes of domestic lighting. The principle of his lamp is that of the "Kipp" used in chemical laboratories, in various forms, for the production of hydrogen sulphide and other gases. The mode of arranging the contact of the water and carbide had to be carefully worked out, as an ordinary "Kipp," charged with calcium carbide and water, gives such a vigorous evolution of acetylene as to be unmanageable. An estimate of the working cost of the lamp compared with that of coal gas is favourable to the former in Paris, where gas is costly (7*s.* per 1000 feet); but in London, if the carbide could be obtained at the same price (4½*d.* per lb.), the cost would still be double that of ordinary lighting gas.

SOME interesting investigations on the vitality of typhoid bacilli inoculated into oysters have been carried out by Mr. Charles Foote. It appears that during the first fortnight following the introduction of the typhoid bacilli, undoubted multiplication of these microbes took place, but after that time had elapsed a steady decline in [numbers] was observed. The presence of typhoid bacilli within the oyster was, however, still demonstrable even thirty days after they were first introduced, and they were, moreover, observed in the stomach of the oyster, where they remained unimpaired in a vital condition. In some other experiments the water in which the oysters were immersed was also inoculated with typhoid bacilli, and it was actually found that they lived longer within the body of the oyster than in the water in which the latter was preserved. These investigations materially assist in justifying the hypothesis as to the possible contraction of typhoid through the consumption of oysters.

THE *Publishers' Circular* states that the number of new books issued in England in the course of last year was 5581, and of new editions 935, making a total of 6516 publications. By dividing these works into thirteen classes, an idea is given of the kinds of literature which make up this total. In the educational, classical, and philological class, 660 new books were published, and 111 new editions. These numbers are a little in advance of those of previous years. The number of new books classified under "Arts, Sciences, and Illustrated Works" is 96, in addition to 16 new editions. But no definite idea with reference to the issue of scientific books can be obtained from these figures, owing to the unsound system of classification adopted. Why illustrated works should be classified with scientific works passes our comprehension. Moreover, there is something wrong about the figures, for in science alone we noticed in these columns last year many more than sixteen new editions of British books. Under the heading "Voyages, Travels, Geographical Research," 263 new books are given and 75 new editions. This was a slight decrease on the publications of 1894. In medicine, surgery, &c., 153 new books were issued and 53 new editions, this being a remarkable increase on the issues of the previous year.

WE note that the table of mean values for pressure, temperature, rainfall, and bright sunshine, which is published in the *Daily Weather Report* issued by the Meteorological Office, has been materially improved this year. In the first place, five more years of observations have been added to those from which the monthly means for each of the elements are calculated. Secondly, new columns have been added, showing the absolute maximum and minimum temperatures recorded during the month and the years in which such extremes occurred. The mean values are now mainly for the twenty-five years 1871–95, and the extreme readings afford valuable information as to whether the maximum and minimum temperatures recorded during each month are exceptionally high or low for the season. A glance at the table for January shows, for instance, that during the last twenty-five years the highest temperature recorded at any station included in it, in that month was 59° at Nairn and Cambridge, and the lowest, −4° at Wick. Sunshine values at a few more stations would further enhance the value of this otherwise very complete *Report*.

THE "Triton" Society for the study of Aquaria and Terraria in Berlin has recently announced its intention of awarding prizes to the amount of 1500 M. for the best original solutions of certain problems connected with the management of fresh-water aquaria. The competition is open to all, and the problems in question are as follows:—(1) A method for the destruction of the more injurious ectoparasites of fishes, *e.g.* Gyrodactylus, Ichthyophthirius, Chilodon, Myxosporidia; (2) a method of exterminating the fresh-water polyp, Hydra, from aquaria; and (3) a method for exterminating the tube-worm, *Tubifex rivulorum*, from aquaria. In all three cases the methods recommended must be simple, easy to carry out, and effective in their results; but, while fatal to the particular organisms mentioned, they must have no injurious effect upon the fish and plant life of the aquarium. The essays must contain exact accounts of the methods recommended, and full descriptions of the experimental evidence upon which they are based, so that the methods may be readily and accurately repeated. Competitors must write in one of the recognised European languages, and must forward their essays by July 1, 1897, to Prof. F. E. Schulze, Direktor des zool. Instituts, Berlin N., Invalidenstrasse 43. The adjudicators will be Profs. F. E. Schulze and K. Möbius, and Drs. Haack, Hofer, and Schillinger. For the first problem two prizes will be awarded of 700 M. and 400 M. respectively; for each of the remaining problems a prize of 200 M. will be awarded. The Minister of Agriculture will also place two State medals in the hands of the adjudicators for award. Further information in regard to the competition will be found in *Der Zoologische Garten*, Frankfurt, vol. xxxvi. No. 9, 1895, pp. 285, 286.

THE annual general meeting of the Institution of Mechanical Engineers will be held on Thursday evening, January 30, and Friday evening, January 31. The annual report of the Council will be presented to the meeting on Thursday. The retiring President, Prof. Alexander B. W. Kennedy, F.R.S., will induct into the chair the President-elect, Mr. E. Windsor Richards.

The following papers will then be read and discussed, as far as time permits: "Telemeters and Range-finders for Naval and other Purposes," by Profs. Barr and Stroud; "Calculation of Horse-power for Marine Propulsion," by Lieut.-Colonel Thomas English; "Notes on Steam Superheating," by Mr. William H. Patchell.

THE Home Secretary has just issued the following order:—(1) The Wild Birds Protection Act, 1880, shall apply within the administrative county of the Parts of Kesteven, Lincolnshire, to the following wild birds, viz.:—Kestrel, merlin, hobby, common buzzard, honey buzzard, swallow, house martin, sand martin, swift, and wryneck, as if those species were included in the schedule to the Act. (2) The taking or destroying of the eggs of the following wild birds is prohibited within the administrative county of the Parts of Kesteven, Lincolnshire, viz.: Goldfinch, kingfisher, nightjar, nightingale, owls (of all species), ruff or reeve, woodpecker, kestrel, merlin, hobby, common buzzard, honey buzzard, swallow, house martin, sand martin, swift, wryneck, teal, and wild ducks (of all species)."

THE last published number of the U.S. *Weather Review* (June 1895) contains some interesting notes on the early history of weather telegraphy. The Morse telegraph was put into operation between Baltimore and New York on May 27, 1844, and it is said that a few days only had elapsed before the operators began to forewarn each other of the more important weather changes. In the *American Journal of Science and Arts*, vol. ii. 1846, Mr. W. C. Redfield notified that the approach of a gale, when the storm was yet on the Gulf of Mexico, or in the Western States, might be made known by means of the electric telegraph. A similar opinion, by Prof. Loomis, was published in the Second Annual Report of the Smithsonian Institution for the year 1847. A remarkable enterprise was undertaken by a news agency in New York; on January 24, 1848, Messrs. Jones and Co. advertised that they had made arrangements to give daily and hourly reports of meteorological phenomena from all parts of the country which were in telegraphic communication with New York; this advertisement appeared in *Silliman's American Journal of Science* for March 1848. The subsequent steady development of telegraphic weather reports culminated in the publication of daily maps; further particulars respecting the early development of meteorological telegraphy will be found in "Weather Charts and Storm Warnings," by Mr. R. H. Scott.

AN apparatus which illustrates all the laws of falling bodies, and also shows the tension or force acting upon them, is described by K. Hrabowski in *Wiedemann's Annalen*. It consists of a carriage moving on a single rail, somewhat on the Lartigue railway system, pulled by a weight drawn over a pulley, the string being connected to the carriage by a spring moving up and down in a vertical tube. To the upper end of the spring a pencil is attached, which moves along a vertical plate, and leaves a mark as the carriage runs along. When the carriage is at rest, the pencil stops at the point indicating the amount of the moving weight. Immediately on starting, the spring contracts, and the pencil-point traces a curved line which gives the force acting upon the carriage at every point. The line becomes horizontal when the carriage and weight have equal velocities, the tension in the spring being then just sufficient to overcome friction, and the amount of the latter may also be seen at a glance. By inclining the rail, the phenomena of acceleration downwards, or retardation upwards, may be easily studied. The apparatus is cheap, and should form a useful adjunct to science classes.

THE following account of the method used by the Bushmen of Namaqualand to poison their arrows is given in the *Scientific African*:—"Many methods of preparing the poison have been described, and according to some the poison is said to be extracted from the root of the plant, *Buphane toxicaria*, or Gift-bol, but it seems that the extract is only used as a resin. Some resin, either from the Gift-bol or from one of the members of the Euphorbia group of cactus-like plants, is first obtained, and the sticky substance is placed on a stone. The Bushman then goes with a forked stick to look for the 'ring-halse' or black night-adder, not the puff-adder which is called the ring-halse. Having found the snake, by a dexterous thrust of the stick the animal is imprisoned just behind the head by the two prongs of the stick. The prepared stone is then placed in the mouth, and the upper jaw forced right back. By this somewhat rough treatment the poison glands become compressed, and two drops of poison forced out on the fangs and caught on the stone. The poison is then well mixed with the resinous matter, and is ready for use. In the earlier days a more complicated procedure was adopted, through the medium of the witch-doctor. The whole head of the puff-adder was obtained and put in a pot along with the resin, and beetles and noxious herbs added to the incantation of the witch-doctor. The whole was stewed up amid great excitement. When the contents of the vessel were properly mixed, the sticky compound was collected by stirring it with a stick, to which the matter adhered, and on becoming cold, remained on the stick as a black knob, and formed then an article of barter."

A DESCRIPTION of the gold fields of the Southern Appalachians, based on a recent survey by Mr. G. F. Becker, forms part of the latest volume of the "Mineral Resources of the United States." There are a few small placer deposits in this field, which afford but little gold. They are of interest, however, in that they furnish undoubted proofs, in Mr. Becker's opinion, that alluvial gold is not formed by accretion, but by the wearing down of particles already present as such in quartz lodes. He accounts for the high standard of alluvial gold, and especially for that of the outer layers of nuggets, by assuming that the silver and other impurities have been removed in solution by running water; and he clinches his argument by quoting the opinion of Orviedo, one of the lieutenants of Columbus. Mr. Becker further narrates how he has traced the complete transition from hard auriferous quartz to true placer gravels through a series of "saprolites," a name proposed by him to designate "thoroughly decomposed, earthy, but untransported rock." He distinguishes them as "granitic saprolite" and the like, and claims that the use of such a term would be very convenient. The other gold deposits of the Appalachians are mainly true lodes, occupying fissures which run across the planes of stratification and have been formed by purely mechanical action. In this the author differs from Mr. J. A. Phillips, who thought they were "segregation veins." In whatever manner the veins may have been formed, however, there can be no doubt about some deposits of a slightly different kind occurring in Carolina, and bearing much resemblance to the *fahlbands* of Norway. These Carolina *fahlbands* are extensive lens-shaped masses of rock, which are conformable to the general schistose structure of the country, and are charged with disseminated pyrites and gold. Quartz stringers and veins appear close to and even in the rock masses, but, curiously enough, are barren. It is evident that the *fahlbands* have been enriched by impregnation with solutions containing gold, and also that no true segregation has occurred in these cases.

THE production and application of anti-toxic serum in the treatment of rabies has naturally been regarded as a subject the study of which could only be a question of time. The preliminary experiments on this subject made by Messrs. Babès and Lepp in 1889, had not been followed by any great advance in this direction until this year, when a most elaborate and weighty memoir on the preparation of anti-rabic serum has been contributed to the *Atti della Reale Accademia delle Scienze dell' Istituto di Bologna*, by Messrs. Tizzoni and Centanni. The authors have succeeded in obtaining a powerful anti-rabic serum from sheep by inoculating them seventeen times in the course of twenty days with attenuated nerve-substance obtained from rabid animals, which is introduced in the proportion of 0·75 grm. per kgr. weight of the animal to be treated. Already a few minutes after the serum has been subcutaneously injected, the blood has acquired immunising properties, a result which with Pasteur's anti-rabic method is only obtained after several days, and then not invariably. As a *preventive* measure the authors state that 1½ drops of serum is sufficient to protect an animal weighing 2 kgr. inoculated twenty-four hours later with dog virus. As a *curative* measure the subcutaneous inoculation of 1 cubic centimetre even eight days after the animal has been infected with rabies, and therefore in the middle of the incubation period, is sufficient to stay all further progress of the disease. With this anti-rabic serum, Messrs. Tizzoni and Centanni have been easily able to render rabbits—these animals being especially susceptible to rabies—immune, a result only accomplished under exceptional circumstances by Pasteur's method. Rabbits again, even after the disease has made considerable progress, can be saved by a single subcutaneous injection of anti-rabic serum, whilst the Pasteur method under such conditions has never succeeded in curing them. The authors claim for their method that it is more efficacious, and at the same time less cumbrous than that at present in use. The serum is readily transferable, as it can be desiccated, and kept in bottles, protected from light, for a long time without undergoing any detriment. It thus can be forwarded to all parts of the world, and can be employed by local physicians, therefore preventing delay in treatment, and the necessity of the patient travelling to be treated in special institutes. The further application of anti-rabic serum will be watched with the greatest interest, and the verdict which time and experience alone can furnish will be anxiously awaited.

The forthcoming number of the *Physical Review* will contain articles on the photometry of differently-coloured lights and the "Flicker" photometer, by Prof. Frank P. Whitman; the chemical potential of the metals, by Mr. Wilder D. Bancroft; and on the freezing-points of dilute aqueous solutions, by Mr. E. H. Loomis.

Messrs. G. Philip and Son have just published a special coloured map of British Guiana, to illustrate the Venezula-Guiana boundary dispute. The map shows clearly British and Venezuelan territories and claims, the original and modified Schomburgk lines, gold-mining districts, and many other features of the region surrounding the disputed area.

At the celebration of the second centenary of the death of Christian Huygens, held at Amsterdam in July 1895, Dr. J. Bosscha delivered before the University a valuable address on the life and work of that rare genius. It will interest many of our readers to know that this address, with numerous details appended to it, has been published by Wilhelm Engelmann, Leipzig.

An illustrated paper "On the Entomology of the Illinois River and Adjacent Waters," by Mr. C. A. Hart, is published in the *Bulletin* of the Illinois State Laboratory of Natural History (vol. iv. pp. 149–273, 1895). The paper gives a part of the results of observation and study of the insect fauna of the Illinois River and adjoining waters in the neighbourhood of the University of Illinois Biological Experiment Station, at Havana, Illinois, during the first year of the station work.

The "Brief Sketch" of the meteorology of the Bombay Presidency for the year 1894–95 shows that the rainfall of the year 1894 was exceptionally good. During the month of July it was excessively heavy, owing to three severe cyclones, whereby disastrous floods were caused in various districts. The abnormally heavy rainfall on the Ghauts converted the mountain streams into rushing torrents, which swept everything before them, and rendered railway traffic impossible. At Surat a sudden rush raised the level of the river four feet within a quarter of an hour; communication was cut off with all surrounding villages, causing great loss of life from starvation or drowning. It is satisfactory to note that little or no damage was done in the town of Bombay by the immense quantity of rain which fell, owing to the great improvements that have been made in the drainage during the past few years.

Last year's volume of the *Journal of Conchology* (vol. viii.), which was founded in 1874 by Mr. J. W. Taylor, of Leeds, and ably conducted by him for a period of twenty-one years, contains the record of some important changes which have taken place in the management of the journal during the past twelve months. Four quarterly numbers of the journal were issued during the year. The first informed us that the journal had become, by purchase, the property of the Conchological Society, and would be continued as the official organ of that Society, under the editorship of Mr. W. E. Hoyle. All four numbers contain original papers of varied character and interest, accompanied in some cases by good lithographic or photographic plates of illustrations; and the Proceedings of the Conchological Society, as published in the journal, alone furnish an interesting record of valuable observations in many departments of malacology. The annual report of the Conchological Society for 1894–5 is contained in the July number. From it we learn that all arrangements have been made for the transfer of the headquarters of the Society from Leeds to Manchester, with branches in Leeds and London—a change which, it may be hoped, will contribute still further to the growth and vigour of the Society.

Several novel scientific instruments and devices described in the new catalogues of scientific apparatus and of lanterns and slides, recently issued by Messrs. Newton and Co., deserve mention here. A very simple method devised to show stereoscopic pictures with the optical lantern is especially noteworthy. A pair of negatives is taken with a stereoscopic camera, and a lantern slide is made from each. One of these slides is mounted in contact with a bluish-green glass, and the other in contact with a red glass. The two slides are simultaneously projected upon a screen, by means of two lanterns, but are not exactly superimposed. The combined picture is then viewed through spectacles, the glasses of which are of the same kind as those covering the slides. Only the red picture is seen through the red glass, and only the bluish-green picture with the bluish-green glass. And as the two pictures are from stereoscopic negatives, a definite stereoscopic effect is produced by making each eye only see one of the pair of pictures, the combination of both of which gives the effect of relief. An advantage which this method possesses is that it can be used with any pair of lanterns. All that is required is stereoscopic slides mounted with suitably coloured glasses, and similarly coloured spectacles through which the pictures must be viewed. Under these conditions, the pictures stand out in strong stereoscopic relief upon the screen. Among the many new forms of instruments described, we notice a new sunshine recorder, and several improved forms of electric lamps for lanterns. The catalogue of lantern slides should be seen by all who use the lantern in science lectures. It includes Prof. Boys' photographs of "flying bullets," sixty-three slides illustrating volcanic action, from photographs by Prof. Johnston Lavis; photo-micrographs of rock-sections, and many other subjects. The slides are so numerous, and cover so wide a range, that teachers of any and every branch of science will find some in which they will be specially interested.

WE have on our table a number of new editions of books already reviewed in NATURE. One of these is the second edition of the "Lehrbuch der Botanik" (Jena: Gustav Fischer), by Drs. Strasburger, Noll, Schenck, and Schimper. This important work was first published in 1894, and the quick call for a second edition shows that botanists have not been long in finding out its admirable qualities. Dr. Oscar Hertwig's classic "Lehrbuch der Entwicklungsgeschichte" (Gustav Fischer) has now reached its fifth German edition. A number of new figures has been added, and results obtained by embryologists in the two years that have elapsed since the publication of the fourth edition have been incorporated in the text. Another fifth edition recently received is "Dynamo-Electric Machinery" (E. and F. N. Spon), by Prof. S. P. Thompson, F.R.S. The chief changes that have been made relate to alternate-current machinery. These and other additions have been made necessary by the development of electric machinery since 1892, when the fourth edition of Prof. Thompson's elaborate work appeared. A second edition has been published of "Dynamo Attendants and their Dynamos" (*Electricity* Office), by Mr. A. H. Gibbings. The book is intended for those practical men who have charge of electric lighting plant without knowing much about electrical principles; it consists, therefore, mainly of hints and advice as to how to manage dynamos, and what to do under those perplexing circumstances which occur in the best regulated dynamo rooms. After six years, a second edition has been published of "Service Chemistry" (W. B. Whittingham and Co.), by Prof. Vivian B. Lewes. The volume is primarily intended to be an exposition of the applications of chemistry in the naval and military services; nevertheless, a fair proportion of its space is taken up with descriptions of the general principles upon which all technical chemistry depends. Messrs. W. Collins, Sons, and Co. have issued a new edition of "A Manual of Inorganic Chemistry," by Prof. T. E. Thorpe, F.R.S. Since this manual was first published, twenty-three years ago, it has been frequently reprinted, but the new edition contains so much new matter, and is so greatly altered, that it is practically a new text-book, which will be found even more serviceable than the original one. The work is published in two volumes, which deal, respectively, with the non-metals and metals; it has been brought thoroughly up to date, and well records the present state of knowledge of the chemistry of the mineral kingdom.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus sinicus*, ♂ ♂) from India, presented by Mr. F. Greswolde Williams; a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Captain Pickthorn; four Pratincoles (*Glareola pratincola*), four Marbled Ducks (*Anas marmorata*), South European, presented by Lord Lilford; a Snow Bunting (*Plectrophanes nivalis*), European, presented by Mr. J. E. Harting; two Passerine-Parrakeets (*Psittacula passerina*) from Brazil, presented by Mrs. Robert McCabe; a Ring-necked Parrakeet (*Palæornis torquata*) from India, presented by Mr. E. Parrott; a Leadbeaters Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mr. B. T. Frere; two Leopard Tortoises (*Testudo pardalis*), two Puff Adders (*Vipera arietans*), an Infernal Snake (*Sepedon hæmachates*) from South Africa, presented by Mr. J. E. Matcham; a Manatee (*Manatus australis*) from Demerara, presented by Captain Edward J. Collings; a Southern River Hog (*Potamochœrus africanus*) from South Africa, presented by Mr. W. Anthony Morgan; a Black-handed Spider Monkey (*Ateles geoffroyi*) from Central America, a —— Terrapin (*Hydromedusa tectifera*) from Rio de la Plata, purchased.

OUR ASTRONOMICAL COLUMN.

CELESTIAL PHOTOGRAPHY BY SIMPLE MEANS.—In the hands of Prof. Barnard, the "magic lantern" lens has developed into an instrument of considerable astronomical importance. The lens actually employed by him is a $1\frac{1}{2}$ inch doublet of 4 or 5 inches equivalent focus, and the scale of the pictures is roughly 10° to an inch. Six beautiful photographs of various parts of the Milky Way taken with this small optical aid are reproduced in the *Astrophysical Journal*, vol. ii. No. 5, and they admirably illustrate the value of such an instrument in the delineation of extended nebulosities and in photographing large areas of the sky. They are selected from the more remarkable parts of the Milky Way, but Prof. Barnard has obtained a great number of such photographs, and proposes soon to construct a photographic chart from them. The picture of the new nebulous region in Scorpio shows two very obvious streams or "dark lanes" which are almost void of stars, and various peculiarities are presented by the other photographs.

In the same journal there is a reproduction and an account of a very fine photograph of the nebula near ξ Persei (N.G.C. 1499) taken with an exposure of six hours by means of the 6-inch Willard telescope, at the Lick Observatory, on September 21, 1895. The nebula is very irregular with numerous condensations, and is remarkable for a small dark spot, about 6′ in diameter, in its northern part; "doubtless a hole in the nebula," says Prof. Barnard. Attention is drawn to the suggestive fact that this nebula lies on the edge of a region in which there is a comparative absence of small stars, as noticed also in the case of most of the large diffused nebulæ lately photographed.

THE CONSTANT OF NUTATION.—A new determination of the constant of nutation has been made by Dr. Chandler (*Astronomical Journal*, No. 361). It is based on a discussion of 20,294 observations of stars with the mural circles of Troughton and Jones at Greenwich during the years 1825–1848. In order to eliminate errors due to possible slow changes of the angle between the pole and the zenith, whether strictly or irregularly systematic, it has been considered necessary to employ a large number of stars, distributed as uniformly as possible over the entire sky; and the Greenwich observations offer this facility, while at the same time possessing the necessary degree of accuracy. The adopted mean value of the latitude of Greenwich is 51° 28′ 38″·42, and assuming that this is the same in all years, the nutation is found to be 9″·197, after eliminating the short-period terms of the latitude variation. This assumption, however, is not justified, as the observations indicate a pronounced deviation, which cannot be explained by anomalies of refraction, but must be due to a change in the place of the zenith. Although such a change may possibly be subjective, Dr. Chandler thinks it much more likely to be due to an actual slow change of the latitude. The observations favour an inequality of the mean latitude with a period of about twelve years, and a range of about a quarter of a second. To whatever cause this change may ultimately be ascribed, it is at least necessary to take account of it in evaluating the constant of nutation; and when this and all other corrections have been applied, the definitive value of the nutation, from the observations with the Greenwich mural circles, is $9''·192 \pm 0''·012$. Combining this result with all previous ones which are entitled to any weight at all, the final value becomes 9″·202. The corresponding reciprocal of the moon's mass, in terms of that of the earth, is 81·80, if 50″·36 be taken for the luni-solar precession.

A YORKSHIRE AEROLITE.

FOLLOWING my recent description of the "Yorkshire Gypsey-Springs," I may say that the great Yorkshire aerolite fell a century ago at the village of Wold Newton, where these springs first rise to light. Wold Newton is ten miles west from Bridlington Quay, no village on the Yorkshire Wolds having so much to interest the students of archæology and natural phenomena. Here, at Wold Cottage, lived Edward Topham, the retired "Tip-top Adjutant," who, in 1787, established *The World*, and whose epilogue, spoken by Lee Lewis in the character of Molière's "Old Woman," created him a star in the dramatic firmament. Two fields south-westerly from Wold Cottage, and protected on the north side by a plantation, you come to a flue-like column of bricks, which used to receive its washing with white lime every year. A yellow slab in the middle bears the following inscription:—

HERE,
on this spot, December 13th, 1795,
fell from the atmosphere
AN EXTRAORDINARY STONE.
In breadth 28 inches,
In length 30 inches,
and
whose weight was 56 pounds.
This column
was erected by
Edward Topham,
1799.

Thus, it is scarcely more than a century since this meteoric stone fell. The day was Sunday, the time about three o'clock in the afternoon, the weather misty, thunder and lightning being at a distance. Suddenly there came a noise like an explosion. George Sawden, a carpenter, was passing within sixty yards of the spot where the aerolite fell; and so much nearer was John Shipley, a farm servant, that he was struck by some soft earth thrown up by the stone when it plunged into the earth. While it was still passing in a north-easterly direction from the sea-coast, a number of persons at Reighton, who, while "turniping" their sheep in the fields, saw it moving down the clouds, made hasty steps for the top of their church-tower to see where it fell, while others spread the tale that it was a cannon-ball shot by a ship-load of French giants who were supposed to have landed to invade the island. Two sons of the Vicar of Wold Newton heard the same body whizz over their heads, and they were among the first on the spot where it fell. It excavated a place 19 inches deep and of something more than 3 feet in diameter, embedding itself so fast in the chalk rock that considerable force was required to dislodge it. A piece split off was, sixty years ago, in the possession of the Rev. Francis Wrangham, F.R.S., Vicar of Hunmanby. It had a black, vitrified surface, and exhibited marks of having been exposed to the action of fire. The inside was white and of a granulated but very compact texture, its composition having no resemblance to any natural stone of the terrestrial sphere. Sent originally to Sowerby's Museum, London, now the aerolite occupies a conspicuous position in the British Museum. It is about the size of a man's head.

HARWOOD BRIERLEY.

PRIZE SUBJECTS OF THE PARIS ACADEMY OF SCIENCES.

AT the recent annual meeting of the Paris Academy of Sciences, the following prizes were announced for the year 1896. In Mathematics the subjects proposed are: the Grand prize for an important improvement in the algebraic theory of groups of substitutions between n letters; the Bordin prize (3000 fr.) for an important advance in the theory of geodesic lines; the Francœur prize (1000 fr.) and the Poncelet prize (2000 fr.) will be awarded for discoveries useful in pure and applied mathematics. In Mechanics, the extraordinary prize of 6000 fr. will be given as a reward for an invention tending to increase the efficiency of the French naval forces, the Montyon for the improvement or invention of instruments useful to the progress of agriculture or the mechanical arts, and the Plumey prize (2500 fr.) for improvements in steam engines or any invention contributing to the progress of steam navigation.

In Astronomy, the Lalande prize (540 fr.) will be awarded to any one (in France or elsewhere) who shall have made the most interesting observation, or have published the most useful work bearing on astronomy; the conditions for the Valz prize (460 fr.) are similar. The subject announced for the Damoiseau prize (1500 fr.) is to connect together by the theory of disturbances the various appearances of Halley's comet, going back as far as 1456 (Toscanelli), taking account of the attraction of Neptune, and also to calculate exactly the next return in 1910. The Janssen prize (a gold medal) is offered for an important result in Physical Astronomy; a Montyon prize (500 fr.) for studies in French statistics, and the Jecker prize (10,000 fr.) for researches in organic chemistry. In Mineralogy and Geology, the subjects for the Vaillant prize (4000 fr.) are to study the physical and chemical causes which determine the existence of rotatory power in transparent substances, especially from an experimental point of view, and to improve, theoretically or practically, methods relating to geodesy or topography; the Fontannes prize (2000 fr.) is offered for contributions to palæontology.

In Botany, there will be awarded the Demazières prize (1600 fr.) for the best contribution, to our knowledge of the Cryptogamia, the Barbier prize (2000 fr.) for a botanical discovery having special reference to medicine, two Montagne prizes (1000 fr. and 500 fr.) for work bearing on the anatomy, physiology, development, or description of the lower Cryptogams, and the Thore prize (200 fr.) for the best memoir on European cellular Cryptogams. In Anatomy and Zoology, the Savigny prize (975 fr.) is given to aid young travellers, who, not receiving Government assistance, specially occupy themselves with the Syrian and Egyptian invertebrates. One or more Montyon prizes will be awarded for discoveries in Medicine and Surgery, the Bréant prize (100,000 fr.) for a specific cure for Asiatic cholera. Other prizes offered in Medicine are the Godard prize (1000 fr.) for the best memoir on the anatomy, physiology, and pathology of the genito-urinary organs, the Serres prize (7500 fr.) for the best work on general embryology applied to physiology and medicine, the Bellion prize (1400 fr.) for work of especial value to the public health, the Mège prize (10,000 fr.) for an essay on the causes which have helped or retarded the progress of medicine, and the Lallemand prize (1800 fr.) for researches on the nervous system. In Physiology, besides a Montyon prize (750 fr.), there is offered the Philipeaux prize (890 fr.) for experimental physiology, and the Pourat prize (1800 fr.).

In Physical Geography, the subject announced for the Gay prize (2500 fr.) is a study of the French lakes from a chemical, physical, and geological point of view. Besides the Arago medal, which is only occasionally awarded for discoveries of special value, the following general prizes are offered for 1896. The Montyon prize (unhealthy trades) for a means of rendering less dangerous an unhealthy trade, the Trémont prize (1100 fr.) the Gegner prize (4000 fr.), the Delalande-Guérineau prize (1000 fr.), the Jean Reynard prize (10,000 fr.), the Jérome Ponti prize (3500 fr.), the Tchihatchef prize (3000 fr.) for the exploration of imperfectly known regions of Asia, the Houllevigue prize (5000 fr.), the Cahours prize (3000 fr.) for the encouragement of young men already known as having done interesting work, especially in chemistry, the Saintour prize (3000 fr.), the Laplace prize of books, and the Rivot prize (2500 fr.).

In the case of the prizes bearing the names of La Caze, Delesse, Desmazières, Lalande, and Leconte (in 1898), it is specially stated that they are awarded entirely without preference of nationality, and of the remainder only two or three are restricted to French subjects. All memoirs for this year must be sent in to the Academy before June 1.

AMATEUR CLOUD PHOTOGRAPHY.[1]

THE blue colour of the sky has as much action on an ordinary sensitive plate as the white colour of light clouds (cirrus and cirro-cumulus); it is therefore necessary to diminish the action of the blue background of the sky. For this purpose a yellow screen is placed so as to intercept the rays; the light coming from the sky contains very few yellow and green rays, and is thus extinguished to a great extent; but, on the other hand, the great proportion of yellow and green rays which exists in the white light of the clouds passes the screen and makes an impression on the plate, if it has been made more sensitive to the action of yellow and green rays than the ordinary plates.

There are, therefore, three points to be considered: (1) the coloured screen; (2) the sensitive plate; (3) the method of development of the images.

(1) *The Coloured Screens.*—Coloured screens formed of films of

[1] By M. Angot. (Translated from *Cosmos*, November 23, 1895.)

gelatine or collodion must be rejected, because their tint changes very quickly in the light, and they easily lose their transparency. Either yellow glass must be used, or cells containing a suitable liquid.

Yellow glasses make the most convenient screens of all; but the difficulty is to find suitable glasses which are always the same, and of sufficiently graduated shade. Some are excellent, others not worth anything. Before recommending the use of coloured glasses exclusively, some experiments ought to be made with the help of a glass maker, in order to ascertain what ought to be the exact composition of the glass so that it may be reproduced with the exact tone at any time. It is unnecessary to add that the glass must be homogeneous and polished with quite parallel surfaces; only glass ought to be used which is coloured in mass, and not white covered with a superficial layer of enamel.

The surest method, in the case of not being able to get glass of which the composition is known, would be to use liquid screens, as I do. They are made with two parallel square glasses cemented together on three sides by square glass rods also with parallel sides, and with a thickness of six or seven millimetres, and length of side seven to eight centimetres, one side remaining open. If one does not wish to go to the trouble of making them, these cells can be obtained from instrument-makers. Needless to say that before cementing, the glasses must be carefully cleaned with a solution of carbonate of soda, then with water, and lastly by being well rubbed with a piece of cotton-wool dipped in alcohol; with these precautions, no air is to be feared along the sides of the cells. Before introducing the liquid, care must be taken to dip the open end of the cell in a bath of resin (a mixture of yellow wax and resin of equal parts). For ultimately closing the cell, it suffices to fasten on the edges, thus covered with resin, a little plate of glass cut to a suitable size, and which must be heated on a plate of copper to prevent its breaking. If found desirable the aperture may be still more securely closed with sealing-wax. Thus cells are obtained hermetically sealed, which can be used at every inclination without the liquid spilling and without air getting along the joints.

The easiest way of fixing these cells in position is to pierce a circular hole in the centre of a flat piece of cork, the size of the sunshade of the lens of the camera. The plate is fitted into the sunshade and held by india-rubber. The screen is thus in front of the lens, and it can be easily replaced by others more or less dark.

For the liquid, I have had to reject all solutions of organic colours, such as aurentia, primuline, chrysoidine, for they alter in the light. The simplest one is to use the bichromate of potash. A saturated solution is prepared at ordinary temperature, to which is added, after straining, a few drops of hydrochloric acid. This saturated solution, introduced into one of the previously described cells, constitutes screen (1), which should be used when the clouds are very light, and the sky of a pale blue. A solution of half the strength forms screen (2), which may be used for well-lighted detached cirrus on a really blue sky; lastly, screen (3), consisting of one part of the saturated solution to three of water, should be reserved for very luminous clouds as cumulus and cumulo-nimbus.

It is certainly more convenient and more simple to use coloured glasses as screens; but while there is a doubt as to finding suitable glass, we can always be certain when using bichromate cells of straightway obtaining excellent screens, always precisely the same. The ones I possess have been in use two years, and no precautions have been taken to preserve them.

(2) *Sensitive Plates.*—Special plates must be used for yellow light. The way of preparing these plates by means of ordinary plates is already well known; I did this at first. But I am certain that the necessity of preparing the plates is the principal obstacle which stops people taking photographs of clouds, who are really desirous of doing so. However, prepared plates are to be had in the trade, and they serve the purpose admirably.

Among the types of plates called orthocromatic or isochromatic, two have given me excellent results: Lumière's orthochromatic plates, sensitive to yellow and green light, and Edward's orthochromatic plates.

There is, therefore, no necessity to prepare plates, as they are to be had ready-made, and, at least in most cases, quite as good as those one could prepare personally. It has been said that the sensitiveness of these plates alters very soon, so much so that they are useless at the end of a few months. With regard to this, I can but quote the following fact. In February 1893, I received from the firm of Lumière, three boxes of orthochromatic plates, of which the date of manufacture is unknown to me. These three boxes were simply placed in a cupboard of my bureau without any other precautions. The first box of twelve plates was used in the course of 1893; the second, only opened at the beginning of 1894, and used between the months of March and November; lastly, the third box was opened only in November 1894, and the two first plates gave negatives which did not differ at all from those obtained from similar plates twenty months before.

Other similar boxes opened, then forgotten, for some months in a cupboard, have always given me excellent results.

I intend to continue these studies; but it seems to me now established, that if the sensitiveness of these plates diminishes with time, this diminution is small enough to permit of the plates being used after more than eighteen months. Under these conditions nothing can be said against their use.

Focussing is done without any difficulty on a distant object, for instance on a house in bright light. If the horizon is not far enough distant, an object can be taken comparatively near (at least twenty-five or thirty metres), then in order that the position shall correspond with infinity, move the ground-glass towards the lens a distance $\frac{f}{k-1}$, f being the focal distance of the lens, and k the number of times that the distance of the object which has been focussed contains the focal length of the lens. For instance, if an object twenty metres distant has been focussed with a lens, of which the focal length is twenty-five centimetres, then we get $k = \frac{2000}{25} = 80$. In order that the clouds may be in focus, the ground-glass must be brought a distance of $\frac{25}{79} = 0{\cdot}32$ c.m., about 3 millimetres, nearer the lens. Of course the focus must be got with the coloured screen, and the position thus found must be marked on the base of the camera, in order that the position of the frame may be known.

(3) *Development.*—No mode of development must be rejected *à priori*; even developers called *automatic*, which can be bought ready prepared. and which have been very much run down, for they are by far the most convenient, and often give excellent results.

If the negative that we wish to develop contains only clouds of more or less the same intensity, the automatic developers may be used without any risk. I have used baths of hydroquinone, Lumière's developer (of paramidophenol), &c., with success. It is advantageous to use baths which have already been used, and consequently containing a good proportion of bromide; a greater contrast is then obtained between the clouds and sky, and the development can be carried further without fear of fogging.

If, on the contrary, the negative consists of clouds of very unequal luminous intensity, as, for instance, delicate cirrus and strongly lighted cumulus, the negative would not turn out well with automatic developers containing much bromide; the image of the cumulus would appear, and be over-developed before that of the cirrus had begun to show itself. In this case either a new bath must be used, very diluted, without bromide, and the development is then very slow, or else (which is preferable) use pyrogallic acid, in employing the method recommended by M. Londe. In this case the development must be commenced with a very small quantity of pyrogallic acid, a little bromide, and relatively enough carbonate of soda, in such a way as to make all the parts of the image appear at first, without much intensity; then the necessary intensity will be obtained little by little, by the successive additions of pyrogallic acid. It is in this case only, where the intensity of the clouds is very different, that I think it advantageous to recommend progressive development instead of pyrogallic acid. In most ordinary cases, however, the automatic developers, which are more rapid, and more convenient to use, act very well.

In fact it is always as well to continue the development till the image is sufficiently dense, without intensifying, which is almost always possible. Negatives ought only very exceptionally to be intensified; to my mind, the intensification is always bad, it spoils the detail; a renewed or feeble negative is never worth as much as one that was made sufficiently dense in the first instance.

If I have gone into all these details, it is only to show that photography of clouds is a very easy operation, and within the reach of all amateurs. And let me just add, that with the darkest screen (saturated bichromate) and Prazmowski's lens, with a focus of 160 millimetres, and diaphragm of $\frac{1}{30}$, I obtain negatives with a maximum exposure of six seconds for cirrus, with an ordinary amount of light with a Zeiss' object-glass, a diaphragm of $\frac{1}{16}$ and very bright cirrus, having an exposure of $\frac{1}{30}$ of a second, has sometimes been more than sufficient, even too much.

It would be very interesting if amateurs in photography, so numerous at the present time, would try to photograph clouds which strike them as having interesting shapes, noting with care the hour when they were taken, and also the direction in which the clouds appeared.

SCIENCE IN THE MAGAZINES.

ONE of the most interesting contributions to this month's magazines is an illustrated account in the *Century* by Mr. Borchgrevink, of his voyage in the *Antarctic*, prefaced by a note by Mr. A. W. Greely. The article will give an impulse to the movement in favour of an expedition to explore the Antarctic continent. Referring to Mr. Borchgrevink's account, Mr. Greely says: "From a scientific standpoint the interest depends entirely upon the discovery by Borchgrevink, on Possession Island and Cape Adare, Victoria Land, of a cryptogamous growth, probably an unidentified lichen. The importance of this discovery rests in the fact that hitherto no land vegetation of any kind or description had been found within the confines of the Antarctic circle. The strained deduction has been drawn that the climatic conditions of the Antarctic zone must have changed since the voyage of Ross, who discovered no vegetation. It should be borne in mind, however, that the great botanist, Sir Joseph Hooker, who served with Ross, was unfortunately prevented from landing with his commander; otherwise it may not be doubted that low forms of vegetable life which escaped the attention of Ross would have been noted by Hooker. In a practical way it emphasises the possibility of much more extended exploration in the Antarctic Ocean, through the agency of the steam-power of to-day, than was practicable for the greatest of Antarctic navigators—Cook, Balleny, Weddell, Wilkes, and Ross—under sail alone in the past." Ethnologists will be interested in the studies of Indian life given by Alice C. Fletcher in the *Century*, under the title "Tribal Life among the Omahas."

An illustrated description of the magnificent new building of the Boston Public Library, contributed by Mr. T. R. Sullivan to *Scribner*, shows how very thoroughly the American people are working for the advancement of learning. The building will hold a million and a quarter volumes, and everything has been done to make it beautiful, while all that modern contrivance can offer has been utilised to secure comfort. "The reference reading-room of the library," we read, "and its seven thousand volumes are free to all who care to take them down, without the intervention of an attendant. At the southern end, always open for consultation, is the card-catalogue of all the books contained in the building; any one of these will be furnished and brought from the main library to the designated table at a few moments' notice. There is room for hundreds of readers to sit here from early morning to a late hour of the night in undisturbed pursuit of knowledge. Those who have tried to work in the overcrowded libraries of Europe, hampered by annoying restrictions and wearisome delays, will fully comprehend the blessing which such freedom brings." In the same magazine there is an article on "Water-ways, from the Ocean to the Lakes," by Mr. T. C. Clarke, dealing chiefly with the great canal from Lake Erie to the Hudson River. In the editorial notes, reference is made to recent gains in the speed of travel. It appears that the distance between Buffalo and Chicago—512 miles—has been covered at a rate of over sixty-five miles per hour, stops excluded. The distance between New York and Washington is now done in about five hours, but a railway exists (on paper) the trains of which are to shoot over this distance of 240 miles in two hours! The track is to be elevated above the ground on a single line of upright piers, and the trains are to be driven by electricity, each car carrying its own motor machinery. The most distinctive mechanical feature of the enterprise is the so-called "bicycle" arrangement, by which a single line of wheels run on single rail. The train is to be kept upright by an auxiliary rail on each side, which will not, however, come into play except in rounding curves.

In the *Popular Science Monthly* Prof. G. F. Wright discusses the "New Evidence of Glacial Man in Ohio," afforded by a small chipped chest implement found by a trustworthy observer close to Brilliant Station on the Ohio River. He concludes that the discovery "must go far to close the question of man's antiquity on the Western continent, and to dispel the doubts upon the subject which, for one reason or another, have heretofore existed." Prof. James Sully continues, in the same magazine, his "Studies of Childhood," and among the other articles are "The Anatomy of Speed Skating," by Mr. R. Tait McKenzie; a criticism by Mr. Le Sueur of Prof. Forbes' article on the work of the Cataract Construction Company, published in *Blackwood's Magazine* for September 1895; "Health Experiments in the French Army," by Mr. Stoddard Dewey; and "Prehistoric Engineering at Lake Copais," by Mr. J. D. Champlin.

Mr. W. H. Mallock continues in the *Contemporary* his essay on "Physics and Sociology." He holds that the struggle which causes social progress is a struggle of the few against the few, and is fundamentally different from the Darwinian struggle for existence. In his words: "Within the limits of the minority, composed of the exceptionally gifted, whether their gifts are those of scientific knowledge, or knowledge of men's characters and wants, or of a power to direct men, there does undoubtedly take place a struggle strictly analogous to that with which Darwinian science has familiarised us, the result being, as Mr. Spencer's celebrated formula expresses it, the survival of the fittest. Only it is not a struggle for existence, if the word existence is taken to mean life; it is a struggle for existence in a position of rule or domination. It is, moreover, not a struggle with the majority of the community, but with the minority only. The fittest, the survivors, the winners, instead of depriving the majority of the means of subsistence, on the contrary, increase those means, and their unsuccessful rivals are defeated, not by being deprived of the means of living, but only of the profits and privileges that come from directing others. That there is a subsidiary struggle amongst the majority, a struggle to obtain work, not to direct work, is true, as has been said already; but, as has been said also, this is not the struggle which primarily either causes the advance of civilisation or maintains such advances as have been made. It contributes to these results, and how far and in what way it does so will require to be discussed hereafter; but it is not the principal, it is not the primary cause of them. The primary cause is the struggle which causes the survival, not of the largest number of men of average capacity, but of the largest number of men of exceptional capacity—the largest number of great men." Thus, according to the argument, the *domination* of the fittest is the true counterpart in the social world of the *survival* of the fittest in the physiological world. The *Contemporary* also contains a short paper by Mr. Herbert Spencer, on the development of the architect, the paper being the ninth of a series on "Professional Institutions." The view is taken that "the earliest architecture bequeathed by ancient nations was an outcome of ancestor-worship."

In *Science Progress*, Dr. H. E. Armstrong describes "The Plan of Research in Education," and makes a powerful plea for scientific teaching and scientific research, both on account of education and industrial progress. Prof. F. O. Bower discusses recent work on mosses and ferns, with special reference to Prof. Campbell's volume on the subject; Mr. J. W. Rodger continues his statement of "The New Theory of Solutions"; Mr. Philip Lake describes "The Geology of Egypt"; and Mr. G. T. Holloway traces "The Evolution of the Thermometer."

A brief mention will suffice for the remaining articles in the magazines received by us. *Good Words* has a short illustrated paper on sponges, by the Rev. T. Bird, and one on "A School of Mackerel," by Mr. Edward Step. The *Strand Magazine* has several splendid reproductions from photographs of frost patterns on window-panes, obtained by Mr. James Leadbeater. The *Phonographic Quarterly Review* always contains two or three scientific articles. The current number has in it "In a Canadian Forest," by General Sir Charles Wilson, K.C.B., F.R.S. "St. Bartholomew and his Hospital," by Dr. W. R. Gowers, F.R.S., and several other articles of interest to scientific phonographers. The *Fortnightly* has an article on "The Climate of South Africa," by Dr. R. Roose; and among the information articles in

Chambers's we notice one descriptive of the Loofah, or Luffa, by Prof. Carmody.

We have received, in addition to the magazines and reviews named in the foregoing, the *Humanitarian*, *Sunday Magazine*, *National*, *English Illustrated*, and *Longman's*, but the articles in them do not call for particular comment in these columns.

RECENT PROGRESS IN OPTICS.[1]

THE reviewer who aspires to give an account of recent progress in any department of science, is met at the outset by two causes for embarrassment. What beginning shall be selected for developments called recent? What developments shall be selected for discussion from the mass of investigations to which his attention has been called? So rapidly is the army of workers increasing, and so numerous are the journals in which their work is recorded, that the effort to keep up with even half of them is hopeless; or, to borrow a simile employed by the late Prof. Huxley, "we are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines, and was crushed under the weight of the reward bestowed upon her."

I have selected a single branch of physics, but one which can scarcely be treated rigorously as single. From the physical standpoint optics includes those phenomena which are presented by ether vibrations within such narrow limits of wave-length as can affect the sense of sight. But these waves can scarcely be studied except in connection with those of shorter and of longer period. Whatever may be the instruments employed, the last one of the series through which information is carried to the brain is the eye. The physicist may fall into error by faulty use of his mathematics; but faulty use of the senses is a danger at least equally frequent. Physiological optics has of late become transferred in large measure to the domain of the psychologist; but he in turn has adopted many of the instruments, as well as the methods, of the physicist. The two cannot afford to part company. If I feel particularly friendly to the psychologist, more so than can be accounted for by devotion to pure physics, it may be fair to plead the influence of old association. If I am known at all in the scientific world, the introduction was accomplished through the medium of physiological optics. But, with the limitations imposed, it is not possible even to do justice to all who have done good work in optics. If prominence is assigned to the work of Americans, it is not necessary to emphasise that this Association is made up of Americans; but, with full recognition of the greater spread of devotion to pure science in Europe, of the extreme utilitarian spirit that causes the value of nearly every piece of work in America to be measured in dollars, we are still able to present work that has challenged the admiration of Europe, that has brought European medals to American hands, that has been done with absolute disregard of monetary standards; work has been recognised, even more in Europe than in America, as producing definite and important additions to the sum of human knowledge.

In drawing attention to some of this work it will be a pleasant duty to recognise also some that has been done beyond the Atlantic—to remember that science is cosmopolitan. The starting-point is necessarily arbitrary, for an investigation may last many years and yet be incomplete. To note recent progress, it may be important to recall what is no longer recent.

LIGHT WAVES AS STANDARDS OF LENGTH.

You are therefore invited to recall the subject of an address to which we listened in this section at the Cleveland meeting in 1888, when Michelson presented his "Plea for Light Waves." In this he described the interferential comparer, an instrument developed from the refractometer of Jamin and Mascart, and discussed various problems which seemed capable of solution by its use. In conjunction with Morley he had already used it in an inquiry as to the relative motion of the earth and the luminiferous ether (*American Journal of Science*, May 1886, p. 377), and these two physicists together worked out an elaborate series of preliminary experiments (*ibid.*, December 1877, p. 427) with a view to the standardising of a metric unit of length in terms of the wave-length of sodium light. By use of a Rowland diffraction grating, Bell had determined the sodium wave-length with an error estimated to be not in excess of one part in two hundred thousand (*American Journal of Science*, March 1887, p. 167). Could this degree of accuracy be surpassed? If so, it must be not so much by increased care in measurement as by increase of delicacy in the means employed. The principle applied in the use of the interferential comparer is simple enough; the mode of application cannot be clearly indicated without a diagram, but probably all physicists have seen this diagram, for it was first brought out eight years ago (*ibid.*, December 1887, p. 427). By interference of beams of light, reflected and transmitted by a plate of plane parallel optical glass, and then reflected back by two mirrors appropriately placed, fringes are caught in an observing telescope. One of the mirrors is movable in front of a micrometer screw, whose motion causes these fringes to move across the telescopic field. If the light be absolutely homogeneous, the determination consists in measurement of the distance through which the movable mirror is pushed parallel to itself and the counting of the number of fringes which pass a given point in the field of view. According to the theory of interference the difference of path between the distances from one face of the plate to the two mirrors should be small; beyond a certain limit interference phenomena vanish, and this limit is smaller in proportion as the light is more complex. In the case of approximately homogeneous light there are periodic variations of distinctness in the fringes. For example, assume sodium light, which in the spectroscope is manifested as a pair of yellow lines near together. In the refractometer there are two sets of interference fringes, one due to each of the two slightly different wave-lengths. When the difference of path is very small, or nearly the same for both of these radiation systems, the fringes coincide. The wave-length for one is about one-thousandth less than that for the other. If the difference of path is about five hundred waves, the maximum of brightness for one system falls on a minimum of brightness for the other, and the fringes become faint. They become again bright when the difference of path reaches a thousand wave-lengths. The case is entirely similar to the familiar production of beats by a pair of slightly mistuned forks.

The method of interference thus furnishes through optical beats a means of detecting radiation differences too minute for resolution by ordinary spectroscopic methods. Spectrum lines are found to be double or multiple when all other means of resolving them fail; and the difficulty of attaining truly homogeneous light is far greater than was a few years ago supposed. By the new method it becomes possible to map out the relative intensities of the components of a multiple line, their distance apart, and even the variations of intensity within what has for convenience been called a single component. Each of the two sodium lines is itself a double whose components are separated by an interval about one-hundredth of that between the long-known main components; and an interval yet less than one-fifth of this has been detected between some of the components of the green line of mercury. Indeed Michelson deems it quite possible to detect a variation of wave-length corresponding to as little as one ten-thousandth of the interval between the two main sodium lines (*Astronomy and Astrophysics*, p. 100, February 1894.)

This new-found complexity of radiation, previously thought to be approximately if not quite simple, proved to be a temporary barrier to the accomplishment of the plan of using a light-wave as a standard of length. It necessitated careful study of all those chemical elements which give bright lines that had been supposed to be simple. The red line of cadmium has been found the simplest of all those yet examined. The vapour in a rarefied state is held in a vacuum tube through which the electric spark is passed, and under this condition the difference of path for the interfering beams in the refractometer may be a number of centimetres. A short intermediate standard, furnished with a mirror at each end, is now introduced into the comparer, and moved by means of the micrometer screw. Its length is thus measured in terms of the cadmium wave-length. A series of intermediate standards, of which the second is double the first, the third double the second, &c., are thus compared, and finally in this way the value of the metre is reached.

The feasibility of this ingenious method having been made apparent, Michelson was honoured with an invitation from the International Bureau of Weights and Measures to carry out the measurement at the observatory near Paris, with the collaboration of the director M. Benoît. After many months of labour, results of extraordinary accuracy were attained. For the red line of

[1] Address delivered by Prof. W. LeConte Stevens before the Section of Physics of the American Association for the Advancement of Science, at the Springfield meeting, August 1895.

cadmium at an air temperature of 15° C. and pressure of 760 mm., two wholly independent determinations were made. From the first a metre was found equal to 1553162·7 wave-lengths; from the second, 1553164·3 wave-lengths, giving a mean of 1553163·5 the deviation of each result from the mean being very nearly one part in two millions ("Travaux et Mémoires du Bureau Internationale des Poids et Mésures," Tome xi. p. 84, 1894). A determination by Benoît from the first series gave 1553163·6, which differs but one-tenth of a wave-length from the mean of Michelson's measurements.

The direct comparison of the lengths of two metre bars, though not easy, is a simple operation in comparison with the indirect method just described, but does not surpass it in accuracy. Every one knows that the metre is not an exact submultiple of the earth's circumference, and that the determination of its exact value from the seconds pendulum is full of difficulty. It may perhaps be said that the optical method is no more absolute than the pendulum method, for no human measurements can be free from error; that there is no possibility of the destruction of the original metre and all certified copies of it; and that there is no proof or probability that molecular changes are gradually producing modifications in standards of length. Even if we should grant that for all practical purposes the labour of determining the metre in terms of an unchanging optical standard has been unnecessary, the achievement is a signal scientific triumph that ranks with the brilliant work of Arago, Fresnel and Regnault. In preparation for it much new truth has been elicited, and light waves have been shown to carry possibilities of application that Fresnel never suspected.

The physicist is nearly powerless without the aid of those who possess the highest order of mechanical skill. The interferential comparer could never have been ultilised for such work as Michelson has done with it, had not Brashear made its optical parts with such an approach to perfection that no error so great as one-twentieth of a wave-length could be found upon the reflecting surfaces ("Travaux et Mémoires du Bureau Internationale des Poids et Mésures," Tome xi. p. 5, 1895). In the conception, mechanical design and execution, the entire work has been distinctly American.

The interferential refractometer has been used with much skill by Hallwachs (*Wiedemann's Annalen*, Band 47, p. 380, and Band 53, p. 1) for comparing the variation of refractive index of dilute solutions with variation of concentration. The fact of solution brings about a change of molecular constitution, affecting both the electric conductivity and the refractive index; and the changes in optical density are measurable in terms of the number of interference fringes which cross the field of view for a given variation of dilution.

LUMINESCENCE.

While all work on the visible spectrum is confessedly optical, we can no longer make an arbitrary division point, and declare that one part of the spectrum belongs to the domain of optics and the other not. Since the days of Brewster and the elder Becquerel fluorescent solutions have enabled us to bring within the domain of optics many wave-lengths that were previously invisible. Stokes's explanation of this, as a degradation of energy quite analogous to the radiation of heat from a surface on which sunlight is shining, has been generally accepted. But whether the phenomena of fluorescence and phosphorescence are in general physical or chemical, has for the most part remained unknown or at least very uncertain. E. Wiedemann, who suggested the term luminescence to include all such phenomena, published in 1895 (*Annalen der Physik und Chemie*, p. 604, April 1895), in conjunction with Schmidt, a part of the outcome of an extended investigation undertaken with a view to clearing up these uncertainties. He has shown that it is often possible to distinguish between cases in which the emission of light springs from physical processes and those in which it is due to chemical action, or at least invariably accompanied by this. We have here, as in photography, a transformation of radiant into chemical energy, to which is superadded the retransformation of chemical into radiant energy of longer period, and this either at the same time or long after the action of the exciting rays. Indeed, between this process and that of photography in colours, the analogy is quite striking. What has generally been called phosphorescence is well known to be the effect of oxidation in the case of phosphorus itself and in that of decaying wood or other organic matter, which under certain conditions shines in the dark.

Wiedemann has shown that the shining of Balmain's luminous paint, and generally of the sulphides of the alkaline earths, is accompanied with chemical action. A long period of luminosity after the removal of the source renders highly probable the existence of what he now calls chemi-luminescence. A large number of substances, both inorganic and organic, have been examined both by direct action of light and by the action of kathode rays in a controllable vacuum tube through which sparks from a powerful electric influence machine were passed. Careful examination with appropriate reagents before and after exposure was sufficient to determine whether any chemical change had been produced. Thus the neutral chlorides of sodium and potassium, after being rendered luminous by action of kathode rays, are thereby reduced to the condition of subchloride, so as to give a distinctly alkaline reaction.

Many substances, moreover, which manifest no luminescence at ordinary temperatures after exposure, or which do so for only a short time, become distinctly luminescent when warmed. This striking phenomenon is sufficient to warrant the use of a special name, thermo-luminescence. Among such substances may be named the well-known sulphides of the alkaline earths, the haloid salts of the alkali metals, a series of salts of the zinc and alkaline earth groups, various compounds with aluminium, and various kinds of glass. Some of these after exposure give intense colours when heated, even after the lapse of days or weeks. That the vibratory motion corresponding to the absorption of luminous energy should maintain itself for so long a time as a mere physical process is highly improbable if not unparalleled. That it should become locked in, to be subsequently evoked by warming, certainly indicates the storing of chemical energy, just as the storage battery constitutes a chemical accumulator of electrical energy. Other indications that luminescence is as much a chemical as a physical phenomenon are found in the fact that the sudden solution of certain substances is accompanied by the manifestation of light, if they have been previously subjected to luminous radiation, but not otherwise: that alteration of colour is brought about by such exposure; and that friction or crushing may cause momentary shining in such bodies as sugar. There is no conclusive direct evidence thus far that such luminescence as vanishes instantly upon the withdrawal of light is accompanied by chemical action. But Becquerel demonstrated long ago with his phosphoroscope that there is a measurable duration of luminous effect when to the unaided eye the disappearance seems instantaneous (Becquerel, *Comptes rendus* 96–121). Wiedemann now shows that when this duration is considerable there is generally chemical change. Since duration is only a relative term it seems highly probable that even cases of instantaneous luminescence, commonly called fluorescence, are accompanied with chemical action on a very minute scale, and that all luminescence is therefore jointly physical and chemical in character. We have thus colour evoked by the direct action of light, which disturbs the atomic equilibrium that existed before exposure, and the manifestation of such colour continues only until the cessation of the chemical action thus brought into play.

The influence of very low temperature upon luminescence and photographic action has been studied by Dewar (*Chemical News*, lxx. p. 252, 1894). The effect of light upon a photographic plate at the temperature of liquid air – 180° C. is reduced to only a fifth of what it is at ordinary temperature; and at –200° the reduction is still greater, while all other kinds of chemical action cease. In like manner, at –80° calcium sulphide ceases to be luminescent; but, if illuminated at this low temperature and then warmed, it gives out light. At the temperature of liquid air many substances manifest luminescence which ordinarily seem almost incapable of it; such are gelatine, ivory, and even pure water. A crystal of ammonium platinocyanide, on the other hand, when immersed in liquid air and illuminated by the electric light, shines faintly when this is withdrawn. If now the liquid air be poured off so that the crystal rises rapidly in temperature, it glows brightly.

LUMINESCENCE AND PHOTOGRAPHY.

Photography, like luminescence, is a manifestation of the transformation of energy, most frequently of initial short wave-length. The production of colour by photography is nothing new. It was noticed by Seebeck nearly a century ago that silver chloride becomes tinted by exposure to ordinary light, with accompanying chemical change; that if then subjected a long time to red light it assumes a dull red hue, or a dull bluish hue if held in blue light. It is likewise possible by proper selection of luminescent salts to produce a selected series of tints during and after exposure to those rays which are most effective in photography. But such colours cannot be made fixed and permanent. The problem of securing on the photographic plate a faithful and lasting reproduction of the various tints of a spectrum thrown upon it has baffled most of those who grappled with this subject. That it has been fully and quite satisfactorily solved cannot yet be affirmed, but the last few years have brought a far nearer approach to success than an equal number of decades previously. Viewed from the scientific standpoint the goal has certainly been touched, even if commercial demands are still made in vain.

STATIONARY LIGHT WAVES.

Two quite different methods are to be considered in tracing the recent development of this interesting application of optical principles. The first is originally due to Becquerel (*Am. de Chimie et de Physique* (3), p. 451, 1848), but lately, in the hands of Lippmann, it has been improved and brought much nearer to success than by its originator. It depends upon the production of stationary waves of light. Every one is familiar with the formation of stationary waves upon an elastic stretched cord, and with the acoustic exhibition of stationary air waves in a closed tube by Kundt's method of light powders. That similar loops and nodes must be produced under proper conditions by interference of waves of light would appear obviously possible; and so long ago as 1868 Dr. Zenker "Lehrbuch der Photochromie," Berlin, 1868), of Berlin, explained the photographic reproduction of colour, so far as it had then been accomplished, by reference to stationary light waves. But no definite proof of their production had been brought forward. A few years ago Hertz demonstrated objectively the electromagnetic waves whose existence had been foretold by Maxwell's genius; and with suitable apparatus stationary electric waves are now almost as readily made evident as are those of sound. Hertz's brilliant success stimulated his fellow countryman, Otter Wiener, to undertake the apparently hopeless task of producing and studying stationary light waves. Wiener's admirable work (*Wiedemann's Annalen*, Band xl. 1890, p. 203) excited great interest on the continent of Europe, but it has been singularly neglected in England and America. It is worth much more than a passing notice.

Assume a plane silvered mirror upon which a bundle of rays of monochromatic light fall normally so as to be reflected back upon its own path. The superposition of reflected and direct waves causes a system of stationary waves, but under ordinary conditions these are wholly imperceptible. The nodes are formed upon a series of planes obviously parallel to the reflecting plane at successive distances of a half wave-length. If now we consider a plane oblique to the mirror, it will cut these successive nodal planes in parallel lines, whose distance apart will be greater in proportion as the oblique plane approaches parallelism to the mirror. Although a half wave-length of violet light is only $\frac{1}{5000}$ of a millimetre, it is easy to conceive of the cutting plane forming so small an angle with the mirror that the distance between the parallel nodal lines shall be a thousand times a half wave-length. Such would be the case if the inclination of the cutting plane is reduced to a little less than four minutes of arc. The nodal lines would be $\frac{1}{5}$ of a millimetre apart, and readily capable of resolution if their presence can be manifested at all. Imagine a very thin transparent photographic film to be stretched along the oblique cutting plane, and developed after exposure to violet light as nearly monochromatic as possible. Then the developed negative should present a succession of parallel clear and dark lines, corresponding to nodal and anti-nodal bands along the oblique plane, the photographic effect being annihilated along an optical nodal line.

The realisation of a photographic film thin enough for such an experiment is quite conceivable when we remember that under the hammer gold is beaten into leaves so delicate that 8000 of them would be required to make a pile one millimetre thick. By electrochemical deposit, Outerbridge (*Journal of the Franklin Institute*, vol. ciii. p. 284, 1877) has made films of gold whose thickness is only $\frac{1}{100000}$ of a millimetre, or $\frac{1}{60}$ of a wave-length of sodium light. Wiener obtained a perfectly transparent silver chloride film of collodion, whose thickness was about $\frac{1}{30}$ of a wave-length of sodium light. This was formed on a plate of glass and inclined at a very small angle to a plane silvered mirror which served as reflector. From an electric arc lamp the light was sent through an appropriate slit and prism, so that a selected spectral band of violet fell normally on the prepared plate in the dark room. The developed negative presented the alternate bands, in perfectly regular order, more than a half millimetre apart. Various tests were applied to guard against error in interpretation, and the existence of such stationary waves was proved beyond all doubt.

These waves, moreover, when polarised light was employed, furnished the means of determining the direction of vibration with relation to the plane in which the light is most copiously reflected when incident at the polarising angle, and thus of subjecting to experiment the question as to whether the plane of vibration is coincident with this plane of polarisation or is perpendicular to it. The former of these views was held by Neumann and MacCullagh, the latter by Fresnel. Let a beam of polarised light fall upon the mirror at an angle of about 45°. If the vibrations in the incident beam are parallel to the mirror, and hence perpendicular to the plane of polarisation, those of the reflected and incident beams will be parallel to each other, and hence capable of interference. But if the vibrations of the incident beams are in a plane identical with that of incidence, and hence in the plane of polarisation, the vibrations of incident and reflected beams are in mutually perpendicular planes, and hence cannot interfere. Wiener obtained interference fringes when the light was polarised in the plane of incidence, while the polarised in the plane perpendicular to this gave no trace of interference. The theory of Fresnel was thus confirmed experimentally. Again, the familiar phenomenon of Newton's rings shows us that on changing media there is a change of phase of the incident light, else the central spot where the two surfaces come into optical contact would be white instead of black. But there has been difference of opinion as to whether this change of phase occurs at the upper surface of the air film, where the light passes from glass to less dense air, or at the lower surface where it passes from air to more dense glass. In the latter event, there should be a node at the reflecting surface. Replacing the silvered plane surface by a lens in contact with the photographic film, Wiener obtained circular fringes with no photographic action, at the centre, showing the nodal point to be at the point of contact, and thus again confirming the theory of Fresnel.

COLOUR PHOTOGRAPHY.

The conditions being now specified under which stationary light waves are produced, let us imagine common instead of monochromatic light to be transmitted normally through a transparent sensitive film. Then a variety of stationary interference planes are produced. This is the underlying principle of the process employed by Lippmann in Paris, who, in 1892 (*Comptes rendus*, t. cxiv. p. 961, and t. cxv. p. 575), succeeded in obtaining a photograph of the solar spectrum in natural colours. Upon a surface backed with a reflecting mirror of mercury is a silver bromide albumen film, which has been treated with one or more aniline dyes to render it equally sensitive to waves of long and short period. After exposure and development the natural colours are manifested with brilliancy. Apart from the fundamental principle already expressed, it can scarcely be said that the *rationale* of the process has yet been very fully and clearly explained. Lippmann recognises the stationary wave systems, with maxima and minima of brightness in the film and corresponding maxima and minima of silver deposit. If the incident light is homogeneous, a series of equidistant parallel planes of equal photographic efficiency are produced in the film. If the plate after development is illuminated with white light, then to every point within the film there comes from below a certain amount of reflected energy which is a continuous periodic function of the distance from the reflecting surface. The total reflected light of any colour becomes then represented by the integral of this periodic function for the entire thickness of the layer. The solution of this integral brings the result that the intensity of the reflected light decreases with increasing thickness of the layer, approaching zero as a limit, so long as this light is of different wave length from the homogeneous light employed for illumination of the plate. Only light of the same wave-length, or of an entire multiple of this, maintains a finite value. A similar consideration applies to each of the hues composing white light. By such mathematical considerations Lippmann (*Journal de Physique*, p. 97, 1894) reaches the conclusion that the light reflected from the plate must have exactly the same relations of wave-length as that with which the plate was illuminated.

For the Lippmann photographs, which at first required a very long exposure, and could even then be satisfactorily viewed at only a single definite angle, it is now claimed that an exposure of only a few seconds is needed, and that the colours are visible at all angles of incidence so long as the plate is moist (*Journal de Physique*, p. 84, 1894). But, like the daguerreotypes of fifty years ago, they are incapable of multiplication, and great as is the scientific interest connected with them, it seems scarcely probable that they can long continue to hold an important place practically. The problem of ascertaining definitely the cause of the return of a colour the same as that which falls upon a given surface may seem to be solved mathematically, but the mastery of the physical conditions required to produce a single coloured negative, from which may be had any desired number of positives with varied hues accurately reproduced, is still in the future. From the very nature of stationary light waves it does not appear probable that the Becquerel method as improved by Lippmann will give the means of multiplying copies of a single picture. Wiener has lately published an elaborate research upon this subject (O. Wiener, *Wiedemann's Annalen*, pp. 225-281, June 1895), in which he recognises the necessity for the employment not of interference colours but rather of what he calls body colours (Körperfarben) due to chemical modification of the reflecting surface. M. Carey Lea (*American Journal of Science*, p. 349, May 1887), in 1887 obtained a rose-coloured form of silver photochloride which "in the violet of the spectrum assumed a pure violet colour, in the blue it acquired a slate blue, in green and yellow a bleaching influence was shown, in the red it remained unchanged." But in the absence of any means of fixing these colours, a promising prospect brings disappointment.

While it is abundantly possible that coloured illumination upon suitable colour-receptive materials can give rise to similar body colours, we are still far from having these materials under control. There seems at present to be greater promise in another and quite different application of optical principles. The suggestion appears to have been first named by Maxwell (Royal Institution Lecture, May 17, 1861) in 1861 that photography in colours would be possible if sensitising substances were discovered, each sensitive to only a single primary colour. Three negatives might be obtained, one in each colour; and three complementary positives from these, when superposed and carefully adjusted, would present a combination that includes all the colours of nature. In 1873 H. W. Vogel in Berlin discovered that silver bromide, by treatment with certain aniline dyes, notably eosine and cyanine blue, can be made sensitive to waves of much longer period than those hitherto effective in photography. In 1885 he proposed to sensitise plates for each of a number of successive regions in the spectrum, and to make as many complementary pigment prints as negatives, which should then be superimposed. This somewhat complicated plan proved difficult in practice. In 1888 F. E. Ives (*Journal* of the Franklin Institute, January 1889), of Philadelphia, adopting the more simple Helmholtz-Maxwell modification of Young's theory of colour, applied it to the preparation of suitable compound colour screens which were carefully adjusted to secure correspondence with Maxwell's intensity curves for the primary colours. The result was a good reproduction of the solar spectrum. But to reproduce the compound hues of nature it is necessary specially to recognise the fact that although the spectrum is made up of an infinite number of successive hues, the three colour sensations in the eye are most powerfully excited by combinations rather than by simple spectral hues. Thus according to Maxwell's curves, the sensation of red is excited more strongly by the orange rays than by the brightest red rays, but the green sensation is excited at the same time. This fact has to be applied in the preparation of the negatives, while images or prints from these must be made with colours that represent only the primary colour sensations. Properly selected colour screens must therefore be used for transmission of light to plates sensitised with suitable aniline dyes; and the adjustment of ratios with this end in view is not easy. But it has been successfully accomplished. From three negatives thus made, each in its proper tint, positives are secured; and these are projected, each through its appropriate colour screen, to the same area upon a white screen. The addition of lights thus sent from the triple lantern gives the original tints with great fidelity.

Mr. Ives has devised a special form of camera by which the three elementary negatives are taken simultaneously, and also an instrument, the photochromoscope, in which a system of mirrors and lenses brings to the eye a combination similar to that projected with the triple lantern. A double instrument of this kind forms the most perfect type of stereoscope, bringing out with great vividness from the prepared stereographs the combined effect of colour, form and binocular perspective. It is only within the past year that these improvements have been perfected. By further application of the same principles, Mr. Ives has produced permanent coloured prints on glass, which do not require to be examined by the aid of any instrument. Each of these negatives is made with a coloured streen which transmits tints complementary to those which it is desired to reproduce. The three gelatine films are soaked in aniline dyes of suitable tint, and superimposed between plates of glass. When viewed as a transparency such a print gives a faithful reproduction of the natural colours.

The problem of colour reproduction is thus solved, not indeed so simply, but more effectively, than by the method of interference of light, or by those body-colour methods that have thus far been applied. To the imaginative enthusiasts who are fond of repeating the once novel information that "electricity is still in its infancy," it may be a source of equal delight to believe that photography in colours, a yet more delicate infant, is soon to take the place of that photography in light and shade with which most of us have had to content ourselves thus far; but so long as an instrument is needed to help in viewing chromograms, the popular appreciation of these will be limited. We may take a lesson from the history of the stereoscope. Yet it is gratifying to recognise the great impetus that this beautiful art has received during the last few years. We may quite reasonably expect that the best is yet to come, and that it will have an important place among the future applications of optical science.

THE INFRA-RED SPECTRUM.

Among the splendid optical discoveries of this century, probably the most prominent are photography and spectrum analysis, each belonging jointly to optics and chemistry. Photography was at first supposed to be concerned only with the most refrangible rays of the spectrum, but Abney and Rowland have photographed considerably below the visible red. Beyond the range thus attained qualitative knowledge was secured by Herschel, Becquerel, Draper, Melloni, Müller, Tyndall, Lamansky and Mouton. But our quantitative knowledge of this region began with the invention and use of the bolometer by Langley ("Selective Absorption of Solar Energy," *Am. Journal of Science*, March 1883, p. 169), whose solar energy curve has been familiar to all physicists during the last dozen years. During this interval the bolometer has been used with signal success by Ångström, Rubens, Snow and Paschen, who have made improvements not only in the instrument itself but in the delicacy of its necessary accompaniment, the galvanometer. The work of Snow (*Physical Review*, vol i. pp. 28 and 95), particularly, on the infra-red spectra of the voltaic arc and of the alkalies, and that done by him in conjunction with Rubens (*Astronomy and Astrophysics*, March 1893, p. 231), on refraction through rock-salt, sylvite, and fluorite, exhibited the capacities of the bolometer even better perhaps than Langley's previous work on the sun. But more recently with the collaboration of several able assistants, and more particularly the great ingenuity and mechanical skill of Wadsworth, the sensitiveness of Langley's galvanometer has been so exalted, and the bolometer connected in such manner with photographic apparatus as to make it an automatically controlled system, by which an hour's work now brings results superior in both quantity and quality to what formerly required many weeks or even months (Langley, "On Recent Researches in the Infra-red Spectrum": Report of Oxford Meeting of British Association, 1894). Not only is an entire solar energy curve now easily obtained in a single day, but even a succession of them. It becomes thus possible by comparison to eliminate the effect of temporary disturbing conditions, and to combine results in such a way as to represent the infra-red cold bands almost as accurately as the absorption lines of the visible spectrum are indicated by use of the diffraction grating. It will undoubtedly become possible to determine in large measure to what extent these bands are due to atmospheric absorption, and which of them are produced by absorption outside of the earth's atmosphere.

With the diffraction grating, supplemented by the radiomicrometer, Percival Lewis (*Astrophysical Journal*, June 1895, p. 1, and August 1895, p. 106), has recently investigated the infra-red spectra of sodium, lithium, thallium, strontium, calcium and silver, attaining results which accord well with the best previously attained by those who had employed the bolometer, and which demonstrate the exceeding delicacy of the radiomicrometer as an instrument of research.

THE VISIBLE SPECTRUM.

To follow out all the applications of the spectroscope that have resulted in recent additions to our knowledge would carry us far beyond the scope of a single paper. It is possible only to make brief mention of a few.

For a number of years Rowland (*ibid.*, January to August 1895) has been investigating the spectra of all the chemical elements, photographing them in connection with the normal solar spectrum, and reducing them to his table of standards, which is now accepted everywhere. The work is of such magnitude that years more must elapse before its completion. It now includes all wave lengths from 3722 to 7200, and of these the list already published extends as far as wave-length 5150, or from ultra-violet nearly to the middle of the green.

Through the spectroscope chiefly has been established during the present year the discovery of the new atmospheric element, argon, by Lord Rayleigh and Prof. Ramsay (*Proc. Royal Society*, January 31, 1895); its remarkable property of green fluorescence when the electric spark is passed through it in presence of benzene, by Berthelot and Deslandres (*Comptes rendus*, June 24, 1895); and its association in meteoric iron and various minerals with helium, now proved to be a terrestrial as well as solar element, by Ramsay (NATURE, April 4, May 16, July 4 and 25, 1895), Crookes, Lockyer, and others.

With the diffraction spectroscope Rydberg (*Wiedemann's Annalen*, 1893-94) and Kayser and Runge (*ibid.*, 1888-95) have discovered interesting relations among the spectral lines of a large number of terrestial elements, arranging them into series whose distribution manifests chemical relationship quite analogous to that indicated in Mendelejeff's periodic law.

By photographing the spectrum of Saturn's rings and noting the relative displacement of the different parts of a spectral line, Keeler (*Astrophysical Journal*, May 1895, p. 416) has obtained a beautiful direct proof of the meteoric constitution of these rings, a confirmation of the hypothesis put forth by Maxwell in 1859, that the outer portion of the rings must revolve more slowly than the inner portion, and yet not satisfy the conditions of fluidity. His work has been repeated and confirmed by Campbell (*ibid.*, August 1895, p. 127) at the Lick Observatory.

The spectroheliograph devised by Hale (*Astronomy and Astrophysics*, March, 1893, p. 256) has enabled him to photograph, on any bright day, not only the solar photosphere and spots, but also the chromosphere and protuberances. He has made some remarkable attempts with this instrument to photograph the corona without an eclipse, unsuccessfully thus far, but not without promise of future success.

POLARISED LIGHT.

In the domain of polarised light, there have been several noteworthy recent researches. Nichols and Snow (*Philosophical Magazine* (5), vol xxxiii. p. 379) have shown that calcite, though readily transparent for the brighter rays of the spectrum, rapidly diminishes in power of transmission for waves of short period, so that for the extreme violet this power is scarcely half so great as for the yellow. The transmissive power of this crystal for the infra-red rays, between the wave-length limits of 1 micron and 5·5 microns, has been investigated with the bolometer by Merritt (*Physical Review*, May-June 1895, p. 424) who reaches the interesting result that the transmission curve for the ordinary ray is wholly independent of that for the extraordinary, the absorption being in general much greater for the former. Several sharp absorption bands are found for each ray. For radiations whose wave-length exceeds 3·2 microns, the absorption of the ordinary ray is almost complete, so that calcite behaves for such radiation just as tourmaline does for the rays of the visible spectrum. The independence of the two transmission curves is found to exist also for quartz and tourmaline, these curves for the latter crossing each other twice in the infra-red region

The application of polarised light to the investigation of internal stress in transparent media was made more than forty years ago by Wertheim (*Comptes rendus*, 32, p. 289, 1851), who demonstrated that the retardation of the rays is proportional to the load. An extended series of such experiments has been lately made in America by Marston (*Physical Review*, September, October, p. 127, 1893) who, besides confirming Wertheim's conclusion, shows that, "for small strains at least, the colours seen in a strained glass body, when polarised light is passed through it in a direction parallel to one of the axes of strain, are measured by the algebraic difference of the intensities of those two principal strains whose directions are perpendicular to the direction of the polarised light."

A new substance with double rotatory power, like quartz, has been discovered by Wyrouboff (*Journal de Physique* (3), 3, 452, 1894), the neutral anhydrous tartrate of rubidium, which is unique in one respect. The rotatory power of the substance in the crystalline state becomes reversed in solution. This wholly new phenomenon introduces some perplexity in connection with certain molecular theories that have been formulated to account for double rotatory power.

Crehore (*Transactions* of the American Institute of Electrical Engineers, October 1894, p. 91) has ingeniously applied Faraday's principle of electro-magnetic rotation of the plane of polarisation in carbon bisulphide to the photographing of alternate current curves. Every variation in the magnetic field causes variation in the amount of light transmitted through a pair of crossed Nicol prisms. The combination becomes a chronograph with an index as free from inertia as the beam reflected from a galvanometer mirror. The same instrument has been applied to measurement of the velocity of projectiles (*Journal of the United States Artillery*, p. 409, July 1895), with results of exceeding interest to the student of gunnery.

PHYSIOLOGICAL OPTICS.

The temptation to dilate upon recent progress in physiological optics has to be resisted. The revision of Helmholtz's great book on this subject was interrupted by the death of the distinguished author, but the last part is now approaching completion under the care of his pupil, Arthur König, who, in conjunction with Diederici, has done much important work in this domain. The selection of hues for the three primary colour sensations has been slightly modified. Young selected the two extremes of the spectrum, red and violet, together with green, which is about midway between them. The hues now accepted by Helmholtz and those who follow his lead, including the great majority of physicists, are a highly saturated carmine red, an equally saturated ultramarine blue, and a yellowish green, corresponding somewhat to that of vegetation. The red and blue agree with those previously determined by Hering, but the rivalry between the two schools on the subject of colour sensation continues, and perhaps will last through a period commensurate with the difficulty of devising crucial experiments.

Independent theories of colour sensation have been brought out by Mrs. Franklin (Christine Ladd Franklin, "Eine neue Theorie der Lichtempfundungen," *Zeitschrift für Psychologie und Physiologie der Sinnesorgane*, 1892) in America, and by Ebbinghaus ("Theorie des Farbensehens," *ibid.*, 1893) in Germany. The former particularly is worthy of much more extended notice than can here be given. It may perhaps be quite properly called a chemical theory of vision. Light is always bringing about chemical changes in external objects, and the eye is the one organ whose exercise requires the action of light, while such chemical action is implied in the performance of most of the bodily functions, such as the assimilation of food and the oxidation of the blood. The bleaching action of light upon the visual purple, which is continually formed on the retina, has been known ever since the discovery of this in 1877 by Kühne, who secured evanescent retinal photographs in the eyes of rabbits. Mrs. Franklin considers that light sensat'on is the outcome of photo-chemical dissociation of two kinds of retinal molecules that she denominates grey molecules and colour molecules, of which the latter arise from the grey molecules by differentiation in such a way that the atoms of the outer layer group themselves differently in three directions, and the corresponding action of light of proper wave-length gives rise to the three fundamental colour sensations. She develops the theory with much skill, applying it particularly to the phenomena of retinal fatigue and colour blindness. To the objection that there is no direct proof of the existence of the assumed grey and colour molecules, it may be answered that Helmholtz himself fully recognised the uncertainty of the assumption that three different sets of nerves respond to the three fundamental colour sensations, and he admitted that these may be only different activities in the same retinal cone. The supposition of three adjacent cones, responding respectively to the three fundamental sensations, is made only for the sake of greater convenience in discussion.

Indeed there is still much for us to learn regarding the nature of colour sensation. Among the yet unexplained phenomena are those of simultaneous colour contrast. The fact that a small brightly-coloured area on a grey background appears surrounded by its complementary tint is familiar enough. For its explanation it has been common to assume that there is unconscious motion of the observer's eyes, incipient retinal fatigue, an error of judgment, or fluctuation of judgment. This has been tested by A. M. Mayer (*American Journal of Science*, July 1893), who ingeniously devised methods for showing these contrast phenomena on surfaces large enough to match the colours with those of rotating colour discs, and thus to arrive at quantitative statements of their hues. When viewed through a small opening in a revolving disc the subjective contrast colour was unmistakably perceptible when the duration of passage of the opening was less than $\frac{1}{1000}$ of a second. The same effect was obtained in a dark room with instantaneous illumination of the coloured surface by the strong spark of an electric influence machine. The duration of illumination is thus almost infinitestimal, certainly not more than $\frac{1}{10000000}$ of a second. The hypothesis of fluctuation of judgment is thus shown to be wholly untenable. I have performed most of these experiments, either with Prof. Mayer or separately, and my testimony can therefore be united with his. The case is quite analogous to that of the perception of binocular relief, which was once explained as the product of a judgment, but was found to be always possible with instantaneous illumination. Prof. Mayer has devised a disc photometer based on colour contrast, with which the error of a single reading was found much less than with the Bunsen photometer.

The rotating colour disc has been applied by O. N. Rood (*American Journal of Science*, September 1893) to the determination of luminosity independently of colour, by taking advantage of the flickering appearance on a rotating disc upon which two parts have different reflecting powers. An extreme case of this is that of a white sector upon a black disc. At a certain critical speed the retinal shock due to momentary impression by white light becomes analysed into the subjective impression of spectral colours, the duration of the retinal sensation varying with the wave-length of the incident light. The law of this variation has been studied by Plateau ("Dissertation sur quelques propriétés des impressions produits par la lumière sur l'organe de la vue," Liège, 1829), Nichols (*American Journal of Science*, October 1884), and more recently with much precision by Ferry (*ibid.*, September 1892), who showed that retinal persistence varies inversely as the logarithm of the luminosity. For a given source of light separated into its spectral components, the yellow is the brightest. For this hue accordingly the retinal impression is shortest, and for violet it is longest.

Under appropriate conditions the after-effect on the retina has a certain pulsatory character, as first noted by C. A. Young (*Philosophical Magazine*, vol. xliii. p. 343, 1872) in 1872, and carefully studied within the last few years by Charpentier ("Oscillations rétiniennes," *Comptes rendus*, vol. cxiii. p. 147, 1891) in France, and Shelford Bidwell ("On the Recurrent Images following Visual Impressions," *Proc. Royal Society*, March 27, 1894) in England. A disc with properly arranged black and white sectors, if brightly illuminated and looked at while revolving at a moderate rate, becomes apparently coloured, just as a momentary glance at the sun causes the perception of a succession of subjective spectral hues which may last a number of seconds. The phenomenon in relation to the disc was known as early as 1838 (Fechner, *Poggendorff's Annalen*, 1838), and explained by Rood (*American Journal of Science*, September 1860) in 1860. The re-discovery of what has been long forgotten arouses all the interest of novelty. The "artificial spectrum top," devised by Benham (NATURE, November 29, 1894, p. 113) last autumn, excited interest on two continents, and was promptly copy righted by a prominent firm of opticians (*ibid.*, March 14, 1895, p. 463) in England. It would perhaps be equally enterprising to copyright the solar spectrum.

The limits of a single address forbid my touching upon the large and practically important subject of colour blindness. Indeed, in both physical and physiological optics much has been omitted that is abundantly worthy of attention. In behalf of my hearers it may be wise to take heed, once more, of the fate of Tarpeia, who was overwhelmed with the abundance of her reward.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Technical Education Board of the London County Council has just awarded 278 minor scholarships, viz. 178 to boys and 100 to girls in Elementary Schools; 334 scholarships of the same class were awarded last spring, upon the results of examination, so that altogether the number awarded by the Board in 1895 was 612.

AT a meeting of the Fellows of the Royal College of Surgeons, held on Thursday last in the theatre of the college, a resolution was carried, "that, in the opinion of the Fellows of this college, women should be admitted to the diplomas of the college," forty-seven Fellows voting for the resolution and only ten against. The Fellows alone form the electorate who vote for election to the council, and the effect of this resolution will probably cause the council (who are understood not to be unwilling) to open the examinations to women candidates. At a mixed meeting of Fellows and members, called by the President last November to consider an application from the Dean of the London Medical School for Women for this privilege, Mr. Clement Lucas's proposal to the same effect was negatived by the narrow majority of ten in a house of over a hundred.

IN connection with the new Technical Institute recently opened at Wandsworth, the London *Technical Education Gazette* recalls the interesting fact that the first technical school in this country was opened in Wandsworth. The third annual report issued by the Science and Art Department, in 1856, gives an interesting account of this first technical school, which was called the Wandsworth Trade School. The curriculum included partly subjects of general instruction and partly courses of trade instruction classified under three heads, according as they had relation to (1) the building trades, (2) the mechanical and engineering trades, and (3) the chemical and manufacturing trades. The new Technical Institute will, it is hoped, revive the traditions established by the pioneer school of 1856. In addition to an equipment grant of £500, the Technical Education Board has agreed to contribute £1000 to the maintenance of the institute for the current year, apart from any grants which it may make for the maintenance of the technical day school.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, vol. ii. No. 2, November 1895.—Concerning Jordan's linear groups, is a paper by Prof. E. H. Moore, which was read before the Society in August last. It is a continuation of a paper read in November 1894, entitled "The group of holoedric transformation into itself of a given group" and is an exhaustive one supplemented by numerous bibliographical details.—Prof. A. S. Hathaway presented, at the same meeting in August, an elementary proof of the quaternion associative principle. Hamilton in his "Elements" writes: "The *associative principle* of multiplication may also be proved without the distributive principle, by certain considerations of *rotations of a system*, on which we cannot enter here." This note states that it is easy to see that such a proof is possible; but the details of it could not have presented themselves to Hamilton in an elementary form, or he would have seen that it was just the demonstration for which he was looking, simple in character, and direct in its application. We are not sure that we have not seen a proof somewhat similar to the Professor's, but we cannot recall it to our recollection. The proof given is a simple one.—The next article is a paper read at the October meeting of the Society, entitled "Moral Values," by Mr. R. Henderson. The author reminds us that the question of moral values in connection with the theory of probability has given rise to great diversity of opinion among mathematicians, and that Bertrand, in his classical work, dismisses it with contempt. More than the usual space is devoted to the notes and new publications.

American Meteorological Journal, December 1895.—Psychrometer studies, by Dr. Nils Ekholm. This article chiefly refers to the peculiar action of the wet-bulb thermometer near the freezing point of water. The author's observations and other investigations show that in an air saturated with water-vapour, the ice-covered bulb reads higher than the water-covered one, which, under those conditions, reads exactly as the dry bulb. These results are explained by Prof. W. Ramsay's experiments, which prove that there is a difference in the tension of water-vapour and ice-vapour at the same temperature.—Meteorology as a University course, by R. de C. Ward, Instructor in Meteorology in Harvard University. The author's aim is to show the need of more instruction in meteorology, and to emphasise the fact that instruction is needed in general, rather than in the higher mathematical and physical meteorology; while the investigation of problems in the latter branches should be undertaken by eminent physicists who are fitted to do work of such an advanced character. The author considers that, at the present time, Germany takes the lead in the teaching and in the research of meteorology.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1895.—"Researches on the Structure, Organisation, and Classification of the Fossil Reptilia. Part X. On the complete Skeleton of an Anomodont Reptile (*Aristodesmus Rütimeyeri*, Wiedersheim), from the Bunter Sandstone of Reihen, near Basel, giving new Evidence of the Relation of the Anomodontia to the Monotremata." By H. G. Seeley, F.R.S.

The author has examined the fossil described by Dr. Robert Wiedersheim in 1878 as *Labyrinthodon Rütimeyeri*. The bones are differently interpreted :—

The reputed humerus is the interclavicle.

The reputed right and left coracoids are the pre-coracoid and coracoid of the right side.

The author regards the Labyrinthodont osteology as demonstrating close relationship with Ichthyosauria and Anomodontia. The group forms a branchiate division of the reptilian class.

The fossil now named *Aristodesmus* is identified as an Anomodont reptile chiefly on the basis of resemblances to *Procolophon* and *Pareiasaurus*.

The teeth are in sockets placed obliquely. The proportions of the vertebral column are those of *Echidna*, though the transverse processes are longer. The ribs are those of a Monotreme. The shoulder girdle resembles *Procolophon*, and the humerus does not show the peculiar lateral curvature seen in Monotremes. The ulna gives no evidence of an olecranon process; the pelvic bones are without acetabular or obturator perforations, are not anchylosed together, and the ilium is not expanded transversely. The femur is more slender than in *Echidna*. The fibula is prolonged proximally beyond the stout tibia, round which it may rotate. The proximal row of the tarsus is one large bone, the blended astragalus and os calcis.

Monotreme mammals make a close approximation to this fossil and other Anomodontia. A group *Theropsida* may be made to include Monotremata and Anomodontia. *Ornithorhynchus* shows pre-frontal and post-frontal bones, and has the malar formed as in Anomodonts.

Aristodesmus is placed in the Procolophonia, which has two occipital condyles, with the occipital plate vertical, without lateral vacuities; and has the shoulder girdle distinct from Pareiasauria in the separate pre-coracoid extending in advance to the scapula.

PARIS.

Academy of Sciences, December 30.—M. Marey in the chair.—Development of the lymphatic vessels, by M. L. Ranvier. The author has examined the development of the lymphatic vessels in the embryo of the pig. By examining the mesentery, hardened in osmic acid and stained with picro-carmine, no lymphatic vessels can be observed in embryos of less than 9 cm. in length, the first signs appearing in those of 10 cm. The conclusion is drawn that the lymphatic system may be considered as an immense vascular gland, having its embryological origin in the venous system, and throwing its secretory product, the lymph, into the veins.—On the second scientific expedition of the *Princesse Alice*, by Albert First, Prince of Monaco. (See pp. 223–225.)—Note on the history of seas, by M. Suess. From the results of geological explorations, by MM. Mojsisovics, Waagen, and Diener, undertaken with special reference to the Trias formation, the conclusion is drawn that at that period the Pacific Ocean possessed two great branches—one (the Arctic branch) stretching over Eastern Siberia as far as Spitzbergen, the other across Central Asia and the Alps up to the Western Mediterranean.—On the acoustic analysis of mixtures of two gases of different densities, by M. E. Hardy. The method was capable of detecting one volume of illuminating gas in 1000 volumes of air.—Observations, made at the observatory of Algiers, of Brooks' and Perrine's comets, by MM. Rambaud and Sy.—Observations of Faye's comet and a minor planet, made at the Toulouse Observatory, by M. F. Rossard.—Observations of the sun, made at the observatory of Lyons, by M. J. Guillaume.—On some problems in variations, by M. G. Kœnigs.—On the summation of divergent series, by M. E. Borel.—On a new transformation of Taylor's theorem, by M. N. U. Bougaief.—On the unicursal varieties of three dimensions, by M. Antonne.—New properties of the cathode rays, by M. Jean Perrin. According to the views of Goldstein, Hertz, and Lenard, the cathode rays are due, like light, to a vibration of the ether; whilst Crookes and J. J. Thomson prefer to attribute the phenomena to matter charged negatively travelling with a high velocity. All the results of the extremely ingenious experiments of M. Perrier tend to show that the latter view is the correct one.—Observations on the zodiacal light, made at the observatory of the Pic du Midi, by M. E. Marchand.—On the elliptic refraction of quartz, by M. G. Quesneville. It is shown by a recalculation of Jamin's experiments, that the formula used by Jamin, calculated from Airy's theory, gives quite erroneous results in the neighbourhood of the axis.—The position in the solar spectrum of the calorific maximum, by M. Aymonnet. A comparison of the results obtained by various workers in this subject, shows that the position of this maximum depends not only on the composition of the prism, but also on the other parts of the spectroscope which reflect or transmit the ray. The continual variation in the intensity of the solar radiation is also a source of grave error in these measurements.—On the mechanical production of extreme temperatures, by M. E. Solvay. Remarking on the liquefaction of air in quantity recently achieved by M. Linde, M. Solvay observes that he used the same principle, the successive expansions of the same quantity of gas, in 1886, but, having imposed on himself as practical conditions that the pressure must not exceed 5 atmospheres, and not take more than 15-horse power, the lowest temperature he actually reached in this way was $-95°$. It is further pointed out that inversely the same principle would serve to reach extremely high temperatures, were it not for the fact that these can be more easily attained by electrical means.—On the combustion of acetylene, by M. H. Le Chatelier. Mixtures of acetylene with air containing less than 7·7 per cent. of acetylene, burn completely to water and carbon dioxide, for proportions of acetylene between 7·7 per cent. and 17·4 per cent., the products consist of water, carbon monoxide and dioxide, water, and hydrogen, in mixtures containing more acetylene than this free carbon and unburnt acetylene are found. With oxygen, mixtures containing anything between 2·8 per cent. and 93 per cent. of acetylene will catch fire; with air the limits are 2·8 per cent. and 65 per cent. In tubes, these limits are narrowed down, until in tubes of 0·5 m.m. diameter or less it is impossible to propagate a flame.—On the fixation of nitrogen by the metals of the alkaline earths, by M. L. Maquenne. After referring to his earlier work on this subject, the author describes a simple lecture experiment illustrating the ease with which nitrogen is absorbed. A mixture of lime and magnesium powder heated in a hard glass tube over a Bunsen burner will, in five minutes, absorb 96 per cent. of a confined volume of air.—On crystallised titanium and the combinations of titanium and silicon, by M. L. Levy. A silicide of the composition Ti_2Si has been isolated.—On the rotatory power of rhamnose in a state of superfusion, by M. D. Gernez. The rotatory power of fused rhamnose diminishes regularly with rise of temperature; at 100° it is only 61 per cent. of its value at 0°, and is in all cases less than that deduced from the rotatory power of its solutions.—On some dithiazolic derivatives, by M. C. Lauth.—Syntheses of acid chlorides and amide hydrochlorides, by M. A. Colson. The following reaction is found to occur.

$$RCN + R^1.CO_2H + 2HCl = R.CO.WH_2.HCl + R^1COCl.$$

when R, R^1 may be methyl or ethyl. This reaction is suggested as a method for preparing acid chlorides without the use of the phosphorus chlorides. If the acid is replaced by its anhydride the yield is improved.—Action of the halogens upon formaldehyde, by M. A. Brochet. In the case of chlorine, the primary reaction is $CH_2O + Cl_2 = CO + 2HCl$. The $COCl_2$, previously observed, is a secondary product.—On essence of lemon, by

MM. P. Barbier and L. Bouveault.—Study in germination, by M. J. de Rey-Pailhade.—On the simultaneous determination of the mineral and organic acidity in the juice of the beetroot, by M. D. Sidersky. Advantage may be taken of the indifference of Congo-red paper to the organic acids, but a simpler method is to use a colouring matter present in the juice itself.—The origin of the three-colour theory of the optic nerve, by M. J. P. Durand. A recognition of the work of Thomas Young.—On the influence of lecithin on the growth and multiplication of organisms, by M. B. Danilewsky.—Comparative study of the buccal mass of gasteropods, by M. A. Amaudrut.—Cephalopods from the stomach of a cachalot, caught at the Azores, by M. L. Joubin.—Some effects of the synodic revolution of the moon on the distribution of atmospheric pressures in the autumn season, by M. A. Poincaré.—On a meteor observed in Algeria, December 14, 1895, 10h. 15m. p.m., by M. J. Triboulet.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JANUARY 9.

SOCIETY OF ANTIQUARIES, at 8.30.
MATHEMATICAL SOCIETY, at 8.—On a certain Ternary Cubic: Prof. Lloyd Tanner.—Further Communication on Boltzmann's Minimum Function: S. H. Burbury, F.R.S.—Examples illustrating Lord Rayleigh's Theory of the Stability or Instability of certain Fluid Motions: A. E. H. Love, F.R.S.
ROYAL INSTITUTION, at 3.—Sound, Hearing, and Speech: Prof. McKendrick, F.R.S.

FRIDAY, JANUARY 10.

MALACOLOGICAL SOCIETY, at 8.—List of South Australian Pleurotomidæ with Descriptions of New Species: G. B. Sowerby.—Descriptions of New Land Mollusca from New Zealand and Macquarie Island: Henry Suter.—The Genus Hyalimax, or a near Ally (Neohyalimax), in Brazil: Dr. H. Simroth.—On a Collection of Slugs from the Sandwich Islands: Walter E. Collinge.
ROYAL ASTRONOMICAL SOCIETY, at 8.
CLINICAL SOCIETY, at 8.30.

SATURDAY, JANUARY 11.

ASSOCIATION FOR THE IMPROVEMENT OF GEOMETRICAL TEACHING (University College), at 11.—At 2.—Business Meeting.—Geometrical Methods: Dr. Larmor.
ROYAL BOTANIC SOCIETY, at 3.45.

SUNDAY, JANUARY 12.

SUNDAY LECTURE SOCIETY, at 4.—Pasteur and his Work: Prof. Percy Frankland, F.R.S.

MONDAY, JANUARY 13.

MEDICAL SOCIETY, at 8.30.

TUESDAY, JANUARY 14.

ROYAL INSTITUTION, at 3.—The External Covering of Plants and Animals: its Structure and Functions: Prof. C. Stewart.
INSTITUTION OF CIVIL ENGINEERS, at 8.—The Sanitary Works of Buenos Ayres: Sewerage, Drainage, and Water-Supply: Hon. R. C. Parsons.
ZOOLOGICAL SOCIETY, at 8.30.—A Preliminary Revision and Synonymic Catalogue of the Hesperiidæ of Africa and the adjacent Islands, with Descriptions of some apparently New Species: Rev. W. J. Holland.—On a Collection of Butterflies obtained by Mr. R. Crawshay in Nyasaland between the Months of January and April, 1895: Dr. Arthur G. Butler.—On a Newly-discovered Modification of the Iris in the Eyes of certain of the Ungulata adapted for assisting Vision: Dr. G. Lindsay Johnson.
ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Astigmatism and a New Stigmatic Portrait Lens: H. L. Aldis.
ROYAL ASIATIC SOCIETY, at 3.
ROYAL MEDICAL AND CHIRURGICAL SOCIETY, at 8.30.

WEDNESDAY, JANUARY 15.

SOCIETY OF ARTS, at 8.—The Making of a Great University for London: Prof. Silvanus P. Thompson, F.R.S.
ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.—Election of Council and Officers.—The Speculative Method in Entomology: Prof. Meldola, F.R.S., President.
ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Meeting.—Election of Council.—Address by the President, A. D. Michael.
ROYAL METEOROLOGICAL SOCIETY, at 8.—Annual General Meeting.
BRITISH ARCHÆOLOGICAL ASSOCIATION, at 8.

THURSDAY, JANUARY 16.

ROYAL SOCIETY, at 4.30.
LONDON INSTITUTION, at 6.—Experiments with Incandescent Lamps: Prof. Fleming, F.R.S.
LINNEAN SOCIETY, at 8.—On the Fistulose Polymorphinæ and the Ramulinæ: Prof. T. Rupert Jones, F.R.S., and F. Chapman.
SOCIETY OF ARTS, at 4.30.—The Shan Hills: their Peoples and Products: Colonel R. G. Woodthorpe, C.B., R.E.
SOCIETY OF ANTIQUARIES, at 8.30.
CHEMICAL SOCIETY, at 8.—The Acetylene Theory of the Luminosity of Hydrocarbon Flames: Prof. Vivian B. Lewes.—And other Papers.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Presentation of Premiums.—Inaugural Address of the President, Dr. John Hopkinson, F.R.S.
NUMISMATIC SOCIETY, at 7.

FRIDAY, JANUARY 17.

ROYAL INSTITUTION, at 9.—More about Argon: Lord Rayleigh.
QUEKETT MICROSCOPICAL CLUB, at 8.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Iron Tunnels: W. O. Leitch.
EPIDEMIOLOGICAL SOCIETY, at 8.—Experiences in Relation to Cholera in India from 1842–79: Surgeon-General C. A. Gordon, C.B.

SATURDAY, JANUARY 18.

ROYAL INSTITUTION, at 3.—To the North of Lake Rudolf and among the Gallas: Dr. A. Donaldson Smith.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Annuaire pour l'an 1896, publié par Le Bureau des Longitudes (Paris, Gauthier-Villars).—Le Mouvement: E. J. Marey (Paris, Masson).—Principii della Teoria Matematica del Movimento dei Corpi: Prof. G. A. Maggi (Milano, Hoepli).—Elementary Treatise on Electricity and Magnetism: Profs. Foster and Atkinson (Longmans).—History of the Cholera Controversy: Sir G. Johnson (Churchill).—Quain's Elements of Anatomy, 10th edition, Vol. 3, Part 4, Splanchnology: Profs. Schäfer and Symington (Longmans).—Comité International des Poids et Mesures. Procès-Verbaux des Séances de 1894 (Paris, Gauthier-Villars).—Travaux et Mémoires de Bureau International des Poids et Mesures, tome xi. (Paris, Gauthier-Villars).—Transactions of the Royal Society of Victoria. Vol. iv. A Monograph of the Tertiary Polyzoa of Victoria: Dr. P. H. MacGillivray (Melbourne).

PAMPHLETS.—Special Map of British Guiana (Philip): Frederic Kitton (Redway).—Guide to the British Mycetozoa exhibited in the Department of Botany, British Museum (Natural History) (London).—Ninth Annual Report of the Liverpool Marine Biology Committee and their Biological Station at Port Erin: Prof. W. A. Herdman (Liverpool).

SERIALS.—National Review, January (Arnold).—Norges Geologiske Undersögelse, Nos. 10 to 17 (Kristiania).—Bulletin of the American Mathematical Society, December (New York).—Geographical Journal, January (Stanford).—Science Progress, January (Scientific Press).—Mind, January (Williams).—Zeitschrift für Wissenschafte Zoologie, Sechzigster Band, Drittes Heft (Williams).—Annals of Scottish Natural History, January (Edinburgh, Douglas).—Proceedings of the Aristotelian Society, Vol. 3, No. 1 (Williams).—Brain, Part 72 (Macmillan).—Journal of the Royal Agricultural Society of England, Vol. 6, Part 4 (Murray).—Minnesota Botanical Studies, Bulletin No. 9 (Minneapolis).—Scribner's Magazine, January (S. Low).—Académie des Sciences de l'Empereur François Joseph I. Bulletin International Classe des Sciences Mathématiques et Naturelles, II.—Journal of the Royal Statistical Society, December, Stanford).—Geological Magazine, January (Dulau).

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