THURSDAY, MARCH 16, 1905.

## MODERN OPTICAL THEORY.

*An Introduction to the Theory of Optics.* By Prof. A. Schuster, F.R.S. Pp. xv+340. (London: Edward Arnold, 1904.) Price 15*s.* net.

PROF. SCHUSTER has done excellent service to teachers and students alike by publishing this book, which fills a very obvious gap. It is an introduction to the theory, and purposely does not deal with details of methods of measurement or instrumental appliances; these are properly left to courses of laboratory instruction. At the same time the necessity for experiments and observations is everywhere present to the author's mind. The book is not a mere mathematical treatise on simple harmonic motion; indeed, the analysis is generally easy, and purely mathematical difficulties are avoided. Prof. Schuster writes as a physicist. The physical meaning of the steps and processes employed is everywhere insisted on, and the student is made to think throughout.

The standpoint of the author is best explained by two short extracts from his preface. After stating that the elastic solid theory of optics as developed in England by Green and Stokes has proved insufficient, he continues,

"Those who believe in the possibility of a mechanical conception of the universe, and are not willing to abandon the methods which from the time of Galileo and Needham have led uniformly and exclusively to success, must look with the gravest concern on a growing school of scientific thought which rests content with equations correctly representing numerical relationships between different phenomena, even though no precise meaning can be attached to the symbols used."

And again,

"The equations which at present represent the electromagnetic theory of light have rendered excellent service, and we must look upon them as a framework into which a more complete theory must necessarily fit, but they cannot be accepted as constituting in themselves a final theory of light.

"The study of physics must be based on a knowledge of mechanics, and the problem of light will only be solved when we have discovered the mechanical properties of the ether. While we are in ignorance on fundamental matters concerning the origin of electric and magnetic strains and stresses, it is necessary to introduce the theoretical study of light by a careful treatment of wave propagation through media the elastic properties of which are known. A study of the theory of sound and of the old elastic solid theory of light must precede therefore the introduction of the electromagnetic equations."

The book proceeds on these lines; the first part is almost entirely kinematical; the second part deals with theories of light, starting first from an analysis of the equations of motion of an elastic medium; then passing to those of the electromagnetic field, and developing the two theories side by side as far as possible.

To turn now to some details. In the earlier chapters, in accordance with the views expressed in the preface, the author deals with the properties of vibrating mechanical systems, *e.g.*, the air in a closed space, or a stretched string. After some discussion as to periodic motion in general, the equation of motion for an elastic body, propagating plane waves of distortion, is found in an elementary manner, and certain fundamental results are shown to follow from its similarity to the equation for a stretched string. Huyghens' principle of the superposition of small motions is explained, and then the reader, after a chapter on the nature of light, is introduced to the principle of interference.

The problems of diffraction are treated very fully, making use of the method of Fresnel's zones; the method is modified by the author in a manner which permits numerical results of a high order of accuracy to be obtained without the introduction of Fresnel's integrals.

After an interesting chapter on diffraction gratings we come to one on the theory of optical instruments, in which the resolving power of telescopes and spectroscopes is carefully discussed. The theory of the microscope does not find a place in Prof. Schuster's book; perhaps it belongs rather to the domain of geometrical optics.

Fresnel's theory of double refraction is given very fully, and it is based not on any unsound dynamical reasoning, but on the observed experimental fact that the velocities of wave propagation of a plane wave moving through a crystal are given by the axes of the section of a certain ellipsoid by the plane of the wave; this is clearly the right way to deal with this problem. When the laws of the propagation of light in a crystal are once determined the discussion of the rays and brushes due to the interference of polarised light follows easily, and thus we are led to Part II., which, as has been already said, deals with theories of light.

The equations of motion are found both on the elastic solid and electromagnetic theory, and the simpler phenomena are considered from both standpoints.

The weak points of the elastic solid theory, however, soon manifest themselves, and for the rest of the book the equations of the electromagnetic theory are mostly used; in dealing with dispersion Sellmeyers' hypothesis of sympathetic vibrations is applied to the electrons of a molecule, following Drude, and the usual expression connecting the refractive index and the frequency obtained; the same method is applied to explain the rotatory effects of sugar and other active substances, and in a most interesting series of sections the Zeeman and other allied effects are dealt with. In the last chapter we have a discussion on the nature of light as the resultant disturbance arising from the individual vibrations of the molecules of the source. Enough has probably been said to show the nature of the book, but one characteristic should not be omitted. Prof. Schuster has included short historical accounts of the men who have made the science of physical optics. Among them we find the names of Young, Fresnel, Cauchy, Stokes, and Maxwell; the interest

of the book is increased by this course, and the subject made more human.

In conclusion, it is perhaps sufficient to say that the treatment is marked throughout by the author's well-known and admirable lucidity of style. Take, for example, the last paragraph in the book discussing the result which follows from the fact that as an extreme case for the green thallium light the periods of 88 per cent. of the vibrating molecules are identical within about one part in two millions.

"If you had a great many clocks, and found that taking their average rate to be correct, not more than one in eight would be wrong by a second in twenty-three days, that would represent the maximum amount of variation which one interpretation of the experiment allows us to admit in the case of molecular vibrations. But would any maker undertake to supply you with a number of clocks satisfying that test? If, further, it is considered that the limits we have chosen for the possible variations of molecular vibrations are far too great, we see that though Sir John Herschel's saying that atoms possess the essential character of manufactured articles is still correct, yet no manufactured article approaches in accuracy of execution the exactitude of atomic construction. We may conclude with Maxwell that 'Each molecule therefore throughout the universe bears impressed on it the stamp of a metric system as distinctly as does the metre of the archives at Paris or the double royal cubit of the Temple at Karnac.'"

## TECHNICAL ANALYSIS.

*Manual of Chemical Analysis.* By E. Prost, D.Sc. Translated by J. C. Smith, B.Sc. Pp. iv+300. (London: Maclaren and Sons, 1904.) Price 12*s.* 6*d.* net.

*Techno-Chemical Analysis.* By Dr. G. Lunge. Translated by A. I. Cohn. Pp. vi+136. (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1905.) Price 4*s.* 6*d.* net.

DR. PROST'S manual contains a number of selected methods dealing more particularly with mineral and metal analysis which have been compiled, so the preface states, for the use of the "industrial chemist," and which the author assures us are the result of his own experience or that of specialists with whom he is in touch.

The analysis of mineral products—silicates, phosphates, clays, cements, iron and iron ores, and the assaying of lead, silver, gold, &c., have been so fully elaborated that no analyst deserving the name would be satisfied without knowing the latest improvements in the methods connected with his own industry. A chemist in an iron works, for example, wants all the information he can obtain from the specialist who has made a minute study of iron and steel analysis, including the character of etched surfaces, and through whose hands a large variety of specimens have passed The same, of course, applies to raw materials and finished products of other manufactures. The works analyst is not a student, and though he may wish to be informed on analysis in general, it is not essential to his business.

Does Dr. Prost's book as a whole fulfil its promise? Whilst there is no doubt that many of the methods answer to the description given in the preface, and will be found serviceable to the works analyst, it must be confessed there are also many others which fall short of it. In too many instances there is a lack of descriptive detail, an absence of reference to recent improvements, and the omission of recognised and standard methods. The common fault of this class of book is to be too discursive; to cover too much ground. The small treatise on one subject by an expert like Blair or Ledebur on iron and steel analysis, Brown on gold and silver assaying, Lunge on the alkali manufacture, is the sort of thing one would like to see multiplied.

The writer has no wish to deal unfairly with the manual under review. It is not uniform in character, and if the above criticism applies to certain sections, it is also abundantly evident that other portions have been carefully and conscientiously put together by one who possesses a thorough knowledge of his subject. Moreover, the introduction of mechanical tests, which are too frequently overlooked, is a feature deserving mention. The translator's attention should be directed to the mis-spelling of Stanfurt for Stassfurth, p. 41, Vollard for Volhard, p. 106, and Spiegal for Spiegel, p. 206. The illustrations suffer very much from the rough surface of the paper.

The name of Dr. G. Lunge on the title page of any book, and especially one connected with technical analysis, would command a careful perusal and a thoughtful judgment. It must be confessed that in the present case the author has not done himself justice. Anyone who purchased the volume in the hope of obtaining practical information on techno-chemical analysis (the translator's rendering of chemisch-technische Untersuchungsmethoden) would, to say the least, be disappointed.

When it is stated that in 128 small octavo pages, in addition to "general operations," and gas, water, and fuel analysis, the analysis of about eighty technical inorganic and organic products is described, further comment seems superfluous. The subject of glycerine, which comes under the section of *soap*, may be taken as a specimen of the method of analytical treatment.

"Glycerine is found in large quantity only in toilet soaps. The method of determining it is given here, because it must be examined by itself as an individual commercial article, and the glycerine yield of raw fats in the manufacture of stearin must also be determined. The determination is effected either by oxidation with potassium-permanganate solution in alkaline solution, precipitating the oxalic acid formed as a lime salt, and titrating the latter, or by oxidation with normal potassium-dichromate solution, with the addition of an excess of ferrous sulphate solution of known effective value, and then titrating the dichromate solution."

This occupies half a page, sugar is elaborately treated in four pages, tanning in two and a half, dyeing in as many as seven, mineral oils, vegetable oils, and fats in seven, and so on. The most useful page in the volume is the bibliography of important works of reference at the beginning, though it is scarcely worth the price of the book. J. B. C.

## THE ZOOLOGICAL RECORD.

*The Zoological Record, Volume the Fortieth; Relating Chiefly to the Year* 1903. Edited by D. Sharp. (London: The Zoological Society, 1904.) Price 30*s*.

YEAR by year this invaluable publication appears with commendable regularity, and year by year its bulk steadily increases, the bulk of the present issue being nearly double that of its predecessor of forty years ago. Hitherto the subscribers have yearly obtained more for their money, but there are limits beyond which even the generosity of a great scientific society cannot go, and it has consequently been decided, although with reluctance, that in future the price of the annual volume must be increased. The bulk of the present volume has been somewhat diminished by printing it on thinner paper than its predecessors; and, although this innovation may have been unavoidable in order to bring the weight within the limits laid down by the Post Office for transmission abroad, it cannot be said to be altogether an improvement, as in places the type shows through in a decidedly obtrusive manner.

Whether such a radical alteration was really inevitable may perhaps be doubtful, for it is quite evident that a large amount of space might be saved if a uniform plan were adopted throughout the work. For instance, in the section on mammals 385 titles are recorded and their subjects epitomised in a space of forty-two pages, whereas in the section on echinoderms no less than 105 pages are taken up in dealing with 339 papers.

If such prolixity is necessary in the one case, it is equally essential in the other; and, conversely, if the brief mode of treatment will suffice in one instance, it should be adopted in the other. Much space might also be gained, without any loss, in the sections on reptiles and fishes, as well as in certain others.

This lack of uniformity in treatment is, in our opinion, the one point in which this "Record" compares unfavourably with the one issued by the committee of the "International Scientific Record"; and it is high time that it was amended. Surely the editor is strong enough to keep his contributors in hand, and to make them do the work his way and not their own. As an instance of this slackness of the guiding hand we may refer to the fact that in one of the sections the recorder has been allowed to adopt the spelling Meiocene and Pleiocene, which is both wrong (on the supposition that we form our scientific names through the Latin) and pedantic. If any alteration in orthography of this nature were permitted, it should be the substitution of Plistocene for Pleistocene; but if such a change were made it should run through the entire volume.

The comparatively early date at which many of the sections are now sent to press renders it impossible to include so many of the papers for the year to which they specially refer as was formerly the case, but this is a matter of no great moment, so long as such papers make their appearance in the volume for the following year.

Mistakes and omissions there must of course be; but these seem to be few and far between. We notice, however, in the mammal part that Condylarthra has been put in place of Amblypoda, while in the concluding paragraph of the first page of his introduction to the insects the editor is guilty of a blunder which should cause him to be lenient to the shortcomings of his contributors. Whether he can escape blame for errors like the omission of a reference number in the penultimate line of p. 21 of the mammal part may, however, be open to question.

Taken all in all, the volume is a marvellous production, both as regards accuracy, fulness, and the comparatively early date of its appearance; and the editor and his staff are entitled to the best thanks of the zoological world. When we have said that the "Zoological Record" still stands without a rival, we have said sufficient. R. L.

## OUR BOOK SHELF.

*A Synonymic Catalogue of Orthoptera.* By W. F. Kirby. Vol. i. Orthoptera Euplexoptera, Cursoria, et Gressoria. (Forficulidæ, Hemimeridæ, Blattidæ, Mantidæ, Phasmidæ.) Pp. x + 501. (London: the Trustees of the British Museum, 1904.)

THE value of such a general synonymic catalogue as this work is obvious, but the increased interest which has been taken in Orthoptera in recent years, and the rapidly accumulating mass of literature, has made a complete and systematic catalogue of this order an urgent necessity. The work is upon the same model as the author's previous catalogue of dragon-flies. The species are numbered, though no particular order appears to have been followed; the distribution is given in the margin, and synonymy is attached, although a complete list of references is not given in every case. One of the most prominent features of the list is the conscientious manner in which the author refuses to admit as synonymous such names as to the absolute identity of which he is not personally convinced, resulting in an apparent multiplication of species. Thus, on pp. 30 and 31, we find *Spongiphora parallela, S. lherminieri, S. dysoni,* and *S. croceipennis* all entered as separate species, though nowadays there are few who doubt their identity, and fewer still who can discriminate between them. Again, on p. 2, *Diplatys gerstaeckeri* and *D. longisetosa* are regarded as separate, although it is impossible to distinguish them. To such an extent does the author carry this principle, that he admits names published with figures only, such as *Pygidicrana huegeli,* Sharp, and even *Ancistrogaster petropolis,* Wood, based upon a reference and an illustration in a popular work. But yet he relegates *Psalis indica,* Hagenb., var. *minor,* Borm., as a synonym of *P. guttata,* Borm., although the describer insisted upon the extreme variability of the older known species. But questions of nomenclature and classification are of necessity controversial; many may disagree with the author's arrangement of the genus Labidura, in which a number of insufficiently described so-called species are regarded as valid, only on account of the difficulty of proving their identity with the excessively variable and universally distributed *Labidura riparia,* Pallas.

Otherwise, changes of well-known names are few. We are glad to see *Blatta* retained, at the expense of *Stylopyga* for *orientalis* and not for *germanica.*

Hololampra, Saussure, 1864, replaces the more familiar Aphlebia, Brunner, 1865.

But this catalogue should be received less with criticism than with gratitude to the painstaking author, and we hope the second volume will appear at an early date; it will doubtless include such omissions as have been unavoidable in the first volume, owing to the time necessary for publication.

M. B.

*Percentage Tables for Elementary Analysis.* By Leo F. Guttmann, Ph.D. Pp. 43. (London: Whittaker and Co., 1904.) Price 3*s.* net.

THIS book is only intended to facilitate the calculation of the results of an ordinary organic analysis, and its title, therefore, is somewhat misleading. It is stated that "the tables have been carefully calculated and checked, they are therefore absolutely accurate." After this statement, nothing is left to us but to see if they are likely to be useful. After careful consideration of this question we are compelled to give an unfavourable reply. If we have the analytical result that 0·1173 gr. of a substance gave 0·2869 gr. carbon dioxide, we can, in the ordinary course of things, by looking out the logarithm of 0·2869, adding the easily remembered logs. of 12/44 and of 100, and subtracting the log. of 0·1173, get the log. of the percentage. But according to the tables before us, we look out a number corresponding to 0·117 and 0·28. We then look again for a number corresponding to 0·118 and 0·28. We subtract the two numbers, multiply by 0·3 by means of another table, and subtract this result from the first number looked out. We next find a number corresponding to 0·117 and 0·69, divide by 100 and add this result, and thus, after four references to tables, two arithmetical operations in the head, one subtraction and one addition on paper, we get our percentage. Appeal to a chemist constantly engaged in organic analysis has only confirmed the view that these tables are unlikely to save time or to promote exactitude in the calculation of organic analyses.

A. S.

*How to Photograph with Roll and Cut Films.* "The Amateur Photographer" Library, No. 30. By John A. Hodges. Pp. xviii + 120. (London: Hazell, Watson, and Viney, Ltd., 1904.) Price 1*s.* net.

THE ever increasing number of photographers and more especially amateurs, who work with either roll or cut films, will find in these pages all the necessary information for the production of pictures. The author does not pretend to have written a treatise on the whole art and science of photography, but he has given a straightforward account of the various operations that have to be completed to ensure good results. The treatment is well suited for amateurs, and the numerous well reproduced illustrations serve admirably to render many points clear.

*The Telescope.* By Thomas Nolan. (New York. D. Van Nostrand Company, 1904.) Price 50 cents.

THE first edition of this small treatise on the elementary principles of optics as applied to telescopes appeared in 1881. In the present issue the author has left this matter practically as it first appeared, with only one or two minor corrections, but has added a chapter describing in a brief manner the advances that have since been made. At the end is also given a bibliography relating to the telescope, which will be of service to those who wish to study more in detail different branches of the subject to which slight references only have been given. The book is published in the Van Nostrand Science Series, and should prove a useful addition.

## 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 Infection of Laboratories by Radium.

IN a recent attempt in the physics building of McGill University to make electroscopes with a very small natural leak, repeated failures were encountered. The rate of discharge of several instruments, carefully made, was found to be about sixty to one hundred times as large as that obtained by Mr. H. L. Cooke two years earlier in the same building. At first it was supposed that the insulation of the sulphur bead was defective. But the natural leak was large and unaffected when the upper support of the sulphur bead was raised to a higher potential than the gold leaf system, so that the insulation was not at fault. Nor was the rate of discharge altered when the electroscope was entirely surrounded by lead one inch thick. Removal to another building produced no effect on the leak of the electroscope. It appeared probable that the trouble was due to the radio-activity of the materials from which the electroscope was made. A rude instrument, made in a private house with a tobacco tin, the amber mouthpiece of a pipe, and a cork, was found to give better results than the most carefully constructed instrument in the physics building. Some electroscopes were next made in the chemistry building, using materials which had never been into the physics building. Instruments with a very slow rate of discharge were now easily manufactured. These were used to test materials from various parts of the physics building, and it was found that all were infected with excited activity. Sheets of mica, lead foil, iron, zinc and tin were all active, even when taken from drawers or cupboards.

Of the substances tested, the only one which showed no activity was some thin Dutch metal leaf kept between tissue paper in a closed drawer. About 90 per cent. of the excited activity could be removed from the metal sheets by strong hydrochloric acid, but the activity was transferred to the solution. It was also possible to volatilise a portion of the deposit by raising the metal sheet to a red-heat in a Bunsen flame. Both $\alpha$ and $\beta$ rays were detected, but it was difficult to measure their exact proportion. The natural leak of an electroscope was increased to a measurable extent when a mica window was replaced by one cut from a sheet of mica kept in the physics building.

The difficulty of conducting radio-active experiments in rooms where strong preparations of radium were present was early observed by Madame Curie, and later by Elster and Geitel, but the present experiments seem to show that the effect may be widely spread. The emanation from radium used in the large physics building has passed by convection and diffusion into various rooms. In a few days each fresh supply of emanation is transformed into the rapidly changing substances radium A, B, and C. The further changes of the products of radium have been investigated by Prof. Rutherford, and described by him in his Bakerian lecture (*Phil. Trans.*, vol. cciv., pp. 169–219), and in a recent letter to NATURE (February 12). In the former he has pointed out that bodies exposed to the air in the open will be covered with an invisible film of radio-active matter of very slow rate of change, and that the strong radio-activity observed in a room in which radium preparations have once been used is probably due to the deposit on the walls of the room of this slowly decaying matter from the emanation. In his letter to NATURE, he has shown that radium C gives rise to radium D, and that the further change to E is rayless in character and attains half value in forty years. The further change to F emits $\beta$ rays, and reaches half value in six days, whilst the change from F to the final product is accompanied with $\alpha$ rays, reaching half value in 150 days.

The $\alpha$ and $\beta$ rays emitted by the coating on the materials in the physics building are doubtless due to the changes above mentioned. If the supply of emanation were arrested at the present date, the activity already deposited would rise to a maximum in two or three years, and then gradu-

ally decay, following an exponential law, and reaching half value in forty years. But should the supply of emanation in the future equal that in the past, the activity would continue to increase in magnitude for the next hundred years or so, until the supply and decay of radium D attained a steady value. By that time radio-active experiments of a delicate nature would become difficult or impossible, as the excited activity would rapidly discharge a gold-leaf electroscope.

As the excited activity can be largely removed by acid, the infection will at present cause no serious difficulty in the majority of experiments on radio-activity, particularly as the leak arising from it remains almost constant for weeks or months. But when an electroscope with a very small natural leak is required, it will be necessary to employ fresh materials which have not been exposed to emanation.

It appears desirable, in the case of laboratories not yet infected, to keep radium in sealed vessels, and to blow the emanation into the open air, and not into the rooms of the laboratories. A. S. EVE.

McGill University, Montreal, February 25.

### International Atomic Weights.

THE committees engaged in revising the tables of atomic weights have now sent in their reports for 1905. The one which appeared in the *Berichte* is, of course, printed in German, and that which has just been circulated by the Chemical Society is in English.

Unfortunately, there is a want of uniformity in the naming of the elements. Thus, in the English table we find Glucinum, Gl, and Columbium, Cb, whereas in the German table these elements are called Berylium, Be, and Niobium, Nb, respectively. Historically, no doubt, the names adopted in the English table are more accurate. But in all text-books the names and symbols employed in the German tables are used, and have been for many years.

It is difficult to see where the advantage in making the change comes in, but, on the other hand, the disadvantages of having two forms of nomenclature are obvious.

F. MOLLWO PERKIN.

London, March 8.

### The Planet Fortuna.

PERHAPS Airy quoted his Juvenal correctly, which "W. E. P." (p. 410) has failed to do. The poet was so well satisfied with the lines that he gives them twice, in his tenth and fourteenth satires. And they run thus:—

Nullum numen habes, si sit prudentia; nos te
Nos facimus, Fortuna, deam cæloque locamus.

W. T.

THE lines are variously quoted, and I cannot say what version Airy favoured. I believe he spoke from memory.

W. E. P.

## *COSTA RICA.*[1]

UP to 1540, Spain had reserved for the crown that part of the territory of Veragua lying west of the portion which had been granted to the heirs of Columbus; but, in that year, it was erected into a province and called Costa Rica. It lies between Nicaragua and the newly hatched, but featherless, republic of Panamá, and is the smallest State of the New World except Salvador. But it is one of the most interesting, for, with Panamá, it forms the connecting link between North and South America, not only physically but ethnologically. If more were known of its ancient inhabitants, their type, character, modes of life, habits and customs, inter-tribal relations and forms of worship, and of the ruins of ancient towns and burial places which are silently dotted over the country, one might go far towards a solution of many vexed problems as to the relation betwen early Mexican culture and that of the Andean peoples—Chibchas of ancient Cundinamarca, the Quitos and Cañaris of Ecuador, the Quichuas and Aymarás of the Inga empire. Much of the data necessary to the formation of a just conclusion are buried on the slopes of the volcanoes of Turrialba, Irazú, Barba and Poás, and, in that richest of fields for archæological research, the district lying between Lake Nicaragua and the Gulf of Nicoya on the Pacific coast of Costa Rica, while the lowlands lying between Nicaragua and the Atrato River of Colombia probably hide, under their densely matted and almost impenetrable vegetation, whatever evidences may exist of their occupation by man, not only in the far-remote past, but even at the date of the Spanish conquest.

Hence we may welcome a scientific examination of any section of the region outlined above, but especially when the results are so carefully and clearly set forth as they are in the work under review—a large quarto volume richly illustrated. Its publication, as well as the explorations of which it treats, have been made at the expense of Mr. Åke Sjogren, who has presented to the Royal Ethnological Museum of Stockholm the valuable archæological collection with which Mr. Hartman returned home. This gentleman, whose studies had well equipped him for his task, proceeded to Costa Rica in 1897, where he remained more than a year in the territory once occupied by the Guëtare race. He commenced his researches in May (the beginning of the rainy season) near the *hacienda* of Mercedes, which is situated on the Guapiles branch of the Costa Rica Railway, about fifty miles from Port Limon.

"On the Atlantic side, the moisture-laden atmosphere and tropical heat have clothed the mountain chains and the low swamp lands with eternal verdure, with forests which are almost impenetrable, woven together as they are by lianas passing from tree to tree. Neither aboriginal nor Spanish culture ever made great inroads on the primeval forests of the Atlantic coast."

Near Mercedes is a mound about 100 feet in diameter at the base, 65 feet at the top, and 20 feet high. It is in a partially walled enclosure, and probably served as a platform on which to erect statues facing the rising sun. The mound may have been covered with a wooden structure with a thatched roof. Among the many human figures found there, all mutilated, were two of life size, one of which is notable as having ear plugs. The chest and back are crossed by two thick ropes, which pass over the shoulders and reach to the hips. The right wrist supports a human head. The other large statue has its hands resting on the hips. The heads of both figures are covered with conical hats. Rudely sculptured representations of alligators, pumas, and other animals were found, but in fragments. All of these, including the statues, were cut from hard, basaltic lava.

Mr. Hartman also examined the extensive burial places of the ancient inhabitants of this district, and opened a great number of cists. These varied in dimensions, but it is apparent that they were rarely intended for the interment of more than one person. They had side and end walls of cobble stones, but the bottom and top were of slabs of limestone. The horizontal section of the cists was very irregular. Only in one did he find traces of bone, but the "dark soil near the bottom seemed to prove that the body or bodies had been placed there."

Many vessels of burnt clay, sometimes roughly

[1] "Archæological Researches in Costa Rica." By C. V. Hartman. The Royal Ethnological Museum in Stockholm. Pp. 195; map+87 plates. (Stockholm: C. E. Fritzes, 1901.)

decorated, were lying in the cists, but a great part of them, covered with soot, appear to have served as cooking utensils. Several contained charred maize and fragments of corn cobs. In one was found some Millefiori beads, the manufacture of which was an important industry in Venice during the latter part of the fifteenth century, and the author says that, "Later on, I discovered a number of this kind in a grave at Osori in the highlands."

Thus it appears that these Indian towns were still in existence at the time of the Spanish invasion.

Mr. Hartman also opened a *cache*, similar to a cist, but there was no proof that it had ever been used as a grave; in fact, it was too small. It contained sixteen clay vessels, some of them ornamented, and much broken pottery. There were several globular bowls and vases. "The practice of secreting household articles as well as food in pits or in caves has from early days been observed among widely disseminated tribes of North America."

The work-yard of the ancient stone-cutters was happily discovered, and many unfinished idols were lying about.

In June, 1895, I roughly examined the mounds and some of the graves near the *hacienda* of Mercedes, and especially remember the two great statues described by Mr. Hartman. People resident

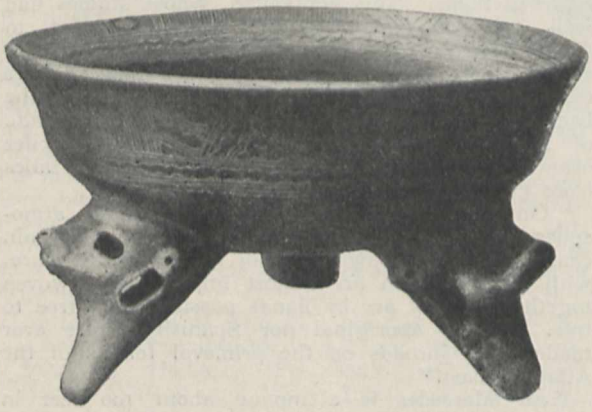


FIG. 1.—Shallow, tripod bowl found in Field II., Chircot. Height, 12·8 cm.; Diameter, 22 cm. From "Archæological Researches in Costa Rica."

in the vicinity, who know much of the region, said that the whole Santa Clara district, occupying the slopes of Turrialba, Irazú and Barba, and the heavily forested lowlands to the north and east, are dotted with ancient burial grounds.

From the coast lands, Mr. Hartman ascended to the highland plains near Cartago, one and a half miles west of which town is the water divide, 5100 feet elevation, between the Atlantic and Pacific Oceans. Cartago is about 4800 feet above sea-level, and lies upon the southern slope of the volcano of Irazú, the only one of Costa Rica which has ejected compact lavas. In its eruptions of 1841 and 1851 it almost completely destroyed Cartago, which was the former capital of Costa Rica. In its vicinity Mr. Hartman uncovered numerous cists similar to those of Mercedes, but they contained a greater variety of potsherds and ornamental pottery. He made especially rich collections at a spot called Chircot, where he observed that a favourite figure of the ancient artists was a flute-playing god. In the stone-bordered necropolis at this place he found 205 cists, many of them in three layers. In about thirty there were skeletons, or fragments of skeletons, which averaged five feet in length. The skulls were dolichocephalic, but most of the remains were too decayed for removal. Summarising his year's work, he says of the culture of the Guëtares "that it proves to be that of a stone-age people of high standing, possessed of ornaments of gold and copper, but with no tools or weapons of metal at all. We have no data whatever to enable us to determine how far back into the past this culture reaches, but the presence of beads of glass in the graves goes to show that it continued to exist after the arrival of the Spaniards. No traces of a more primitive culture were met with."

Similar cists are to be found on the slopes of Popocatapetl in Mexico, Zaculen in Guatemala, Chiriqui in Panama, and at Arayo in the Cauca valley of Colombia. In outline and elegance, the clay vessels of the Guëtares are inferior to those found in Chiriqui, but the objects in stone from the two sources closely resemble each other.

It is to be regretted that Mr. Hartman has not given us his views as to the ethnological relations of the Guëtares to the other aboriginal tribes of Central America. No doubt, in his travels subsequent to the researches so elaborately detailed in his valuable volume, he must have formed opinions of much importance to the student of aboriginal America. Costa Rica was a debatable ground between the Mexican

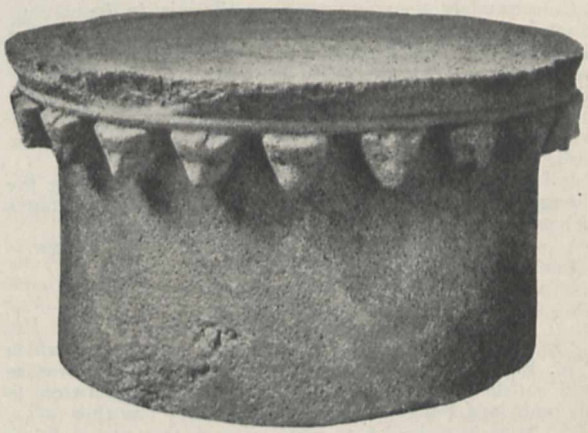


FIG. 2.—Seat of Stone. Found in the forest in the neighbourhood of the large mound, Mercedes. From "Archæological Researches in Costa Rica."

race and the warlike Carib of the northern shore of South America. It may, perhaps, be conceded that an offshoot of the highland people of Mexico pressed south and east from Chiapas into and through the long strip of the Pacific coast occupied by the Chorotegas or Mangues, followed the Pacific slope of the Cordillera and the narrow belt of land between Lake Nicaragua and the ocean, penetrated into north-western Costa Rica, settled and helped the Mangues to develop a considerable civilisation in the Guanacaste and Nicoya districts, and in part subdued all the mountainous area lying north and west of the river Reventazon. The culture which was characteristic of the region indicated was infinitely superior to anything attained by the Guëtares, for the Mangue-Náhua people carried some of the arts, such as pottery, sculpture, weaving, and tilling the ground, to greater perfection than any of the tribes occupying the territory between theirs and that of the Chibchas of the plateau of Bogotá. In their graves are found examples of the ceramic art and gold ornaments showing taste in design superior to any that the present civilised Indian of Costa Rica can equal. Their graves produce beautiful specimens of obsidian, greenstone, and finely wrought nephrite

tools and jade ornaments, knives, hatchets, arrow-heads, armlets, rings, and a multitude of stone seats and idols.

Let us hope that Mr. Hartman may follow up his good and useful work by an exploration of the north-western slope of the country which has been the scene of his labours. GEORGE EARL CHURCH.

## *PROGRESS IN AËRIAL NAVIGATION.*

THE problem of aërial navigation has been attacked by direct methods for so many centuries that the results of the recent aëronautical competition at St. Louis can scarcely be regarded as a matter of surprise. It is doubtful whether the offering of large prizes for the achievement of a result which has been attempted for years without success is the best means of promoting progress. As will have been learnt from the daily Press the great prize of 20,000*l.* was not even competed for, and a much more useful purpose would have been served by a systematic and organised attempt to encourage, by means of prizes, investigations calculated to throw an indirect light on the general question of aërial navigation, such, for example, as improvements in the efficiency of propellers, diminution of the angle of gliding of gravity-propelled machines, reduction of air-resistance of motor-propelled balloons, solution of the difficulties connected with longitudinal stability, especially in gliding machines travelling at low speeds, and what is still more important, the discovery of new results in any direction whatever calculated to open up fresh methods of approaching the whole question.

If we chronicle merely the attempts that have successfully been made in striking out on new lines, leaving out of account improvements subsequently made on the same lines, and also omitting early attempts such as those of Dante of Perugia and Le Bris, a history of aërial navigation will be summed up in the following short list:—(1) Montgolfier's discovery of the balloon; (2) application of mechanical power to the propulsion of balloons by Renard and Krebs; (3) introduction of gliding experiments under gravity by Lilienthal; (4) the introduction of explosion engines and other light motors theoretically capable of maintaining a flying machine in the air. Each of these innovations has brought the goal more distinctly in view, and yet experiments so far have left a wide gap between the results of actual performance and what is necessary to render aërial navigation practically useful. The special difficulty connected with aërial navigation is that it is not easy to see how to approach the problem except by direct methods of attack, while the great majority of scientific discoveries have been made indirectly as the result of observations originally undertaken for some entirely different object that has been known from the very outset to be possible of attainment.

By analogy with fishes and birds, respectively, the two forms of machine experimented on, involving as they do the use of gas bags and aëroplanes or aërocurves, might not inappropriately be described as the aërial swimming machine and the flying machine proper. It is somewhat remarkable in the face of natural evidence that the swimming machine has up to the present proved by far the most tractable of the two, and has undoubtedly led to the best results. It is the safest to experiment with. That accidents have frequently occurred is perfectly true, but they have all been attributable to causes not beyond the ken of an ordinary practical but intelligent mechanic.

Of aërial swimmers constructed within the last few years the most notable ones are undoubtedly the Santos Dumont series, the ill-fated De Bradski airship, the Lebaudy, Barton, Spencer, Baldwin, Benbow, Beedle, and Deutsch forms. A few details of these, collected for comparison, may be of interest.

M. Santos Dumont's No. 7 is 160 feet long and 23 feet in diameter, and is provided with a four-cylinder motor capable of developing 60 horse-power and making 1200 revolutions per minute. Its predecessor, No. 6, was 108 feet long and 20 feet in diameter, with a motor of 16-20 horse-power. This was the machine which won the Deutsch prize, and its speed relative to the air was probably about 19 miles an hour. No. 7 was originally intended to compete at St. Louis, but M. Santos Dumont did not enter.

The De Bradski airship is now a thing of the past. It was 111 feet long and weighed about 1923lb., and a special feature was that the machine was not *quite* light enough to raise itself, the ascent being effected by a screw revolving in a horizontal plane. The experiment ended in October, 1902, with a fatal accident, the airship becoming unmanageable, and the car breaking away owing to the weakness of its supporting wires.

The experiments of MM. Lebaudy have been remarkably successful in spite of an accident which destroyed their first machine in November, 1903. This did not deter these indefatigable aëronauts from constructing, partly out of the wreckage of the old one, a new machine of the following dimensions:—Length 58 metres, greatest diameter 9·8 metres, volume of gas 2600 cubic metres, or about 94,000 cubic feet; motor, a four-cylinder Daimler of 40 horse-power running at 250 to 1200 revolutions per minute; propellers, two screws 2·44 metres in diameter running at 800 to 1000 revolutions per minute. Of the thirty voyages made with this "aërial cruiser" in 1904, the following appear to have been the most successful:—August 16, a distance of 16 miles in 41 minutes; November 22, a run of 1 hour 33 minutes. An accident occurred on August 28 owing to the "swimmer" breaking loose, but it floated away to a distance and finally got caught in a wood 70 kilometres distant, whence it was brought back with slight damage. The present model is remarkably like a fish in shape, and the resemblance is further accentuated by the tail-like double horizontal rudder in the stern. The balloon has a flat base with a long vertical keel, and all these arrangements are well calculated to make it travel steadily.

Beyond the mere rumour of an accident last spring the Barton airship seems to have lapsed into oblivion of late, but it must not be forgotten that a year is a small interval of time in the construction of aëronautical machines. The dimensions given are as follows:—Length of balloon 170 feet, diameter 40 feet, total estimated weight 15,700lb.; number of propellers, six, each consisting of six blades arranged tandem fashion, placed in pairs, one on each side of each motor; motors, three in number, developing 50 horse-power each, and running at 1600 revolutions. A peculiarity of Dr. Barton's design is the series of aëroplanes, thirty in number, employed to raise the machine. The shape of the balloon and the structure of the underlying framework and car suggest the possibility of considerable head resistance.

Of the performances of Messrs. Spencer's airship satisfactory records were given in the Press at the time. The dimensions are:—Length 93 feet, diameter 24 feet; propeller, a single screw 12 feet in diameter, placed in front; engine of 24 horse-power running at 1050 revolutions.

Mr. Baldwin's and Mr. Benbow's airships, exhibited at St. Louis, appear not to have made any

noteworthy performances, the former having failed to stem a wind of six to eight miles an hour, and the latter having made progress at the rate of three miles an hour. We have before us a brief description of the machine with which Mr. Beedle made a successful preliminary trial in November, 1903, and further trials were promised for last spring. Mr. Beedle proposed to dispense with rudders and steer by means of a screw fan in front which could be turned in any desired direction, an arrangement calculated to leave much to be desired in the matter of steadiness. The particulars are:—Length 90 feet, diameter 24 feet, horse-power 12. Of the Deutsch "swimmer" only a model was exhibited at St. Louis.

A comparison of the figures of several of these airships gives the impression that the Lebaudy balloon is far ahead of most of its rivals in its well designed proportions. The only questionable feature is the presence of horizontal rudders at the back of the car, in a place where they might prevent the stream lines of air from closing round the balloon, and thus increase the resistance. About this point MM. Lebaudy are best able to judge.

The limits of speed of the aërial swimmer attainable by existing methods are now pretty well known, and fall far short of the amount necessary to travel in the teeth of a high wind. Still, the navigable balloon offers the most promising field of experiment for those who are not prepared to devote themselves to a long course of purely mathematical and experimental researches, or to run blindfold into the dangers which such a course of study would enable them to predict.

For the successful realisation of mechanical flight proper, what is most wanted is a complete and exhaustive investigation, both by mathematical and experimental methods, of the longitudinal stability of various forms of machine gliding at various angles either under gravity alone or when mechanically propelled.

The small fluctuations of a gliding machine about steady motion are determined by exponential functions of the time the coefficients of which are the roots of an equation of the fourth degree. If these roots determine oscillatory motions there will be, not one, but two different oscillations of the machine in a vertical plane. Either of these oscillations may increase or decrease with the time, and unless they both tend to decrease the pitching will become dangerous and the machine will overturn. Photographs of the paths of gliders taken by Mr. Williams some time ago with magnesium light distinctly showed the two oscillations, and in several cases the final overturning in a manner perfectly consistent with theory.

Now it is possible to determine experimentally for any given machine the coefficients of stability when gliding at every different angle. To do this it would be necessary to measure, by means of dynamometers, the force and couple components acting on either a full-sized machine or a model when moved through the air in different directions in its plane of symmetry. It is necessary also to take account of the small changes in these forces and couples when the machine has a small rotational motion, such as occurs when it is turning upwards or downwards in the course of its oscillations. These small changes may, and in all probability do, play an important part in affecting the stability. A whirling table gives exactly the kind of small rotation required in addition to the necessary translatory motion. By reversing the model experimented on, the direction of this rotation may be reversed, and the differences of the two sets of dynamometer readings will give three of the coefficients of stability.

If observations of this kind were made it would be possible to work out on paper the oscillations, and to ascertain the lowest velocity at which a machine would glide safely.

But experimenters have hitherto confined their attention to measurements of the air resistance, and very few have up to the present given much attention even to the variations in the position of the centre of pressure except for a few cases such as a square lamina. The object in most cases has been merely to find out the speed at which a flying machine would travel under favourable conditions, and not its powers of extricating itself from the most unfavourable positions which it might assume on a gusty day. "Stability of motion" is a phenomenon which rarely enters into practical problems. In the flying machine it is of paramount importance.

A similar mathematical investigation has been made by Signor G. A. Crocco in Italy, in connection with stability of airships, but the author obtains an equation of the third instead of the fourth degree. He, however, takes no account of the fluctuations in the horizontal motion, which are certainly of importance in the case of gliders.

Meanwhile the artificial balancing of gliders under gravity has been the subject of a considerable number of experiments in America, and more recently in France, and the initial success of Mr. Orville Wright in rising from the ground on a motor-driven machine in the face of a wind and landing safely constitutes the first achievement of an actual flight. It is a matter of congratulation that Mr. Wright was not so emboldened by his success that he became reckless, and pushed the experiments on to a premature end.

The large curved surfaces of the disastrous Lilienthal and Pilcher experiments have now given place to a pair of narrow superposed rectangles, first introduced by Chanute and Herring. The tail has since, in the hands of Messrs. Wilbur and Orville Wright, been replaced by a front rudder, and the adoption of a horizontal position "à plat ventre" shows that the maintenance of balance has been reduced to a matter of steering.

These types of gliders have been taken up in France by Captain Ferber, of the Artillery, and subsequently by Mr. Ernest Archdeacon, both of whom have become enthusiastic "aviators," and have in their turn brought gliding experiments into considerable popularity in that country. As Captain Ferber remarks, a sloping hillside with a wind blowing straight up it are necessary, and a convenient experimenting ground has been found at Meudon. With the object of experimenting on larger motor-driven models Captain Ferber constructed an aërodrome consisting of a column eighteen metres high, supporting a rotating beam thirty metres across. This apparatus would be very useful for determining the stability coefficients of an actual machine firmly attached to its beam, but it must not be forgotten that any kind of suspension may seriously modify the longitudinal oscillations. So, too, may the rotation about the vertical axis; it is much easier to make a glider describe a corkscrew path than glide in a straight line. A kite illustrates the same properties. Its oscillations also depend on a biquadratic equation, but the supporting string modifies their character, and Mr. Cody claims that a man has been lifted 1600 feet by kites, though how the *photograph* of "the Cody man-lifting kite 800 feet high" was taken, which appears in the *Aëronautical Journal*, is not explained. The use of kites for saving life at sea might well receive more attention than has been bestowed on this question up to the present. The clumsy plan of sending up rockets in the teeth

of a gale such as would just blow a kite line from ship to shore needs reconsideration.

Little has been published about Prof. Langley's experiments beyond a reference to the accident which gave Prof. Manley a premature bath in the Potomac.

The idea of combining a glider and boat was tried initially with success and ultimately with failure by Herr Kress on a reservoir a few miles out of Vienna, near the main railway line from Germany. Major Baden-Powell has adopted the same plan at the Crystal Palace. The machine descends a kind of chute from a height of about thirty feet, and is shot off into the air about six feet above the water. With this small height it is not unlikely that successful glides might be made even if the steady motion were longitudinally unstable, for by careful projection several wave-lengths might safely be described in the air before the pitching became dangerous.

It is probable that a motor driven machine travelling at high speed would be much more stable than a gravity machine, but to understand the management of the machine is a necessary condition of success, and the more this can be made the subject of mathematical study the easier will the task be for an aëronaut who is perfectly familiar with the equations of motion. In regard to the effect of speed on stability, the pretty butterfly-like "helicoptera" driven by elastic must not be quoted as instances. They raise themselves nearly vertically; we are concerned with machines moving nearly horizontally.

From all that has been said above it will be seen that there is plenty of work to be done in connection with aërial navigation. At the present time, careful quantitative measurements of the coefficients of stability of actual machines by attaching them to whirling tables are even more needed than further balancing experiments in mid-air.

G. H. BRYAN.

## *PHAISTOS AND HAGIA TRIADA, CRETE.*

IN the south of Central Crete, a day's journey from Candia on a good horse, lies the scene of discoveries no less important than those of Dr. A. J. Evans at Knossos. They consist of the ruins of two palaces, one large and one small, but both built on the same general plan and with the same materials (stone and concrete) as that which has made Dr. Evans famous. There can be no doubt that all three belong to one age and one social system; that they were under one Government is clear from the fact that none of the three were fortresses. Crete was, in fact, as Thucydides told us long ago, a sea-power which had no fear of assault by land. With the architectural or historical interest of these remains we need not concern ourselves at present, nor with the general character of the articles found in them. In all three we meet with vessels of use and ornament, painted frescoes, inscribed blocks or tablets, seals, human and animal figures, and articles of domestic or religious character. But in or near Hagia Triada there came to light a number of objects of special interest which distinguish that palace, smallest of the three, above the others.

First there is a sarcophagus of stone, painted upon all four sides. Each of the two ends bears a chariot in which are two female figures; a pair of horses draws one, a pair of griffins the other. The two sides bear a representation of sacrifice to the dead. Men leading animals—bull, goat, or sheep—women with baskets of fruit, others with bowls apparently full of wine or some other liquid, which is being poured into a large jar; a flutist and a harper, playing upon a lyre of seven strings (which are therefore older than Terpander by a thousand years); men carrying animals in their arms; and lastly the dead man himself, standing beside a tree before his own tomb and receiving the pious offerings. A most noteworthy fact in this representation is that the men wear women's skirts.

Next come three vases of steatite, each bearing a scene carved in relief. The workmanship of these carvings is astonishing for its finish, and the designs are full of life, reminding us not distantly of good Attic work. On one vase a couple of youths stand face to face, one leaning upon a spear or staff, the other bearing over his shoulders a staff and a whisk of some sort. Both are naked, save for the familiar loincloth of the Mycenæans (which the Greeks never wore, except in the very earliest times at the Olympian games), and high boots of the same kind which are still worn in Crete and always have been. The second vase represents several pairs of men, some wrestling and some boxing, and a bull-hunt or bull-baiting. The boxers have their hands bound about with straps of leather, or something like a fingerless glove. Some of these men wear helmets, which in part at least seem to be made of metal; and helmets hitherto have been undreamt of at this period.

But the last vase is the most striking of all. It bears a procession of men marching two and two, led by a personage clad in a stiff bell-shaped tunic covered with scales. He is bareheaded and carries a long staff or sceptre resting upon his shoulder. The men behind him wear flat caps something like to a turban, and loincloths, and each carries over his left shoulder a long pole branching out into three long flexible wands at the end. In the middle of the procession are four men singing, one bearing the *sistrum* of Isis; these have no wands. Some see in this a triumphal procession of soldiers after war. The lack of arms or shields makes this unlikely; the three-pronged objects can hardly be weapons, for they seem to be flexible, but what they are it is impossible to say. Those are more likely to be right who believe it to be a harvest festival of some kind, and the three-pronged implement an implement used in some harvesting process. If we may assume that these objects have no use at all, but are ornamental (which is not likely), the whole might be a religious procession without regard either to war or husbandry.

## *NOTES.*

THE Bakerian lecture of the Royal Society will be delivered by Dr. Horace T. Brown, F.R.S., on March 23, upon the subject of "The Reception and Utilisation of Energy by the Green Leaf."

IT is proposed to erect in Jena a memorial to Prof. Ernst Abbe, so that all who see it may be reminded of his great services to optical science and industry, and his sterling qualities as a man. Abbe's work and influence are appreciated wherever physical science and sociology are studied, and there should be no difficulty in obtaining sufficient funds to raise a noble monument to his memory. The committee organised for this purpose includes the names of Dr. Czapski, Dr. Eggeling, Dr. G. Fischer, Prof. Rosenthal, and Prof. Winkelmann. Subscriptions for the memorial should be sent to the treasurer, Dr. Gustav Fischer, Jena.

*Science* states that the Prussian Academy of Science has awarded its Helmholtz medal to Prof. Ramón y Cajal, professor of neurology at Madrid.

IT is announced that Prof. Albert B. Prescott, professor of organic and applied chemistry, dean of the school of pharmacy and director of the chemical laboratory of the University of Michigan, died on February 26 in his seventy-third year.

WE learn from the *Times* that negotiations are in active progress for the amalgamation of the Society of Arts and the London Institution. A scheme has been prepared by a joint committee, and it only remains to be submitted to the general body of the members, whose assent in all likelihood will be given.

A COMMITTEE of the French Physical Society has arranged to have a medal struck in commemoration of M. Alfred Cornu.

THE Royal Society of Naples (mathematical and physical section) has awarded its prize of 40*l.* to Prof. E. Pascal, the subject being the theory of the invariants of the ternary quartic with special reference to the conditions for splitting into inferior forms. A prize of 20*l.* is now offered for the best essay in Italian, Latin or French on "The theory of electrons and the dispersion of light." The last day for sending in is June 30, 1906, and the essays are to be submitted under a pseudonym.

SINCE our note on the late Prof. Emilio Villari appeared in last week's NATURE, we have received a copy of the *Rendiconto* of the physical and mathematical section of the Neapolitan Royal Society (x., 8–11) containing another notice of Prof. Villari by Prof. L. Pinto. It differs from the previous notices in containing a general summary of the scope of Villari's works, classified under the various headings of acoustics, molecular mechanics, heat, light, electricity, and Röntgen rays, and it will be found a very useful notice for purposes of reference, especially for physicists, whose time is limited, interested in Villari's researches.

THE *Lancet* states that the King has acceded to a suggestion that the skeleton of Ambush II., the famous steeplechaser from the Royal Stables which died some weeks ago, should find a place in the Museum of Veterinary Anatomy at the University of Liverpool. The skeleton will be mounted and placed in a prominent position at the University museum, and a plate will be affixed giving a short history of the well-known horse.

IT is announced in the *Electrician* that Lord Kelvin will be the recipient of the first John Fritz gold medal awarded by the joint committee of the four national American engineering societies, under the deed of gift, to the man most representative of, and eminent in, scientific advance in the engineering field. This medal was founded three years ago on the occasion of the eightieth birthday of John Fritz, the famous inventor and engineer in the iron and steel industry, who is still enjoying excellent health.

ON Tuesday next, March 21, Prof. W. E. Dalby will deliver the first of a course of two lectures at the Royal Institution on "Vibration Problems in Engineering," and on Thursday, March 23, Mr. Thomas G. Jackson will begin a course of two lectures on "The Reasonableness of Architecture." The Friday evening discourse on March 24 will be delivered by Sir Oliver Lodge, his subject being "A Pertinacious Current," and on March 31 by Prof. J. Wright on "The Scientific Study of Dialects." Prof. Meldola will give the first of his two lectures on "Synthetic Chemistry" (experimental) on Thursday, April 6.

The Liverpool correspondent of the *Lancet* states that Mr. J. E. S. Moore, who has become director of cancer research in succession to Prof. A. S. F. Grünbaum, has also been appointed a member of the staff of the Royal Infirmary, Liverpool, in accordance with the terms of the donation that the research work in cancer should be carried on at that infirmary. From the same source we learn that, in response to an appeal made for funds to initiate a permanent memorial to the late Sir W. M. Banks, the sum of 5523*l.* has been subscribed. Of this amount, the sum of 1500*l.* is to be devoted to founding a lectureship, to be attached to the University of Liverpool, and to be called the "Mitchell Banks lectureship." The University authorities will be enabled to invite yearly a distinguished surgeon, pathologist, or anatomist to treat of the latest investigations and discoveries in medical science.

AT the Optical Convention to be held in May next at the Northampton Institute, Clerkenwell, to which attention has already been directed in these columns, the following amongst other papers will be read. Dr. R. T. Glazebrook, F.R.S., will deliver the presidential address. Mr. H. Dennis Taylor will read a paper on some properties of lens systems; Mr. Walter Rosenhain will deal with two subjects—the mechanical design of instruments, and some problems relating to optical glass; Dr. C. V. Drysdale will discuss binoculars, and, in collaboration with Mr. S. D. Chalmers, will introduce a discussion on aberration; Mr. J. Gordon will take up the question of diffraction in optical instruments; Mr. J. Blakesley, some optical measurements; Mr. J. H. Sutcliffe, ophthalmometers; Dr. R. M. Walmsley, education in optics; Prof. Forbes, spectroscopic vision; Prof. Poynting, F.R.S., a parallel plate micrometer; and Dr. W. Watson, F.R.S., fused quartz for optical purposes. Full particulars of the convention can be obtained from the secretary, Mr. C. L. Redding, at the Northampton Institute, Clerkenwell, E.C.

THE March number of the *American Journal of Science* contains a short account of the work of Prof. A. S. Packard, who died in Providence, R.I., on February 14, at the age of nearly sixty-six years. Prof. Packard was graduated from the Maine Medical School and the Lawrence Scientific School in 1864. At Cambridge, Mass., he was one of that remarkable group of students—Hyatt, Morse, Packard, Putnam, Scudder, Shaler and Verrill—associated with the elder Agassiz in the early 'sixties. He served for a time in 1864–5 as assistant surgeon in the U.S. Army, but never became a regular practitioner of medicine, his life being devoted to his chosen work in zoology and geology. He was specially distinguished as an entomologist, and he was an enthusiastic field naturalist, collector, and explorer, and a voluminous author who wrote on a remarkably wide range of subjects. He will probably be longest remembered for his original work on insects and his several text-books on entomology and zoology. Early in his career he accepted the theory of evolution and later became an ardent neo-Lamarckian. One of his last works was "Lamarck, the Founder of Evolution, his Life and Work." He was one of the founders of the *American Naturalist*, for twenty years its chief editor, and a constant contributor to its pages. Prof. Packard was a member of the National Academy of Sciences and of many other scientific societies.

THE ceremony of transferring the museum of the Hastings and St. Leonards Museum Association to the Corporation of Hastings took place on March 1. The museum is a representative one, and is divided into several sections. The anthropological section includes a cosmopolitan ethnological collection, geographically arranged. In it are some good local bronze and bone objects, a series of

Neolithic stone implements from many parts of the world, an ethnological collection from New Guinea and the South Sea Islands, the relics recovered from the Hastings kitchen middens—numbering many thousands of specimens—and many worked flints of the Palæolithic period. The geological section is remarkable for its collection of animal remains of the Pleistocene period from the Lewis Abbott collection, and a collection of Wealden fossils from the neighbourhood. The biological section has a representative collection of the local fauna. After the museum had been accepted by the Mayor on behalf of the Corporation of Hastings, Sir Arthur Rücker, F.R.S., delivered a short address, in which he emphasised the value of museums in the study of natural science, and commended the active part municipal authorities are now taking in educational work. Dr. J. J. H. Teall, F.R.S., expressed the opinion that local museums should illustrate local natural history, and outlined a plan which would secure this end. Sir Harry Johnston, G.C.M.G., K.C.B., also spoke on the value of museums.

A BOTTLE thrown overboard in latitude 29° 30′ N., longitude 68° 10′ W., by Colonel Swalm, U.S. Consul at Southampton, in May, 1903, has just been found on the Donegal coast, Ireland, near Arranmore. The bottle had apparently been carried by the Gulf Stream along the North American coast, then across the Atlantic to the Irish coast. To travel this distance it had taken 662 days at an approximate speed of five miles a day.

ACCORDING to a Reuter despatch from St. Petersburg, dated March 9, the North Pole Commission has officially declared that the expedition under Baron Toll to the new Siberian Islands, in the Arctic Ocean, has ended with the death of all the members of the party. The party sent in search of the expedition found in Benett Island a letter written by Baron Toll saying that the members of the expedition had continued on their journey though having only eighteen or twenty days' provisions left. It is therefore believed that Baron Toll and his companions perished of hunger.

THE *Weekly Weather Report* of March 11 issued by the Meteorological Office showed that the rainfall from the beginning of the year was still deficient in all districts except the north of Scotland and the north of Ireland; the deficiency amounted to 2 inches and upwards in several parts of England and in the south of Ireland. During the recent severe gales, however, falls of about an inch in twenty-four hours have been recorded in several localities. In the neighbourhood of London the rainfall during the part of the present month already elapsed has exceeded the mean for March, which is 1·5 inch.

AN exhibition of meteorological instruments with photographs and records of meteorological phenomena, under the auspices of the Royal Meteorological Society, was opened on Tuesday at the Institution of Civil Engineers, Great George Street, Westminster, and the exhibition will remain open until 5 p.m. to-morrow, Friday. The instruments exhibited represent all branches of meteorology, and show clearly the great advance which the science has made in recent years. Continuous records can now be secured in nearly all branches, and in many of these ample choice is provided. There are several forms of self-recording raingauges, notably the Beckley and the Richard patterns, while Halliwell's improved float pattern pluviograph is of more recent invention, and of exceptional scientific value. The thermometer exhibits are fairly numerous, and of various designs, from Callendar's electrically recording thermometer to instruments of an ordinary character. There are to be seen the thermometers in use in Sir J. C. Ross's Antarctic Expedition, 1839–43, and in the Arctic expeditions 1850–59, as well as thermometers used by the National Antarctic Expedition 1901–4. These instruments show the greater degree of accuracy obtainable in manufacture now than was the case, say, half a century ago. Barometers and barographs exhibit considerable advance. An instrument of considerable value is Dines's self-recording mercurial barometer; and a microbarograph, for the study of minor variations of atmospheric pressure, under the joint names of Mr. W. H. Dines and Dr. W. N. Shaw, is likely to prove of much value. A typical climatological station is shown, its enclosure containing all the necessary instruments in position for observation. A prominent position is given to aëronautics, and there are specimen kites with meteorograph in position. There are anemometers of very varied description, many of these being self-recording. Sunshine recorders, past and present, are to be seen, from the wooden bowl, by Campbell, used as early as 1853, to the almost perfect instrument known as the Campbell-Stokes. Among the many drawings and photographs may be mentioned the water-colour drawings made during the recent National Antarctic Expedition, exhibiting sky and cloud effects. The Royal Meteorological Society is to be congratulated on the thoroughly interesting character of the exhibition.

PROF. H. HERGESELL has communicated to the *Comptes rendus* of the Paris Academy of Sciences, January 30, some of the preliminary results of the kite ascents made on the yacht of the Prince of Monaco in the Mediterranean and North Atlantic Ocean in the summer of 1904. Altogether, twenty-five ascents were made, eight in the Mediterranean, one in the Baltic, and sixteen in the Atlantic. The principal object of the latter was the exploration of the meteorological conditions in the region of the trade winds. The results show that in the lowest strata of the air there is a considerable decrease of temperature with increase of altitude; the adiabatic gradient (1° C. per 100 metres) is always attained, and even exceeded in the lowest stratum. The depth of this adiabatic stratum varies from 100 to 600 metres; the relative humidity at the sea-level is 70 or 80 per cent., and rises gradually to 95 or 100 per cent. At the upper limit of this stratum a sudden change occurs; the temperature rises quickly by several degrees, and the humidity suddenly diminishes to below 50 per cent. The temperature continues to rise, through a stratum sometimes extending to a depth of 1000 metres, and the humidity decreases to 10 or 20 per cent.; at a height of 1000 metres, temperatures of 30° C. are experienced, while at the sea-level only 22° or 23° are recorded. Above this stratum the adiabatic gradient again holds, but the humidity is low, compared with that of the first adiabatic stratum. In the lower stratum the N.E. trade is experienced, the velocity being about sixteen miles an hour; with increasing elevation the wind gradually shifted through N. to N.W., and in two instances it shifted through E. to S.E. and S. A south-westerly current, which would correspond to the theory of anti-trades, was never exhibited by the kites, although they several times exceeded the height of the Peak of Teneriffe. The velocity of the N.W. or S.E. winds experienced in the highest strata did not exceed seven or nine miles an hour, and was generally still less in the intermediate strata.

THE latest issues of the *Proceedings* of the U.S. National Museum include a description, by Dr. Stejneger, of a gecko and three frogs from the Philippines, and an article by Mr.

Gill on the gurnard commonly known as *Prionotus stearnsi*, which is made the type of a new genus.

THE structure of the squamoso-parietal crest in the skulls of the horned dinosaurs of the Cretaceous of Alberta is deemed by Mr. L. M. Lambe of sufficient interest to merit a paper by itself, and he has accordingly described this part of the skeleton in a recent issue of the *Transactions* of the Royal Society of Canada (vol. x., sect. iv.).

OUR weekly budget includes copies of Nos. 3 and 4 of the *Sitzungsberichte* of the Vienna Academy for the current year. Among the notes is one by Prof. Molisch on phosphorescence in eggs and potatoes after cooking, and a second by Dr. F. Werner on the Orthoptera of the Egyptian Sudan.

IN the January number of the *American Naturalist*, Mr. J. Stafford discusses the larva and spat of the Canadian oyster, the latter of which is extremely minute and very difficult to discover. Unlike the later stages, the very young spat presents a dark metallic lustre. When once recognised, the young spat is, however, by no means difficult to discover, and the sailors soon became adepts in the search. Although found on many kinds of shells, and sometimes on stones, the spat displays a preference for the young of *Crepidula fornicata* and colonies of *Ralfsia verrucosa*.

TO the *Biologisches Centralblatt* of February 15, Mr. J. P. Lotsy contributes an article on "X-generation and 2X-generation," in which he proposes a theory to explain certain features connected with cell-development and heredity. In the second article in the same issue Mr. E. Wasmann seeks to explain the origin and development of slavery among ants, showing the manner in which a colony of *Formica truncicola* may have been gradually modified from a type in which a certain number of stranger ants were received as guests, to one in which a host of captives are maintained.

THE *Otago Daily Times* of January 6 contains an article on the marine fish-hatchery at Portobello and the progress recently made there. The institution was nominally opened a year ago last January, but it was by no means in good working order, having to contend with such difficulties as leaky tanks. Work during the past year has been to a great extent confined to observing the behaviour of a few kinds of food-fishes in captivity. Many of these died off quickly when introduced into the tanks, some, apparently, on account of having been injured in their capture, and others owing to a difference in the temperature of the water. Blue cod, however, thrive well, although the endeavours to rear the fry were unsuccessful. The introduction of the European lobster is contemplated.

MR. L. FREDERICO, director of the class of science in the Belgian Royal Academy, sends us a copy of an essay (from the *Bulletin* of the Academy for December last) on the Glacial fauna and flora of the plateau of Baraque-Michel, the culminating point of the Ardennes. The boreal conditions of climate have, it appears, preserved on this exposed plateau a small colony of animals and plants of an essentially arctic type, the nearest relatives of which are to be met with only in the extreme north, and on certain much higher mountains in central Europe. This assemblage seems to be at the critical stage as regards temperature, a very slight elevation of which would lead to its disappearance. We thus have a definite refutation of the prevailing idea that the temperature of this part of Europe has been higher at some date since the Glacial epoch than it is at the present day.

THE February number of the Johns Hopkins Hospital *Bulletin* (vol. xvi., No. 167) is mainly devoted to anatomy. The teaching of anatomy is discussed by Mr. Mall, who also writes on the working of the Anatomy Act (U.S.A.) and preservation of material, and the anatomical department of the University of California is described by Dr. Flint. Three papers dealing with points in the development of the kidney, a review of Flechsig's researches on the brain, and an article on body-snatching in England complete the contents of an excellent number.

ON the subject of the mandrake or mandragora, Mr. C. B. Randolph has collated, in the *Proceedings* of the American Academy of Arts and Sciences (vol. xl., No. 12), a number of references from the classics, from which he concludes that, on account of its narcotic qualities, it was employed as an anæsthetic about the first century of the Christian era.

EXPERIMENTS by Mr. E. S. Salmon showing that "biologic forms" of *Erysiphe graminis* can be identified according to their power of infecting different species of cereals have been previously referred to. Pursuing his investigations on the subject, Mr. Salmon states, in the *Annals of Botany* (January, 1905), that portions of a host plant which is normally immune, become susceptible to infection by the fungal conidia if they are injured or subjected to heat or the action of anæsthetics, but the conidia produced as a result of such infection cannot attack a healthy plant of the same species. The practical application of this fact is far reaching, as a wheat-rust can in this way spread to barley leaves which have been injured by animals or storms.

WITH the object of arousing interest in the subject of the giant trees of Victoria—all species of Eucalyptus—Mr. N. J. Caire has collected data as to size, height, and localities of specimens known to him in a paper published in the *Victorian Naturalist* (January, 1905). Big Ben, a specimen of *Eucalyptus amygdalinus*, possessing a trunk of 57 feet girth, was destroyed by a bush fire in 1902, and Billy Barlow, a blackbutt of the same circumference, was sacrificed for the Paris Exhibition; both these veterans were probably more than a thousand years old. Most of these trees of enormous girth present signs of senile decay, as shown by broken tops or later by hollow stems.

THE results of recent experiments have proved conclusively, says the *Pioneer Mail*, that silk of excellent quality can be raised in Ceylon, and samples of cocoons raised at Peradeniya from European seed have been classed by a European expert as second only to the best Italian silk. Hitherto all experiments have been on a small scale, limited partly by the comparative scarcity of mulberry trees. The time seems now to have arrived when more extensive operations might be undertaken with advantage; and, with this object, it is proposed that an experimental silkworm rearing establishment be created. A scheme is under consideration by the Ceylon Board of Agriculture.

SOME interesting observations of the spark discharge from a Holtz machine are described in a paper by Dr. L. Amaduzzi in the *Atti* of the Italian Electrotechnical Association for 1904. Marked variations in the character of the discharge were observed with varying atmospheric conditions.

THE peculiar photographic activity of hydrogen peroxide has recently been considered by Graetz to be due to a special radiation, in virtue of the fact that its influence is capable of penetrating solid bodies, particularly thin

sheets of metals. It is, however, shown by J. Precht and C. Otsuki, in the *Verhandlungen* of the German Physical Society (vol. vii. p. 53), that hydrogen peroxide itself is capable of penetrating thin films of gelatin, celluloid, india-rubber and black paper, the peroxide being subsequently capable of detection by titanic acid. Metals in the form of the thinnest sheet are, nevertheless, impervious to hydrogen peroxide, if small holes be not present; the same is true of thin films of paraffin, glass, and ebonite.

Two papers dealing with the accurate measurement of coefficients of expansion are contained in the January number of the *Physical Review*. Mr. H. McAllister Randall describes the determination of the coefficient of expansion of quartz between the temperatures of 36° and 500° C. by means of Pulfrich's optical method, and shows that up to about 250° C. the expansion of quartz follows a straight-line law; between 250° and 470° C. it is necessary to include a term involving the square of the temperature, whilst at 500° C. a sudden large increase in the expansibility becomes visible. At this temperature it is probable, as suggested by Le Chatelier, that quartz undergoes a change into a second modification having very different physical properties from those of the ordinary form. The second paper, by Mr. H. D. Ayres, deals with the measurement by Pulfrich's method of the coefficients of linear expansion of the metals aluminium and silver at temperatures between 100° and −184° C.

THE firm of Leybolt Nachfolger in Cologne has recently issued a very complete and interesting catalogue of physical apparatus and fittings sold by them. The book starts with a history of the instrument trade in Cologne during the last century. In its second section we find an account of the construction and fittings of various chemical and physical institutions. It is noteworthy, perhaps, that while the students' laboratory, with its work tables and appliances for experiments, figures prominently in the chemical institutions, the arrangements for practical work by the students in the physical laboratories are distinctly less complete. After this follows the catalogue proper, filling some 800 large pages, profusely illustrated and admirably arranged. The book will be most useful to the teacher, and is a striking illustration of German enterprise and go. At the same time it is observable throughout that the apparatus is intended chiefly for demonstrations and the lecture-room. The list of electrical measuring instruments, for example, is comparatively meagre, while there are not many examples of the simpler forms of apparatus supplied to an English school laboratory for use by the students. It is probably the case that such apparatus is less used in Germany than here, but though this is absent the book is full of apparatus of the greatest value and utility.

A SECOND edition of Prof. Luigi de Marchi's "Meteorologia generale" has been published by the house of Hoepli, of Milan. The book has been revised and enlarged.

A SECOND edition of the "Rural Calendar," fully revised and enlarged, has been prepared by Dr. A. J. Ewart and published by Messrs. Davis and Moughton, Ltd., Birmingham. The book is a helpful index to observations of animate nature throughout the year, and a guide to gardening and farming operations. It includes an artificial key to the commoner wild British herbs, giving description, common name, scientific name, and natural order. By using this key as plants become available, a good knowledge of common flowers may be obtained. The price of the book is one shilling net.

## OUR ASTRONOMICAL COLUMN.

STRUCTURE OF THE CORONA.—In an interesting paper published in No. 3 (1905) of the *Revue générale des Sciences*, Dr. Ch. Nordmann discusses the structural details of the solar corona and their causes. In the first place, he shows that the incurvation of the coronal rays cannot be due solely to the action of gravitation, for the angles which they make with the normals to the limb at the points of their projection are far too small for this theory.

He then shows that the "minimum" corona, which obtains at the time when the solar surface is least disturbed, simply assumes the form natural for it to assume under the action of centrifugal force, if it be granted that the particles forming the coronal streams are exactly balanced in the solar atmosphere—that is to say, if their weight is counterbalanced by the force of the light-repulsion. At times of "maximum," when the solar surface in the sun-spot (*i.e.* equatorial) region is most disturbed, the local disturbances, and their consequent convection currents, modify the action of the normal centrifugal forces, and thus produce the *abnormal* coronas observed at eclipses occurring during periods of maximum solar activity, which, although of the same general form, vary greatly in their detailed features.

RADIANT POINT OF THE BIELID METEORS.—From a number of observations of the Bielids made on November 21, 1904, Herr K. Bohlin, of Stockholm, has calculated the radiant point of the shower.

The resulting position is only about 3° from $\gamma$ Andromedæ, and has the following coordinates:—

1904 November 21·33 (Mid-European time).

$$\left.\begin{aligned}\alpha &= 26^\circ\ 2'\\ \delta &= +43^\circ\ 10'\end{aligned}\right\} 1900.$$

(*Astronomische Nachrichten*, No. 3997.)

BRIGHTNESS OF ENCKE'S COMET.—The results of a number of magnitude observations of Encke's comet, made by Herr J. Holetschek, at Vienna, during the present apparition, are published in No. 3997 of the *Astronomische Nachrichten*. The observations covered the period November 25–December 27, and, in the table wherein the results are shown, the vertical diameter, the magnitudes of the nucleus, and the magnitudes of the whole comet are given. From the last-named values we learn that on November 25 the magnitude of the comet was 9·0, on December 10, 6, and on December 23, 5·3. The value obtained on December 27 was mag. = 5·0, but this is queried.

JANUARY FIREBALLS.—A note from Mr. Denning to the *Observatory* (No. 355) shows that the appearance of fireballs during the predicted dates in January was well sustained. On January 14 a bright object was seen by several observers, and on combining the records a radiant point situated in Monoceros at 119°+3° was obtained. The height of this fireball ranged from 60 miles over Brecon to 29 miles over Aberystwith. Two fireballs were seen on January 27 and one on January 29, thus corroborating the January 28 epoch. One of those on the former date was very bright, and was apparently stationary at 118°−18°.

In February, bright fireballs were seen on February 11, 13 and 18, the time of the apparition on the last-named date being 7h. 15m. a.m., *i.e.* in daylight.

ROTATION OF JUPITER'S SATELLITES I. AND II.—During the period January 13–20, Dr. P. Guthnick, of Bothkamp Observatory, made a series of magnitude observations of Jupiter's first and second satellites, the period of observation covering about four revolutions of the former and two revolutions of the latter round the planet.

The measurements were made with a Zollner photometer attached to the 11-inch refractor. Plotting the values obtained on curves having the "anomaly" of each satellite as abscissa and the corresponding apparent magnitude as ordinate, it was seen that the period of the light-variations coincided with that of the revolution about Jupiter, and as a consequence it seems probable that the periods of revolution and rotation are coincident in each case (*Astronomische Nachrichten*, No. 4000).

ORBITS OF MINOR PLANETS.—In No. 4000 of the *Astronomische Nachrichten*, Prof. J. Bauschinger publishes the

elements of the orbits of those minor planets discovered during 1904 of which the paths have been computed at the Berlin Astronomischen Recheninstitut. The list contains the orbits of 28 minor planets, 24 (523–549) of which are referred to the epoch 1904.0, and 4 (550–553) to 1905.0, and is followed by a series of remarks which name the observations on which the computations were based, and the corrections to some of the orbits as obtained from subsequent observations. A note concerning (526) NQ says that that object is probably identical with 1901 HA.

An additional list of five asteroids discovered during November and December, 1904, and to which the permanent numbers 549–553 are now allotted, brings the total number discovered during last year up to thirty-two.

## EFFECT OF AUTUMNAL RAINFALL UPON WHEAT CROPS.[1]

BY autumn, in this note, is to be understood the period from the thirty-sixth to the forty-eighth week, both inclusive, of the year, as represented in the *Weekly Weather Report* of the Meteorological Office; it covers the months of September, October, and November, approximately. The rainfall to be referred to is the average amount in inches, for the "Principal Wheat Producing Districts," for the period mentioned, in successive years. The amounts are taken from the summaries of the *Weekly Weather Report*.

The yield of wheat is that given for successive years in the annual summaries of the Board of Agriculture and Fisheries as the average yield in bushels per acre for England, since 1884, or more strictly since 1885, as that is the first year for which the figures for England are given separately. In 1884 the figure for Great Britain, which generally differs but little from that for England, is used.

These are the only figures in the official publications which are immediately available for the purposes of comparison. The totals of rainfall for the thirteen weeks have been compiled from the weekly amounts, otherwise the figures are taken as they stand in published returns. The areas referred to are not exactly coterminous, but they are more nearly so than if the rainfall values had been taken for the whole of England, or the wheat yield for Great Britain.

When the autumn rainfall and the yields of wheat for successive years from 1884 to 1904, as thus defined, are plotted, the rainfall curve being inverted, *i.e.* rainfall being measured downward on the paper while yield is measured upward, there is a very striking similarity between the curves, so much so as to suggest that if the scales were suitably chosen the two curves would superpose and show general consonance, with exceptions, more or less striking, in a few of the years. In other words, the yield of wheat in any year seems to depend mainly on the absence of rainfall in the previous autumn, and but little on any other factor.

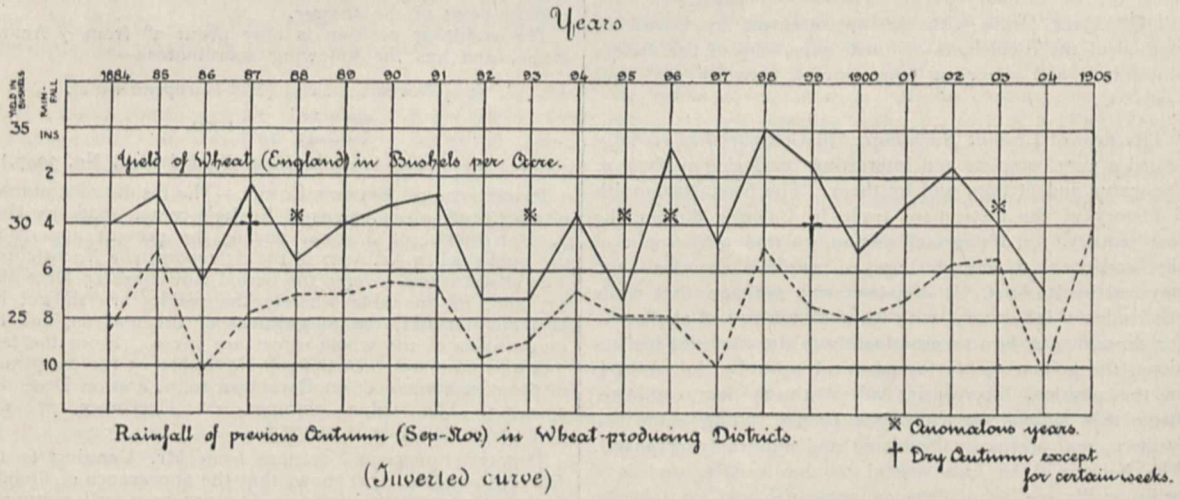
The obvious algebraical expression for such a condition as the curves represent is a linear equation, and the equation which represents the relation between yield of wheat for England and the previous autumn rainfall is :—

Yield = 39.5 bushels per acre − 5/4 (previous autumn rainfall in inches).

If we call the yield obtained from the rainfall by this equation the "computed yield," a comparison with the actual yield for the twenty-one years shows that the computed yield agrees with the actual yield within half a bushel in seven years out of the twenty-one. In fourteen years the agreement is within 2 bushels; in the remaining seven years the difference between computed and actual yield exceeds 2 bushels. The extreme variation of yield in the twenty-one years is 9 bushels, from 26 bushels per acre in 1892 and two other years to 35 bushels per acre in 1898.

Of the seven years for which the formula gives yields differing from the actual by upwards of 2 bushels, 1896 is the most conspicuous; its actual yield exceeds the computed yield by 4.5 bushels.

These seven years all show anomalous seasons. Taken *seriatim*, they are 1887, 1888, 1893, 1895, 1896, 1899, and 1903.




In 1888 and 1903 the crops were washed away by 10 inches of rain in the summer; 1893 is the year of phenomenal drought, and the crop was below the computed figure by 2.5 bushels. The years 1892 and 1899 are interesting, because though the amounts of rain were up to the average, the former had eight dry weeks and the latter ten dry weeks out of the thirteen included in the conventional autumn. They were thus dry autumns, the average amount of rainfall being made up by a few exceptionally wet weeks. The yields correspond with dry autumn values. They are above the average and above the computed figures by some 2 or 3 bushels per acre.

There remain 1895 and 1896. 1895 was the year of remarkably cold weather, and in that year the yield fell short, but in the following year the deficiency was made up by a yield as much above the computed value as the previous one fell short. It would appear that in this instance the productive power not utilised in the year of the great cold was not lost, but stored. On the other hand, it must be remarked that 1896 had the advantage of a specially dry winter.

It appears from these considerations that the dryness of autumn is the dominant element in the determination of the yield of wheat of the following year. The averages of yield and of rainfall are taken over very large areas, and it may be taken for granted that the investigation of the question for more restricted areas would introduce some

[1] "On a Relation between Autumnal Rainfall and the Yield of Wheat of the following Year.—Preliminary Note." By Dr. W. N. Shaw, F.R.S., Secretary of the Meteorological Council. Read before the Royal Society on February 2.

modification in the numerical coefficients, if not in the form of the relation.

The data for making such an investigation are not yet in an available form. A comparison has been made between autumnal rainfall for "England, East," and the average yield for the counties of Cambridge, Essex, Norfolk, and Suffolk, which shows a similar relation but a magnified effect of autumnal rainfall upon the crop, and also two exceptional years which have not yet been investigated.

## GEOLOGICAL NOTES.

FROM the Geological Survey we have received a memoir on the water supply of Lincolnshire from underground sources, with records of sinkings and borings, edited by Mr. H. B. Woodward, with contributions by Mr. W. Whitaker, Dr. H. F. Parsons, Dr. H. R. Mill, and Mr. H. Preston. In the introduction a description is given of the various geological formations with especial reference to the water-bearing strata. The bulk of the work is taken up with records of borings, among which we note particulars of a new boring in progress at Boultham for the supply of Lincoln; many records from the prolific locality of Bourn, where from one bore-hole five million gallons of water a day have been obtained; and other records from Scunthorpe, Skegness, Woodhall Spa, &c. Many analyses of water are given, and Dr. Mill contributes a useful section on rainfall, with a colour-printed map.

The Geological Survey has issued a memoir on the geology of West-Central Skye, with Soay, in explanation of sheet 70 of the geological map of Scotland. The memoir is written by Mr. C. T. Clough and Mr. Alfred Harker. The area is mainly occupied by the Tertiary igneous rocks of the Cuillin Hills, but it includes also some Torridonian rocks, and small tracts of Trias, Lower Lias, and Cretaceous. The occurrence of Cretaceous strata, probably of Upper Greensand age, is of especial interest. The Glacial and post-Glacial accumulations, the physical features and scenery are duly described. The memoir, in short, is in a handy form (pp. 59, and price 1*s*.), well suited as a guide on the ground, and as an introduction, as regards the volcanic rocks, to the larger work by Mr. Harker (lately noticed in NATURE) on the Tertiary igneous rocks of Skye.

Another memoir issued by the Geological Survey is on the geology of the country around Bridgend, being part vi. of the "Geology of the South Wales Coal-field," by Mr. A. Strahan and Mr. T. C. Cantrill, with parts by Mr. H. B. Woodward and Mr. R. H. Tiddeman. The district here described includes the Vale of Glamorgan, for the most part an area of Lias with irregular scatterings of Drift; an agricultural district, famed also for its Blue Lias lime, so well known in old times at Aberthaw, and now largely manufactured at Bridgend. The basement portions of the Lias at Sutton and Southerndown, conglomeratic in character, are duly described, as well as the littoral portions of the Keuper and Rhætic Beds. A small tract of the main coalfield enters the area, bounded by Millstone Grit and Lower Carboniferous Rocks, and the Old Red Sandstone appears in inliers. The bulk of the work is taken up with a description of the Keuper, Rhætic Beds and Lias, which furnish many points of interest.

The fifteenth report by Prof. W. W. Watts on photographs of geological interest in the United Kingdom (Brit. Assoc., Cambridge, 1904) is of a most satisfactory character. A clear profit of 130*l*. has been made. This shows that the work of collecting and storing typical photographs of geological features and phenomena, and of supplying copies to teachers and others in various parts of the world, has proved a great success, and a distinct service to geological and perhaps also to geographical science. This success is due to the indefatigable energy of Prof. Watts.

In his address to the Liverpool Geological Society, Mr. T. H. Cope took as his subject types of rock-flow in the Ceiriog valley and their analogies with river structure (*Proc.* Liverpool Geol. Soc., vol. ix., part iv.). The author points out the evidence of flow structures and other terrestrial movements in igneous and metamorphic rocks, and compares them with the known movements of water.

We have received No. 37 of vol. v. of "Spelunca" (*Bulletin* and *Mémoires* de la Société de Spéléologie). This contains a number of articles on caves and on underground waters, on prehistoric remains from caves, on the present subterranean flora, on contamination of waters, and on the use of fluorescence in detecting the flow of underground streams. A report on the sources of the water of Arcier, with special reference to the water-supply for the town of Besançon, is contributed by Prof. E. Fournier to the same periodical (No. 38), and he concludes that the supply from Arcier must at all costs be abandoned. The subject has excited much controversy owing to the fact that the probable sources of contamination through porous and fissured limestones are at a distance from the outlet of the stream at Arcier.

In the ninth report of the periodic variations of glaciers by Dr. H. F. Reid and M. E. Muret (*Arch. des Sc. phys. et nat. Genève*, xviii., 1904), the general record is one of decrease.

The records of the Geological Survey of India (vol. xxxi. part iii.) contain an article by Mr. R. D. Oldham on the glaciation and history of the Sind Valley, Kashmir, a subject illustrated by six excellent photographic views, which exhibit features produced respectively by glaciers and by rivers, and afford support to the view of the author of a diversion of the drainage since the glaciers attained their greatest dimensions.

A report on the Jammu coal-fields has been written by Mr. R. R. Simpson, mining specialist to the Geological Survey of India (*Mem.* Geol. Surv. India, vol. xxxii. part iv.). The coal-fields lie in a mountainous country, varying from three thousand to nine thousand feet above sea-level, and the strike of the coal-bearing rocks does not conform to any of the main natural features. The prospects of working the coal with profit are not considered good, in present circumstances, as the expenses would be great on account of the inclined and broken character of the rocks, the possibility of landslips, and of trouble from water. Otherwise a fairly good steam-coal may be obtained.

A geological map of Cyprus, by Mr. C. V. Bellamy, has been issued by Mr. Stanford (price 6*s*.). It is accompanied by a key or short explanation, in which the author describes the physical features and the various geological formations which range from Cretaceous to Pliocene and Pleistocene. Between the Oligocene and Pliocene there is a break, marked by the occurrence of basic igneous rocks, which have baked and altered the Oligocene (Idalian) limestones. These igneous rocks, which comprise serpentine, variolite, gabbro, &c., form a broad belt of mountainous ground in the south-central portion of the island. The map, which is produced on a scale of 5½ English miles to one inch, is printed in colours, and clearly shows the extent of the main geological divisions. It will be a useful guide to those interested in the geology, whether from a scientific or practical point of view. The economic products include building stones, marble, pottery clay, gypsum, &c.

Our knowledge of the geology of South Africa proceeds apace. We have received vol. vii., part iii., of the *Transactions* of the Geological Society of South Africa, which contains among other articles an essay by Dr. F. H. Hatch and Dr. G. S. Corstorphine on the petrography of the Witwatersrand conglomerates, with special reference to the origin of the gold. The original explanation was that the Rand conglomerates were ancient placer deposits, in which the gold was as much a product of denudation as the pebbles which accompany it. The authors show that the theory of the subsequent infiltration of the gold is most in accordance with the facts. The gold is practically confined to the matrix of the conglomerate, and occurs there in crystalline particles in association with other minerals of secondary origin.

Mr. E. Jorissen, in the same *Transactions*, deals with some intrusive granites in the Transvaal, the Orange River Colony and in Swaziland. These old granites, mostly grey in colour, penetrate the crystalline schists which are regarded as of Archæan age, but they do not intrude into the Witwatersrand series. Mr. J. P. Johnson contributes further notes on some pigmy stone implements from Elandsfontein No. 1. They are regarded as scrapers belonging to the Neolithic stage of culture.

In his address to the South African Association for the Advancement of Science (Johannesburg meeting, 1904), Dr. Corstorphine took for his subject the history of strati-

graphical investigation in South Africa, and in a table he gives the groupings successively introduced by A. G. Bain, A. Wyley and others up to those of G. A. F. Molengraaff and F. H. Hatch.

We have received from the Minister of Mines, Victoria, a diagram, compiled and drawn up by the director of the Geological Survey, Mr. E. J. Dunn, showing the yield of gold and other statistics from 1851 to 1903. The gross value of the gold is stated to be 266,945,344*l*. The greatest yield was in 1856.

We have received the annual progress report of the Geological Survey of Western Australia for 1903, by Mr. A. Gibb Maitland, Government Geologist. This includes observations on the Pibara and Murchison gold-fields, on the Arrino copper deposits, the Irwin River coal-field, &c., miscellaneous notes on minerals, including gypsum and diatomite, and notes on water supply. The report is accompanied by several maps.

The progress of vertebrate palæontology in Canada forms the subject of an essay by Mr. Lawrence M. Lambe (*Trans.* Roy. Soc. Canada, series 2, vol. x.). As he remarks, our knowledge of this life-history began when Sir William Logan, in 1841, discovered amphibian footprints in the Lower Coal-measures at Horton bluff in Nova Scotia. Since then remains of vertebrates have been found in rocks from the Silurian to the Pleistocene, and a full list is given, together with a bibliography of the subject.

In the *American Journal of Science* (December, 1904) two new species of reptiles from the Titanothere Beds (Oligocene) of Dakota, are described by Mr. F. B. Loomis. These are *Crocodilus prenasalis* and *Chrysemys inornata*. Some derived Cretaceous fossils are recorded also from the same strata, which form a part of the White River formation, and the author is led to regard the beds as of fluviatile origin.

The *American Journal of Science* for January contains an article on the submarine great canyon of the Hudson River, by Dr. J. W. Spencer. The early work of the Coast Survey brought to light a depression extending from near New York to the border of the continental shelf, and J. D. Dana was the first to recognise this feature as the submerged channel of the Hudson River, formed when the continent stood at a greater altitude above the sea than it does now. Later on, Prof. A. Linden Kohl discovered that the channel became suddenly transformed into a canyon near the continental border, reaching to a depth of 2400 feet below the surface of the submerged plain, which was then about 400 feet beneath sea-level. Following on to these observations, Dr. Spencer has pointed out that the channel was traceable to much greater depths—the canyon section having sunk from 6000 to 7000 feet, and the valley beyond to 9000 feet. He maintains that the period of great elevation coincided with the early Pleistocene. Since then there has been a subsidence to somewhat below the present level, followed by a re-elevation of 250 feet, as seen in the shallow channels of the shelf.

The *American Journal of Science* for February contains an important essay on the isomorphism and thermal properties of the feldspars, by Mr. Arthur L. Day and Mr. E. T. Allen. To the same journal Dr. Albrecht Penck contributes an interesting article on climatic features in the land surface, and indicates how the features of past as well as present climates may be discerned. Instances are seen in areas that were formerly covered by ice and are now exposed to river action. They are seen in desert regions, as in those of the Great Salt Lake and of the Sahara, where ancient shore lines and old river valleys have been traced. In some mountain areas evidence of river action, preceding glacial action, has been noticed. Dr. Penck points out that a study of the oscillations in the situation of the climatic belts of the earth is fraught with interest, and that observations on the erosional forms of rocks and on the corresponding deposits derived from them assist in the interpretation of climatic conditions.

In the *Bulletin* from the Laboratories of Natural History of the State University of Iowa (vol. v., No. 4) there is a series of papers on the loess by Prof. B. Shimek. The loess of Natchez and of the lower Mississippi valley is of special interest, inasmuch as in that region loess was first recognised in America by Lyell in 1846. The researches of the author afford arguments against both the aqueous and glacial-theories of its origin. The characteristic fossils are terrestrial upland species of land snails. Even the extremely delicate shells of snails' eggs are preserved in the loess. Natchez lies far south of the limits of glaciation, and the molluscan fauna does not support the notion of a glacial climate. The æolian theory offers the best explanation. The discovery of human remains in a deposit regarded as loess near Lansing, in Kansas, is discussed, and Prof. Shimek concludes that the deposit is not loess, but a talus. Considering, again, the relations of loess to the Iowan drift, the author points out that there were several periods of loess formation, inter-Glacial and post-Glacial. Far beyond the border of the newer drift sheets, however, the sharp lines of distinction between the successive accumulations disappear, and there the deposits of loess probably represent the combined accumulation of several inter-Glacial and later drift periods. The essays are illustrated by pictorial views and figures of the mollusca. In another article Mr. F. J. Seaver describes and illustrates the Discomycetes of eastern Iowa.

The "Materials and Manufacture of Portland Cement," by Mr. E. C. Eckel, with an essay on the cement resources of Alabama, by Mr. E. A. Smith, form the contents of *Bulletin* No. 8, Geological Survey of Alabama. In that State there is found an extensive series of limestones capable of furnishing material for the manufacture of Portland cement, while clays and shales necessary to complete the mixture are abundant.

In an article on the genesis of the magnetite deposits in Sussex Co., New Jersey (*Mining Magazine*, December, 1904), Mr. Arthur C. Spencer concludes that they are connected in origin with intrusive dioritic pegmatites. To the same magazine Mr. W. H. Heydrick contributes a paper on the physical and commercial conditions of the Kansas oil-fields. The area extends over more than ten thousand square miles. In 1889 the yield was 500 barrels of oil, while in ten months during 1904 the yield was more than four million barrels.

A reconnaissance in Trans-Pecos Texas, by Mr. G. B. Richardson (Univ. of Texas, Mineral Survey, *Bulletin* No. 9), was undertaken mainly to determine the conditions of occurrence of underground water. The author was enabled, however, to make general observations on the successive formations from the pre-Cambrian to the Cretaceous and Quaternary, and on the occurrence of coal, salt, petroleum, and sulphur. The presence of underground water was found to be widespread, but in a number of places the wells contain much gypsum and other salts. The report is accompanied by a geological map and pictorial views.

Some account of the exploration of the Potter Creek Cave in California, is given by Mr. W. J. Sinclair (Univ. of California Publications, *Amer. Archaeol. and Ethnol.*, vol. ii., No. 1). The cave is about one mile south-east of the United States fishery station at Baird, on the McCloud River, and it lies in a belt of carboniferous limestone at an elevation of 1500 feet above sea-level, and about 800 feet above the river-level at the mouth of Potter Creek. Remains of various vertebrate animals were obtained from fan-like deposits of earth and stalagmite-cemented breccia, which formed the floor in a large chamber, above which there were vertical chimney-like openings. With the exception of the stalagmitic growths and fallen blocks, the entire cave deposit was brought in through the vertical chutes. Apart from fragments, more than 4600 determinable specimens were collected of dissociated limb bones, jaws, and teeth. Complete skeletons were not common. Associated parts of the skeletons of squirrels and wood-rats, of a snake (Crotalus), and a bat were found; also several complete limbs of *Arctotherium simum*, remains of Megalonyx, Mastodon, *Elephas primigenius*, and a new genus named Euceratherium, a member of the cavicorn division of Artiodactyla, which combines characters of several groups. Of the fifty-two species listed, twenty-one belong to extinct forms. No human remains were found, but some very doubtful "implement-like bone fragments" are described and figured. The cave-fauna is older than the Glacial period in California, and it is remarked that the 1500 foot contour marks approximately the present elevation of an earlier valley stage beneath which the existing cañons are trenched.

## *FORTHCOMING BOOKS OF SCIENCE.*

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In Messrs. A. and C. Black's list we notice :—" The Metaphysics of Nature," by Carveth Read, and a " Treatise on Zoology," edited by Dr. E. Ray Lankester, F.R.S., part v., " Mollusca."

The announcements of the Cambridge University Press include :—" The Lands of the Eastern Caliphate," by G. Le Strange ; " Trees, vol. iii., Inflorescences and Flowers," by Prof. H. Marshall Ward, F.R.S. ; " The Origin and Influence of the Thorough-bred Horse," by Prof. W. Ridgeway ; " The Plague," by Dr. W. J. Simpson ; and " Immunity in Infectious Diseases," by Prof. E. Metchnikoff, authorised English translation by F. G. Binnie, illustrated.

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## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An Arnold Gerstenberg studentship will be offered for competition in the Michaelmas term of 1906. The studentship will be awarded by means of essays. Every candidate must send on or before October 1, 1906, an essay on one of the subjects printed below addressed to Dr. James Ward, Trinity College. The studentship, which will be of the annual value of nearly 90*l.*, will be tenable for two years, upon the condition that at the end of the first year the student's progress in philosophical study is deemed satisfactory by the board of managers. The subjects for essays are :—(1) a philosophical discussion of the doctrine of energy and particularly of the new theory of energetics; (2) a critical examination of Descartes' philosophy of nature; (3) the relation of mathematics and the theory of probability to physics; (4) the theory of psychophysical parallelism; (5) the scope and methods of comparative psychology; (6) the philosophical import of post-Darwinian theories of natural selection.

The principal and the professors at McGill University, Montreal have nominated Mr. L. V. King, a student in the faculty of arts, to the Canadian scholarship lately established at Christ's College.

An exhibition of 50*l.* a year tenable for two years is offered by the governing body of Emmanuel College to an advanced student commencing residence at the college in October, 1905. Applications should be sent to the master of Emmanuel (from whom further particulars may be obtained) not later than October 1.

The local examinations and lectures syndicate is about to elect an assistant secretary for the department of the local lectures. The appointment will be in the first instance for one year. The stipend will be 150*l.* in an ordinary year, and 200*l.* in those years in which summer meetings are held. Graduates of the university who desire to offer themselves as candidates are requested to send their names before May 8 to the Rev. D. H. S. Cranage.

THE London School of Tropical Medicine has been admitted as a school of the University of London in the faculty of medicine in tropical medicine only.

The committee of the Liverpool School of Tropical Medicine has appointed Mr. R. T. Newstead lecturer in economic entomology and parasitology.

THE fourth annual students' soirée of the Sir John Cass Technical Institute will be held in the institute, Jewry Street, Aldgate, E.C., on Saturday, March 18. Exhibits and demonstrations referring to the work of the various departments form part of the programme.

IT is reported, says *Science*, that Mr. Andrew Carnegie has offered to give 100,000*l.* to the University of Virginia on the condition that the authorities of the institution raise a similar amount from other sources, and that the late James C. Carter, the eminent New York lawyer, has bequeathed 40,000*l.* to Harvard University. *Science* also states that at the first of the winter convocations of the George Washington University a gift of property, estimated to be worth 20,000*l.*, was announced for the establishment of a chair and course of graduate study on the history of civilisation. Various sums of money raised by the trustees and alumni association, aggregating 55,000*l.*, were also announced.

A COMMISSION was appointed a few years ago to inquire into the condition of manual and practical instruction in Irish primary schools, and, as the result of the recommendations made by this Commission, instruction in elementary experimental science was introduced into the primary schools of Ireland. The results of this teaching have, in the opinion of competent authorities, been in every way satisfactory. Not only has the educational value of experimental science again been demonstrated, but its beneficial effects on the progress of Ireland's industries and agriculture have been made clear. Notwithstanding the success which naturally has followed the introduction of practical instruction in scientific principles into Irish elementary schools, the Treasury has refused to renew the small grant required to meet the necessary expenditure, and the work of organising science instruction in the schools—after four years—is being stopped. It is difficult indeed to understand so retrograde a policy. The incompleteness of all schemes of education which ignore the claims of practical instruction in the fundamental facts of science has been demonstrated repeatedly; the connection between American and German industrial success and the scientific systems of education established in these countries has become familiar to all interested in their country's welfare, so that no excuse—not even the urgent need of economy in national expenditure—can justify this action of the Treasury. It is to be hoped earnestly that steps may yet be taken to avert what would be nothing short of a calamity to Ireland, and that the work, which has begun so auspiciously under the present organisers of science instruction, instead of being stopped may be broadened and extended.

IT is stated in the *Times* that the committee, presided over by Mr. Haldane, M.P., appointed to consider the allocation of the increased grant-in-aid of education of a university standard in arts and science has now finished its inquiry. Excluding 9000*l.* to be allotted later in the financial year, the committee proposes that the sum of 45,000*l.* (making a total grant of 54,000*l.*) be allotted as follows :—Manchester, 6000*l.*; University College, London, 5000*l.*; Liverpool, 5000*l.*; Birmingham, 4500*l.*; Leeds, 4000*l.*; King's College, London, 3900*l.*; Newcastle-on-Tyne, 3000*l.*; Nottingham, 2900*l.*; Sheffield, 2300*l.*; Bedford College, London, 2000*l.*; Bristol, 2000*l.*; Reading, 1700*l.*; Southampton, 1700*l.*; Dundee, 1000*l.* The committee expresses the view that the time has come for making a new departure in the principle on which State assistance is to be given to the highest education. It is recommended that a moderate sum should be set aside for distribution by way of payment to post-graduate students from the university colleges who devote themselves for one, two, or three years to special problems; and that to ensure the money being applied most efficiently to the stimulation of individual study, as distinguished from the general purposes of the college to the development of which other sums out of the grant are directed, the distribution should assume the form of a grant made directly to the student on the advice of some impartial authority. It is also suggested that the grant-in-aid should in future be made to a committee, instead of to the colleges direct, and that this committee should make an annual report to the Treasury, to be laid before Parliament. In conclusion the committee urges the necessity of leaving to the advisory committee discretion to deal with particular circumstances as they arise.

## SOCIETIES AND ACADEMIES.

LONDON.

**Royal Society**, February 9.—" On the Stellar Line near λ 4686." By Sir Norman **Lockyer**, K.C.B., F.R.S., and F. E. **Baxandall**, A.R.C.Sc.

In this paper the authors direct attention to a well-marked line of unknown origin which appears in one of the Kensington photographs of the helium spectrum near λ 4686.

It is shown that a conspicuous line near the same wave-length occurs in the spectra of the chromosphere, nebulæ, bright-line stars, certain Orion stars, and in ζ Puppis, the star the spectrum of which was found by Prof. Pickering to contain a new series of lines which he considered to belong to hydrogen.

The mean wave-length of the stellar line, as derived from the available published records, is shown to agree very closely with the wave-length of the line in the laboratory spectrum, and the authors conclude that the identity of the two lines is probably a real one.

Rydberg has shown that the line near λ 4686 is the first line in the principal series of hydrogen, and the authors of the present paper consider that the " strange " line in

the helium spectrum is probably none other than the same line. They can, however, assign no reason for its appearance in only one of the numerous photographs of the helium spectrum taken at Kensington.

"Note on the Spectrum of $\mu$ Centauri." By Sir Norman **Lockyer,** K.C.B., F.R.S., and F. E. **Baxandall,** A.R.C.Sc.

In this note the authors give an analysis of some of the bright lines in the spectrum of $\mu$ Centauri. This star not being available at Kensington, an excellent reproduction by Prof. Pickering was used as a basis for the analysis.

The chief bright lines belong to hydrogen, as Pickering and other observers have pointed out. The minor bright lines, however, have hitherto had no origin suggested for them. In this note it is shown that the most marked of the minor bright lines agree very closely in position with the strongest enhanced lines of iron, and the authors conclude that the stellar and terrestrial lines are probably identical in origin. It is pointed out that the same lines are conspicuous in the spectra of Novæ in their earlier stages.

"The Arc Spectrum of Scandium and its Relation to Celestial Spectra." By Sir Norman **Lockyer,** K.C.B., F.R.S., and F. E. **Baxandall,** A.R.C.Sc.

In this paper a record is given of the lines in the arc spectrum of the rare element scandium between $\lambda$ 3900 and $\lambda$ 5720. The photograph used for reduction was taken with a large Rowland concave grating, having a ruled surface of $5\frac{3}{4} \times 2$ inches ($14\frac{1}{2} \times 5$ cm.) and a radius of 21 feet 6 inches. The scale of the photograph is such that the distance between K and D is $30\frac{1}{4}$ inches, or 77 cm. This is equivalent to 2·6 tenth-metres per millimetre.

An analysis of the lines is given with regard to their appearance in the Fraunhoferic spectrum. It is shown that nearly all the stronger lines occur as solar lines, but the great majority of the lines weaker than intensity 6 (maximum intensity 10) are missing from the solar spectrum.

Short analyses are also given of the relation of the scandium arc lines to the lines in the spectra of the chromosphere, sun-spots, and stars. The strongest scandium lines are shown to be specially prominent in the chromospheric spectrum, the same lines being conspicuous in stellar spectra of the Polarian type (*e.g.* $\gamma$ Cygni). In the higher stellar type Cygnian ($\alpha$ Cygni), the strongest scandium lines are present, but only weak. At the still higher stages of stellar spectra the scandium lines are lacking.

With regard to sun-spot spectra, the only solar-scandium line ($\lambda$ 5672·047) given by Rowland in the region F to D, is found to be nearly always well affected, and it often occurs amongst the twelve most widened lines recorded at Kensington in spot spectra.

"On Europium and its Ultra-violet Spectrum": Sir William **Crookes,** F.R.S.

Exner and Haschek have measured the wave-lengths of the europium lines[1] from material supplied by Demarçay. A comparison of their lines with the present author's shows that the material was by no means pure. Urbain's europia is not quite so free from impurities as his gadolinia. The author has been able to detect in his photographs the following lines:—Gadolinium is represented by very faint lines at 3450.55, 3481.99, 3585.10, 3646.36, 3654.79, 3656.32, 3664.76, 3697.90, 3699.89, 3743.62, 3768.52, 3796.58, 3805.70, 3850.83, 3851.16, 4050.08, 4225.33. Yttrium is represented by the line at 3774.51, lanthanum by the line at 3988.66, and calcium by the two lines at 3933.825 and 3968.625.

February 9 and February 23.—"Phosphorescence caused by the Beta and Gamma Rays of Radium." By G. T. **Beilby.** Communicated by Prof. Larmor, Sec. R.S. Part i. read February 9, part ii. read February 23.

The conclusions arrived at in these papers may be summarised as follows:—

(1) Certain types of phosphorescence are due to the molecular movement or displacement which is produced by heat, by mechanical stresses, or by radiant energy.

(2) Certain other types are distinguished by their appearance in three stages, called here primary, secondary, and revived phosphorescence. These can be explained as due to atomic changes in which chemical affinity is the controlling factor.

(3) The phenomena of this type appear to support the view that a species of electrolysis occurs in solids exposed to the $\beta$ or kathode rays; that the products of electrolysis are insulated from each other, as in a viscous electrolyte; and that it is the breaking down of this insulation with the re-combination of the ions which causes revived phosphorescence.

When the canary-yellow crystals of barium platinocyanide are exposed to the $\beta$ and $\gamma$ rays for some hours, they turn red, and their phosphorescence in the rays falls to 8 per cent. of its original value. Neither the colour nor the phosphorescence is restored by exposure to sunlight or to diffused daylight. The only way completely to restore these qualities is to dissolve the salt in water and re-crystallise it. In this way the reddened salt is completely re-converted into the yellow form, and there are no signs that the reddening has been associated with any permanent chemical change. The possible physical changes were, therefore, investigated. When the crystalline structure of the yellow salt is impaired, either by mechanical flowing or by dehydration by heat, there is a very conspicuous colour change, the canary-yellow giving place to an intense brick-red colour, while the phosphorescence in the radium rays falls to 2 per cent. of its original value. By solution and crystallisation these amorphous forms are restored to the yellow crystalline state with its full phosphorescent value. The effects produced by the $\beta$ rays are, therefore, closely analogous to those produced by the change from the crystalline to the amorphous state. In the light of the author's earlier observations on the phase changes A$\rightleftarrows$C in metals and salts, it was to be expected that the change C$\rightarrow$A, produced by mechanical flow, would be reversed by raising the temperature of the substance to the stability point of the A phase. Making due allowance for the difficulty caused by the presence of water of crystallisation and its partial loss on heating the salt, it was found that the change A$\rightarrow$C could be brought about in the mechanically-flowed salt at a temperature of about 90°, the colour being thereby changed from red to yellow, and the phosphorescence raised from 2 per cent. to 33 per cent. of its original value. It was found that the crystals reddened by the rays could also be partially restored to their former condition of colour and phosphorescence by quickly heating them in a sealed capillary tube to about 120°. By this treatment the phosphorescence was raised from 8 per cent. to 33 per cent, of its original value in the yellow crystals. The analogy between the phase changes caused by mechanical flow and the change which results from exposure to the $\beta$ rays is thus complete, and it is concluded that the over-stimulation to which the vibrating molecules of the platinocyanide crystals are subjected under the action of the $\beta$ rays during the preliminary stage of bright phosphorescence results in a state analogous to that of elastic fatigue in vibrating metal wires or glass fibres. Up to a certain point, this fatigue may be recovered from, that is to say, if the relative displacement of the molecules from their proper crystalline relations has not passed beyond a certain stage; but beyond this stage there is no power of self-recovery, and heat is necessary to endow the molecules with freedom of movement sufficient to enable them to return to their crystalline positions. The final stage of permanent fatigue or over-strain in the salt corresponds with the amorphous condition which results from mechanically-produced flow. The comparative instability of the crystalline structure in this salt has thus been the means of directing attention to the part which may be played by physical structure in phosphorescence. But the persistence of phosphorescence, even in the amorphous state, gives an equally clear indication that a more general explanation of these phenomena is still needed.

This further explanation was reached by a study of the action of the $\beta$ and $\gamma$ rays on quartz, glass, calcspar, and the haloid salts of potassium. In these substances, in addition to a primary phosphorescence, the rays produce certain well-marked coloration effects; quartz is turned brown, calcspar faint yellow, glass purple or brown, potassium chloride reddish-violet, and bromide and iodide blue to green. Further, whether the coloration lasts for months or only for a few moments, it is found that phosphor-

[1] "Wellenlängen-Tabellen für Spektralanalytische Untersuchungen," F. Deuticke. (Leipzig and Vienna, 1902.)

escence is revived when the substance is heated, while the colour fades or disappears. In quartz, glass, and calcspar it is easy to locate the seat of phosphorescence within the layers which have been penetrated and coloured by the rays. This penetration may take place to the depth of several millimetres, and in materials like quartz, glass, or calcspar it is certain that whatever changes occur in these layers must be chemically self-contained and quite removed from atmospheric influences. The view, therefore, that coloration is due to the reduction of one of the elements of the substance, *e.g.* potassium in glass, affords only a partial explanation of the phenomena. It is necessary to suppose that the separation and retention of the metal ions must equally involve the separation and retention of the ions of the acid radicle with which the metal had been combined. Further, in order that the different ions may be kept apart, the unaltered molecules must act as barriers or insulators to prevent their re-combination. But the molecules are not always immovable barriers, for, as the temperature is raised, their mobility is increased, and their insulating power is correspondingly diminished. Experiments were made on the storage of latent phosphorescing power at all temperatures between $-100°$ and $+300°$. While for each substance there is a range of temperature over which its storage capacity is at a maximum, yet the range over which storage can take place is sometimes very wide. In calcspar, storage occurs over the whole range investigated, while in crystallised platinocyanide of barium it was only observed between $-100°$ and $-50°$.

February 16.—"Polarised Röntgen Radiation." By Dr. Charles G. **Barkla.** Communicated by Prof. J. J. Thomson, F.R.S.

Experiments on secondary radiation from gases and light solids subject to X-rays led to the theory that during the passage of Röntgen radiation through such substances each electron has its motion accelerated by the intense electric fields in the primary pulses, and consequently is the origin of a secondary radiation which is most intense in the direction perpendicular to that of acceleration of the electron, and vanishes in the direction of that acceleration. The direction of electric intensity at a point in a secondary pulse is perpendicular to the line joining that point and the origin of the pulse, and is in the plane passing through the direction of acceleration of the electron.

A secondary beam the direction of propagation of which is perpendicular to that of the primary will, according to this theory, be plane polarised, the direction of electric intensity being parallel to the pulse front in the primary beam. If the primary beam be plane polarised, the secondary radiation from the electrons has a maximum intensity in a direction perpendicular to that of electric displacement in the primary beam, and zero intensity in the direction of electric displacement.

In these experiments the secondary radiation from light substances was too feeble to allow accurate measurement of the intensity of the tertiary radiation.

A consideration of the method of production of primary Röntgen rays in an X-ray tube, however, leads one to expect partial polarisation of the primary beam proceeding from the antikathode in a direction perpendicular to that of propagation of the impinging kathode rays, for there is probably at the antikathode a greater acceleration along the line of propagation of the kathode rays than in a direction at right angles; consequently, in a beam of X-rays proceeding in a direction perpendicular to that of the kathode stream, there should be greater electric intensity parallel to the stream than in a direction at right angles.

Using such a beam as the primary radiation, and a light substance, as air, paper, or aluminium, as the radiator, the intensity of a secondary beam as indicated by an electroscope was found to reach a maximum when the direction of the kathode stream was perpendicular to that of propagation of the secondary beam, and a minimum when these two were parallel.

A number of experiments made this evidence of partial polarisation of the primary radiation conclusive.

When heavier metals, such as copper, tin, and lead, which emit a secondary radiation differing considerably in character from the primary producing it, were used as the radiators, no variation in intensity of secondary radiation was observed as the bulb was rotated, though experiments were made with primary radiations varying considerably in penetrating power.

**Geological Society,** February 17.—Dr. J. E. Marr, F.R.S., president, in the chair.—Annual general meeting.—In his anniversary address, the president directed attention to the classification of the sedimentary rocks, pointing out that the arrangement of the events which, taken together, constitute earth-history, according to their proper sequence in time must ever remain the territory of the geologist in which he will pursue his labours by exclusively-geological methods. He pointed out that, since the time of William Smith, and mainly by the adoption of his principles, the classification of the strata had progressed towards perfection by the method of successive approximations. He directed attention to the many similarities between the records of the geological column and the records preserved in the "meteorograms" of meteorologists. In each case the records were impressed as zigzag and broken lines, though an additional difficulty occurred in the case of the geological records owing to their frequently-blurred nature. Further, the meteorologist had his chronometer, whereas the geologist must construct his time-scale from the records on what might, for purposes of comparison, be referred to as the "geograms," or strips of the geological sediments. In some cases the lines of the geograms closely coincided with time-lines, in other cases they departed therefrom more or less widely, and it was one of the tasks of the geologists, from study of the geograms, to attempt to draw in the time-lines. It was to be remembered, however, that however closely the time-lines and lines of the records coincided, they were not the same lines. The principal variations in the records of the geograms are due to alternate formation and cessation of deposit; to the differences in character of the deposits owing to various local conditions; to accumulation of contemporaneous volcanic material; to variations in the nature of the earth-movements; to changes in the nature of the included organisms; and lastly to climatic changes, and proceeded to consider the significance of these records as bearing upon the classification of the sediments. The president advocated the adoption of a triple classification, such as had been already tacitly adopted in the case of some of the sediments, as, for instance, those of Jurassic age, where divisions were made according to (1) lithological change, (2) organic change, and (3) time; and pointed out how such a classification could be adopted without any violent changes in an existing nomenclature or in the rules of priority. He illustrated the suggested changes by a more detailed discussion of the classification of the Ordovician strata, and pointed out that we had names which might be used with chronological significance in the case of the divisions of the rocks of most of the great systems; and maintained that, as our knowledge increased, we could refer beds of new areas to their places among the different series, marking periods of time with a confidence similar to that with which we have long assigned strata of remote regions to one or other of the great systems.

February 22.—Dr. J. E. Marr, F.R.S., president, in the chair.—Exhibition of a series of Danish rocks illustrating (1) the share that Echinoderms may take in rock-building; (2) the transition from the Secondary to the Tertiary Era in the Baltic basin near Denmark; (3) the special conditions at the close of the Glacial Period, in the limited area where alone these rocks are now found as erratic blocks: Dr. F. A. **Bather.**—On the order of succession of the Manx slates in their northern half, and its bearing on the origin of the schistose breccia associated therewith: Rev. J. F. **Blake.**—On the wash-outs in the Middle Coal-measures of south Yorkshire: F. E. **Middleton.** The opinion of the author is that the wash-outs occupy the sites of winding streams, meandering through the alluvial tracts in which the coal-seams were being formed.

**Zoological Society,** February 21.—Mr. Howard Saunders, vice-president, in the chair.—A contribution to our knowledge of the varieties of *Lacerta muralis* in western Europe and North Africa: G. A. **Boulenger.**—The Nigerian giraffe (*Giraffa camelopardalis peralta*) and the Kilimanjaro Giraffe (*G. camelopardalis tippelskirchi*): R. **Lydekker.**—Dolphins from Travancore: R. **Lydekker.** In this paper the author made special reference to two specimens of the genus

Tursiops, drawings and particulars of which had been supplied to him from the Trevandrum Museum.—A second collection of mammals made by Mr. C. H. B. Grant for Mr. C. D. Rudd's exploration of South Africa: Oldfield **Thomas** and Harold **Schwann.** The collection, which has been presented to the National Museum by Mr. Rudd, was made in the Wakkerstroom district of the South-eastern Transvaal, and includes examples of twenty-six species. Several local subspecies were described, besides a new shrew from Zululand.—The greater kudu of Somaliland: R. I. **Pocock.** The author pointed out that the northern form of *Strepsiceros strepsiceros* differed from the southern in having only about five white stripes instead of nine or ten on each side of the body. The northern form should thus rank as a distinct subspecies, for which the name *chora* was available. The difference in coloration seemed to be correlated with a difference of habitat, the northern form frequenting more mountainous and less thickly-wooded country than the southern, which was frequently found in the thick jungle along river-banks as well as in the hills.

**Anthropological Institute**, February 28.—Prof. W. Gowland, president, in the chair.—Group marriage, with especial reference to Australia: N. W. **Thomas.** In the course of his remarks the author pointed out that the theories of Lewis Morgan were without sufficient basis. In the place of Lewis Morgan's fifteen stages, later theorists had postulated first a period of promiscuity, and following on that group marriage, so-called, which in Australia is only now being transformed into individual marriage. But here too no sufficient account had been given of the causes which led to the abolition of promiscuity. The grounds on which it was assumed that promiscuity and group marriage were stages in human development were first philological and secondly sociological. The philological grounds were shown in the paper to be wholly insufficient, and the facts of present-day Australian life to be susceptible of other explanations.

**Chemical Society**, March 2.—Prof. W. A. Tilden, F.R.S., president, in the chair.—The following papers were read:—The relation between natural and synthetical glycerylphosphoric acids: F. B. **Power** and F. **Tutin.** The authors have shown that the discrepancies of statement respecting the properties of the glycerylphosphates are due to contamination with salts of the di-ester. They have prepared and analysed a number of these salts in pure condition. Proof is also adduced that the conclusions of Willstätter and Lüdecke that the differences between the salts of natural (derived from lecithin) and artificial glycerylphosphoric acids are not those existing between mere optical isomerides are not justified.—The transmutation of geometrical isomerides: A. W. **Stewart.** The author assumes as a phase of the reaction the formation and disruption of a tetramethylene compound, which in the case of fumaric and maleic acids would be tetramethylene-1 : 2 : 3 : 4-tetracarboxylic acid, and this by disruption in two different directions would give rise to either fumaric or maleic derivatives. Illustrations of the applicability of this explanation to other cases are also given.—Linin: J. S. **Hills** and W. P. **Wynne.** Linin, $C_{23}H_{24}O_9$, a crystalline substance obtained by hydrolysis of a glucoside present in *Linum catharticum*, melts at 203°, contains four methoxyl groups, and is physiologically inactive.—The constitution of phenylmethylacridol: J. J. **Dobbie.** Hantzsch's view that the substance formed when phenylacridine methiodide is treated with an alkali is a carbinol is confirmed by the fact that the absorption spectra are different from those of the parent methiodide, and similar to those of dihydrophenylacridine.—The ultra-violet absorption spectra of certain diazo-compounds in relation to their constitution: J. J. **Dobbie** and C. K. **Tinkler.**—The latent heat of evaporation of benzene and some other compounds: J. C. **Brown.**—The reduction of *iso*phthalic acid: W. H. **Perkin,** jun., and S. S. **Pickles.** When *iso*phthalic acid is reduced with sodium amalgam at 45° it yields two tetrahydro-acids, $\Delta^2$ and *cis*-$\Delta^5$, and from these two others may be obtained, so that the four possible tetrahydro*iso*phthalic acids have now been prepared. The properties and reactions of these are described.—The influence of temperature on the interaction between acetylthiocyanate and certain bases. Thiocarbamides, including carboxy-aromatic groups: the late R. E. **Doran** (compiled by A. E. Dixon).—The influence of solvents on the rotation of optically active compounds. Part viii. Ethyl tartrate in chloroform: T. S. **Patterson.**—A further note on the addition of sodium hydrogen sulphite to ketonic compounds: A. W. **Stewart.**—Action of hydrogen peroxide on carbohydrates in presence of ferrous sulphate: R. S. **Morrell** and A. E. **Bellars.** In this work attempts have been made to trace the disappearance of different sugars by optical measurements during oxidation, and from the initial and final reducing powers of the solutions. The simpler acids, formic and oxalic, resulting from the oxidation, were detected, but the more important keto-acids could not be isolated, though evidence of their presence was obtained.—Studies in chlorination. The chlorination of the isomeric chloronitrobenzenes: J. B. **Cohen** and H. G. **Bennett.** It is shown that when the first two hydrogen atoms of benzene or toluene have been substituted either by two chlorine atoms or by one chlorine atom and one nitro-group the positions occupied by subsequent chlorine atoms or nitro-groups are the same.

**Linnean Society**, March 2.—Prof. W. A. Herdman, F.R.S., president, in the chair.—The Ashe-Finlayson "Comparascope": D. **Finlayson.** The instrument displays two objects in the same magnified field, this being attained by a secondary stage and objective at right-angles to the primary instrument, the rays being transmitted up the body of the microscope through a right-angled prism, and clearness of the two images preserved by means of a diaphragm placed longitudinally in the microscope-tube.—Zoological nomenclature: international rules and others: Rev. T. R. R. **Stebbing.** The author's paper, introductory to a discussion, insisted on the paramount importance of obtaining agreement among zoologists on this subject. Incidentally, Mr. Stebbing ventured to ask whether there were not many rules of nomenclature on which it would be satisfactory and advisable for zoologists not only to agree among themselves, but also to come to terms with their botanical colleagues. In this regard he offered some remarks in favour of adopting the year 1751 and the "Philosophia Botanica" as starting-point and basis for what might be called the Linnean era. A section of the paper was devoted to the "Nomenclator Entomologicus" of F. Weber, published in 1795, with the object of showing that the generic names in that catalogue are without value in questions of priority. While consigning various smaller details to an appendix, the body of the paper concluded with a proposal to get rid of tautonymy (as in *Trutta trutta, Apus* (*Apus*) *apus,* or other comical arrangements) by a plan distinguishing what was legal in the past from what is to be legal in the future.—Biscayan plankton collected by H.M.S. *Research* in 1901, part ii., Thaliacea: Dr. G. Herbert **Fowler.**

**Mathematical Society**, March 9.—Prof. Forsyth, president, and temporarily Dr. Hobson, in the chair.—The following papers were communicated:—On the projection of two triangles on to the same triangle: Prof. M. J. M. **Hill,** Dr. L. N. G. **Filon,** and Mr. H. W. **Chapman.** A construction is given for projecting two given triangles on to the same third triangle when the plane of the latter is given, and this construction makes it possible to determine the projective relation between two planes when four points in the one and the four corresponding points in the other are given. The lines joining corresponding vertices of the two given triangles are generators of one system of a regulus, and the possible points of projection when both are projected on to the same triangle lie on a generator of the other system. As this line describes the regulus, the locus of the point in the plane of the second triangle which corresponds to a given point in the plane of the first triangle is a cubic curve with a double point. A construction for the points of the cubic is obtained.—The Weddle quartic surface: H. **Bateman.** The surface is the locus of pairs of points which are conjugate with regard to all quadrics passing through six given points. Any chord of the twisted cubic which passes through the six given points is cut harmonically by the surface. This result leads to a parametric representation of the points of the surface. The reciprocal of the surface belongs to a family of surfaces, described by Darboux, which possess conjugate systems of plane curves.—On the complete reduction of any transitive permutation group, and on the arithmetical nature of the

coefficients in its irreducible components: Prof. W. **Burnside.** The first part of the paper contains a determination of the number of times that any given irreducible component occurs, when any representation of a group of finite order as a transitive permutation group is completely reduced. The second part of the paper is occupied with the actual reduction of the permutation group. The reduction takes two forms according as the domain of rationality is defined by the characteristics, or by the roots of unity of which the characteristics are functions.—On the theory of the logarithmic potential: Prof. T. J. I'A. **Bromwich.** The paper is occupied with the conditions for the existence of the second differential coefficients of the potential within an area carrying surface-density, and of the first differential coefficients of the potential on a curve carrying line-density. At a corner of the area in the first case, or of the curve in the second, the differential coefficients in question do not exist unless the axes of coordinates have certain special directions.—Alternative expressions for perpetuant types: P. W. **Wood.**—An informal communication on the theory of geodesics was made by Prof. **Forsyth.**

CAMBRIDGE.

**Philosophical Society,** February 27.—Mr. F. H. Neville in the chair.—Soluble forms of metallic dihydroxytartrates: H. J. H. **Fenton,** F.R.S. Sodium dihydroxytartrate is remarkable for its very sparing solubility in water, and it has previously been shown by the author that this property may be made use of for the qualitative and quantitative estimation of sodium. When equivalent quantities of dihydroxytartaric acid and sodium ethylate are mixed in alcoholic solution a semi-transparent gelatinous precipitate is obtained which is altogether unlike the salt above mentioned and is extremely easily soluble in water. Its aqueous solution after standing for a few minutes deposits a white, crystalline precipitate of the sodium salt in its ordinary hydrated form. The calcium salt shows a similar behaviour, and it would appear that the ordinary metallic dihydroxytartrates must be regarded as derivatives of a hydrated form of the acid $C_4H_6O_8$.—Studies on unsaturated ketonic compounds: S. **Ruhemann.** The author has continued his researches on the combination of mercaptans with unsaturated ketones (see *Trans.* Chem Soc., 1905, lxxxvii., 17). In the light of previous researches, an explanation is given of the catalytic action of organic bases in the formation of additive products of mercaptans with unsaturated ketonic compounds.—Some compounds of guanidine with sugars: R. S. **Morrell** and A. E. **Bellars.** The addition of guanidine to a solution of any sugar in absolute alcohol causes a precipitate of an addition product of the sugar and the base. The compounds are only slightly hydrolysed in aqueous solution, but they are easily decomposed by acids. Their optical properties are peculiar; in some cases the rotation angle is opposite in sign to that of the parent sugar, in others there is a marked multi-rotation.—The influence of strong electromagnetic fields on the spark spectra of some metals: J. E. **Purvis.** The electromagnet is an exceptionally strong one. The pole pieces are conical, and the strength of the field between the two poles with a current of 25 amperes is 40,000 C.G.S. units. It was placed in such a position that a line joining the poles was perpendicular to a line drawn from the slit to the grating. The metals of which an account is given are gold, bismuth, antimony, lead, and tin. The results so far show that amongst the various lines a considerable number are divided into triplets; whilst, of those which do not show any division, some seem to be widened when the spark is in the field. By analysing the divided lines by means of a calcite crystal, the components do not seem to be polarised in the same way; *i.e.* the outside components of one triplet are vibrating perpendicular to the lines of force, whilst those of another are parallel to the lines of force, and the same applies to the inner component. Some lines appear as doublets; but in many cases most probably the doublets are reversals, and these phenomena are particularly marked amongst the lines of antimony and bismuth. It will be necessary to study these with the magnet placed "end on." Two lines may be very close together, one stronger than the other, and the stronger line will be divided into three, whilst the weaker one is slightly widened only. The work is still in progress, and with other metals.

PARIS.

**Academy of Sciences,** March 6.—M. Troost in the chair.—The president read a telegram from Dr. Jean Charcot concerning the work of the Antarctic Expedition.—On the orthogonal trajectories of a family of surfaces: Gaston **Darboux.**—A rational formula for the coefficient of absorption of light by a translucent body: J. **Boussinesq.**—The study of 1-methyl-4-benzylcyclohexanol and 1-methyl-4-dibenzylcyclohexanol: A. **Haller** and F. **March.** Methylcyclohexanone reacts with sodium derivatives of alcohols in a manner resembling camphor, the sodium derivative of benzyl alcohol giving a mixture of methyl-benzyl- and methyl-dibenzyl-hexanol, separable by fractional distillation in a vacuum.—*Eumedon convictor,* a crustacean accompanying a sea-urchin: E. L. **Bouvier** and G. **Seurat.** The Eumedon occupies a pouch near the anal region of the sea-urchin, and is well protected by the long spines of the latter. The crustacean is not parasitic on its host, the relations between the two closely resembling those holding between *Pionodesmotes phormosoae* and the sea-urchin *Phormosoma uranus.*—On the constitution of sun-spots: Th. **Moreux.** A discussion of the penumbra of the large sun-spot of January, 1904, of which a drawing is given. The second penumbra, attributed by some observers to irregularities in the nucleus of the spot, is clearly shown, and the author regards this as an additional proof of the theory advanced by him in June, 1900.—On sliding friction: L. **Lecornu.** The author considers that the law of Coulomb cannot be regarded as rigorously true, but is rather an empirical rule only roughly approximate.—The oscillations of railway carriages on their springs: Georges **Marié.** The author has deduced a relation between the periodic variations in level of the permanent way, the friction of the spring, and the deflection of the spring, and has applied this experimentally to various classes of rolling stock. As a rule, the condition of convergence was realised, but there were a few faulty vehicles in which this was not the case.—On the determination by the chronometer of differences of latitude at Madagascar and Réunion: M. **Driencourt.** The data given have a probable accuracy of 0·1 sec. This precision is rarely attained in such measurements, and details of the working methods are given.—On the determination of gaseous densities and the accuracy possible in such measurements: A. **Leduc.** For the more permanent gases the author regards the possible accuracy in the density as about 1 in 10,000; for the more easily condensable gases the probable accuracy is lower. The results recently published by MM. Moissan and Chavanne, Moissan and Binet du Jassoneix, Guye and Pintza, and Jacquerod and Pintza are criticised.—The action of radium bromide on the electrical resistance of metals: Bronislas **Sabat.** Bromide of radium, placed near wires of bismuth, iron, steel, copper, platinum, brass and German silver, increases their electrical resistance. This effect cannot be wholly attributed to the rise of temperature caused by the radium salt.—Contribution to the study of ionisation in flames: Pierre **Massoulier.** Previous experimenters have employed electrodes placed one above the other in the flame, and the dissymmetry thus necessarily introduced partially masks the results. The author employs vertical electrodes placed symmetrically in the flame, and the reversal of the field is then without effect on the course of the phenomena. Curves are given showing the relation between the distances from the electrodes and the fall of potential.—The variations of the equivalent spark of an X-ray tube: S. **Turchini.**—On the time that appears before precipitation appears in solutions of hyposulphites: Gaston **Gaillard.**—On the electrolytic solution of platinum in sulphuric acid: André **Brochet** and Joseph **Petit.** Platinum is dissolved in sulphuric acid under the action of a variable current, and the action of the alternating current is not specially due to the change in the sense of the current. In the presence of an oxidising agent the solution of the platinum is impeded.—A comparison of the physical properties of pure nickel and cobalt: H. **Copaux.** Nickel and cobalt have been obtained practically free from other metals, and containing only one or two thousandths of non-metallic impurities. They are magnetic, very crystalline metals, not malleable in the cold. They differ in appearance, cobalt being bright, resembling silver, whilst nickel is dull. Determinations of the density, hardness,

melting point, electrical resistance, and breaking load are given.—The action of potassium permanganate on salts of hydroxylamine: L. J. **Simon.** A study of the oxidation of the nitrate, phosphate, and arsenate of hydroxylamine.—On quadrivalent oxygen: E. E. **Blaise.** The author has succeeded in obtaining a zinc compound,

$$(C_2H_5)_2.O.(I).Zn.(I).O.(C_2H_5)_2,$$

crystallising in fine prisms, and corresponding in composition to the magnesium compound previously described. The bearing of this compound on the theory of quadrivalent oxygen is discussed.—On the decomposition of orthonitrobenzyl alcohol under the influence of aqueous and alcoholic soda: P. **Carré.**—On the comparative assimilability of ammonia salts, amines, amides, and nitriles: L. **Lutz.** Experiments with Aspergillus and Penicillium show that of all nitrogenous compounds amides are the most easily assimilated; ammonia salts come next, then amines and nitriles.—The distribution of estragol and terpene compounds between the various parts of an annual plant: Eug. **Charabot** and G. **Laloue.**—On the so-called physicochemical analysis of arable earth: H. **Lagatu.** A description of a graphical mode of representing the analysis into three proximate constituents of an arable earth.—On some facts relating to the development of the kidney in Elasmobranchs: I. **Borcea.** A detailed study, illustrated with four diagrams, of the development of the renal system of *Acanthias vulgaris*.—On a form of scales peculiar to the Pandalidæ: H. **Coutière.**—On some anomalous forms of amitosis in the epithelium of mammals: M. **Pacaut.**—On some diseases of the tobacco plant: Georges **Delacroix.**—An experimental study of the conditions which determine the penetration of the vapours of chloroform into the blood during chloroformic anæsthesia, and on the influence of the variations of the pulmonary ventilation on this penetration: J. **Tissot.** It is shown that, contrary to the view generally accepted, during anæsthesia with mixtures containing between 7 and 12 per cent. of chloroform there is no possibility of establishing an equilibrium between the blood and the mixture, since this equilibrium would correspond to a fatal dose of chloroform. The variable equilibrium which is actually produced depends largely on the pulmonary ventilation.—On the secreting power of the kidney: Henri **Lamy** and André **Mayer.**—The spectroscopic study of oxyhæmoglobin: M. **Piettre** and A. **Vila.**—The action of ammoniacal salts on the nitrification of sodium nitrite by the nitric ferment: E. **Boullanger** and L. **Massol.**—On the distemper of dogs: H. **Carré.**—On a geological section of the High Atlas in the region of Glaoui, Morocco: Paul **Lemoine.**—Examination of the fossils brought from the Yunnan by the Lantenois expedition: H. **Mansuy.** The study of these fossils confirms the analogies previously recognised between the primary and secondary fauna of the Indo-Chinese region and the synchronic fauna of India and Central Asia.—The Bishop's circle of Mt. Pelée, Martinique: F. A. **Forel.**

## DIARY OF SOCIETIES.

*THURSDAY*, MARCH 16.

ROYAL SOCIETY, at 4.30.—A New Radio-active Element, which evolves Thorium Emanation. Preliminary Communication: Dr. O. Hahn.—A Determination of the Amounts of Neon and Helium in Atmospheric Air: Sir William Ramsay, K.C.B., F.R.S.—A Preliminary Note upon the Question of the Nutrition of the Early Embryo: E. Emrys-Roberts.—On the Absence or Marked Diminution of Free Hydrochloric Acid in the Gastric Contents, in Malignant Disease of Organs other than the Stomach: Prof. B. Moore (with W. Alexander, R. E. Kelly, and H. E. Roaf).—On the Occurrence of certain Ciliated Infusoria within the Eggs of a Rotifer, considered from the Point of View of Heterogenesis: Dr. H. C. Bastian, F.R.S.—On the Dimorphism of the English Species of Nummulites, and the Size of the Megalosphere in Relation to that of the Microspheric and Megalospheric Tests in this Genus: J. J. Lister, F.R.S.—Observations on the Brains of Man and Animals with Trypanosome Infection. Preliminary Note: Dr. F. W. Mott, F.R.S.

ROYAL INSTITUTION, at 5.—Recent Astronomical Progress: Prof. H. H. Turner, F.R.S.

SOCIETY OF ARTS, at 4.30.—Manipur and its Tribes: T. C. Hodson.

LINNEAN SOCIETY, at 8.—Contributions to the Flora of Liberia: Dr. Otto Stapf.—*Exhibitions:* Penguins and other Birds from the Falkland Islands, and Scratched Rocks from a Rockhopper's Rookery: R. Vallentin.

*FRIDAY*, MARCH 17.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—First Report to the Steam-Engine Research Committee: Prof. David S. Capper.

*SATURDAY*, MARCH 18.

ROYAL INSTITUTION, at 3.—Electrical Properties of Radio-active Substances: Prof. J. J. Thomson, F.R.S.

*MONDAY*, MARCH 20.

SOCIETY OF ARTS, at 8.—Telephony: H. L. Webb.

VICTORIA INSTITUTE, at 4.30.—The Nebular and Planetesimal Theories of the Earth's Origin: Warren Upham.

*TUESDAY*, MARCH 21.

ROYAL INSTITUTION, at 5.—Engineering Problems: Prof. W. E. Dalby.

ROYAL STATISTICAL SOCIETY, at 5.

ZOOLOGICAL SOCIETY, at 8.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Discussion:* Shipbuilding for the Navy: Lord Brassey, K.C.B.—*Paper:* Coolgardie Water-Supply: C. S. R. Palmer.

*WEDNESDAY*, MARCH 22.

GEOLOGICAL SOCIETY, at 8.—An Experiment in Mountain-Building. Part II.: Lord Avebury, P.C., F.R.S.—The Rhætic Rocks of Monmouthshire: L. Richardson.

SOCIETY OF DYERS AND COLOURISTS, at 7.30.—The Dyeing and Finishing of Leather for Bookbinding; with remarks on Preparatory Manufacturing Processes: F. W. Colin Robinson.—A Dyeing Drum Door, removable and replaceable without stopping the Drum: H. W. Ley.

*THURSDAY*, MARCH 23.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: The Reception and Utilisation of Energy by the Green Leaf: Dr. Horace T. Brown, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Report of Experiments carried out at the National Physical Laboratory: On the Effect of Heat on the Electrical and Mechanical Properties of Dielectrics, and on the Temperature Distribution in the Interior of Field Coils: E. H. Rayner.—*Discussion:* On Temperature Curves and the Rating of Electrical Machinery: R. Goldschmidt.

ROYAL INSTITUTION, at 5.—The Reasonableness of Architecture: Thomas G. Jackson.

*FRIDAY*, MARCH 24.

ROYAL INSTITUTION, at 9.—A Pertinacious Current: Sir Oliver Lodge, F.R.S.

PHYSICAL SOCIETY, at 5.—Note on the Voltage Ratios of an Inverted Rotary Converter: W. C. Clinton.—On the Flux of Light from the Electric Arc with varying Power Supply: G. B. Dyke.—The Application of the Cymometer and the Determination of the Coefficient of Coupling of Oscillation Transformers: Prof. J. A. Fleming, F.R.S.—Exhibition of Cymometers and other Instruments.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Wanki to Victoria Falls Section; Victoria Falls Railway: C. T. Gardner.—Design of a Double-Line Plate-Girder Railway-Bridge: H. S. Coppock.

*SATURDAY*, MARCH 25.

ROYAL INSTITUTION, at 3.—Electrical Properties of Radio-active Substances: Prof. J. J. Thomson, F.R.S.

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