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RADIATION AND SPECTROSCOPY.

Handbuch der Spectroscopie. Vol. ii. Von H. Kayser. Pp. xi + 696. (Leipzig: Hirzel, 1902.) Price 21. net.

THE second volume of this important work follows the first after a remarkably short interval of time. Being essentially a book of reference, the reviewer's task is an easy one, as the value of the work is best indicated by means of a short summary of its contents. Generally speaking, we may say that this volume deals with the theory of molecular radiation and those facts of spectroscopy which throw some light on the theory. The discussion therefore embraces the question of multiple spectra, the observed regularities in the spectra of bodies and the Zeeman effect.

The first chapter deals with the connection between emission and radiation. The early work of Balfour Stewart and of Kirchhoff, which had already been touched upon in the first volume from the historical side, is now discussed as regards its logical stringency. It is, perhaps, to be regretted that this chapter was written before Lord Rayleigh's defence of Stewart's proof had been published; but Kayser has added a footnote in which he quotes Rayleigh's opinion, having already given in the text the verbal transcription of the passage in Stewart's writing on which his claim to independent and previous discovery of the fundamental law of spectroscopy rests, so that every reader may form his own judgment.

The paragraphs dealing with the experimental verification of the relation between absorption and radiation are of considerable interest, and reveal the great need of further work in this direction. No one doubts the accuracy of the theoretical law in he case for which it applies, which is that of thermic equilibrium. But experimental investigation of the absorption in flames and Geissler tubes is very likely to throw some fresh light on the mechanism of luminescence due to chemical or electric action. The results of Gouy's investigation are sufficiently curious to render their repetition and extension desirable.

The second chapter, which treats of the radiation of solid bodies, is a most valuable and complete summary of our knowledge of the radiation of hot solids, first as regards their total radiation, leading up to Stefan's law, and secondly as to the partition of the total energy into its elementary portions depending on wave-length. Great progress has recently been made in our knowledge of the emission of black bodies, but the radiative properties of gases, dealt with in the third chapter, present greater difficulties. In the first place, we are not able experimentally to render a gas luminous by a purely thermal process, and it is well known that some writers have gone so far as to assert that a purely thermal radiation cannot give a discontinuous spectrum. There is no doubt that such a view would get over some theoretical difficulties, but at present the facts seem against it. At any rate, so far as experiments go, the relation of radiation to absorption has not been found to be materially different in the flame and in the arc than it is in a body which is in thermal equilibrium. We may mention in this connection an observation of Gunther quoted by Kayser (p. 182), in which sodium rendered luminous in a Bunsen flame shows absorption lines when the light from a platinum wire made incandescent in the same flame is sent through it.

The question of the mechanics of radiation is at present in a state of transition, the electron theory rapidly gaining ground. A certain inequality of treatment in this respect in different parts of the book could not be avoided, but the modern theory is not neglected, though not pressed forward with that sympathy which some might perhaps have wished.

One small matter I should like to set right. Prof. Kayser quotes me as supporting E. Wiedemann's calorimetric measurement of the heat necessary to dissociate the molecule of hydrogen into its constituent atoms. I was indeed surprised to find, on looking up the reference given by Kayser, how strongly I had expressed myself in this respect, a few months after Wiedemann's paper had appeared. I have long since become convinced that the experiments were inconclusive, and I therefore quite agree with Kayser's own views on the subject.

The questions relating to the variability of spectra, including the effects of pressure, temperature and mode of incandescence, are fully discussed in the fourth and fifth chapters.

Our knowledge of the influence of the various forms of electric discharge and the different modes of producing incandescence is gradually becoming more complete, but there is still considerable difference of opinion as to the interpretation of the facts. The additional lines which, *e.g.*, are introduced into the spectra of metals when a Leyden is introduced into the discharge of an induction coil may be interpreted as due to an increase of temperature merely, or as due to some peculiarity of the form of discharge.

The general opinion of spectroscopists, towards which Prof. Kayser seems also to lean, is that there are effects which may be peculiar to the method of discharge and cannot be explained by mere changes of temperature; but, on the other hand, all classifications of star spectra are more or less based on the supposition that the temperature is the chief, if not the only, cause of the differences observed. Little has been done of late years to obtain a direct answer to the question whether a spectrum is completely defined by temperature and pressure without reference to electrical effects. If we limit ourselves to temperatures not higher than that of the electric arc or the oscillatory discharge obtained by means of a condenser and self-induction, experimental evidence seems to show that the method of producing incandescence is immaterial. At any rate, identical spectra may be obtained (*a*) in an electric arc produced by a constant current, (*b*) by an oscillatory discharge from metallic poles, (*c*) in the cone of a Bunsen burner. At present there seems, therefore, no reason to suppose that high temperature is not in itself sufficient to produce all the effects observed when incandescence is produced by a high-tension spark.

Some of the older researches, which were carried out at temperatures sufficiently low to admit of measurement or approximate estimation, might with advantage be repeated or extended. It is now generally admitted that

differences in spectra such as that indicated by a change from a band to a line spectrum are due to changes in molecular complexity, but one would like to see at least one case worked out in detail. The change from the band spectrum of sodium to the spectrum of lines probably takes place simultaneously with the splitting up of the molecule containing two atoms, but this has never been clearly proved. A single example of this character thoroughly investigated would set many conscientious doubts at rest. When we further consider gases which show much greater variability, such as oxygen, which has seven undoubted different spectra, not counting subdivisions, justifiable speculation is obliged to go still further ahead of experimental demonstration. All things are possible in a vacuum tube, but all the same it would be more satisfactory to know exactly what takes place.

To explain the difference in spectra observed in different circumstances, we have the choice between molecular dissociations and molecular associations, and I should like to suggest one further possible cause of variability. We cannot doubt at present that it is possible to separate an electron from matter, and it is possible to imagine that an atom may under electric influence have on its surface one electron less or one electron more than it possesses in its normal condition. Such an increase or diminution would doubtless have a very material effect on the radiations which the atom can emit. Possibly the peculiar spectra which are seen in the glow surrounding the negative pole of a vacuum tube may be due to the association of an ordinary molecule with the originally free electron projected from the kathode.

There is an interesting short chapter on the appearance of spectrum lines, and Doppler's principle is discussed at length (nearly one hundred pages) by Dr. H. Konen.

We can only say a few words about the two last chapters, yet they are perhaps the most important portions of the book. In chapter viii. the relationships discovered between the wave-lengths of lines belonging to the same spectrum are discussed. Every reader of this notice knows how much science owes to Prof. Kayser in this portion of the subject and will give special weight to his exposition of it. The structures of the so-called fluted bands have not, perhaps, attracted the same amount of attention as the regularities found in the component lines of a "series" spectrum. The large number of lines which make up a band may give larger possibility of accidental coincidences, but the subject is one which well deserves the attention of those who wish to advance the mechanics of molecular structure. It is needless to say that the series laws are fully discussed, as well as the relationships so far found between the spectra of different elements.

The last chapter, which deals with vibrations in the magnetic field, is written by Prof. Runge. It is full of interest, not only on account of the complete statement of the facts so far as they are known at present, but also on account of the clear exposition of the theoretical discussions by Lorentz and others, Prof. Runge himself adding important contributions to it. Zeeman's discovery has been remarkably fruitful in dividing spectral lines into groups which seem intimately connected with each other, and the subject is far from being exhausted. The insensibility of band spectra to magnetic influence is probably connected with their insensibility to the effects of pressure, and seems to point to a materially different origin of the two classes of spectra.

Prof. Kayser may congratulate himself on the successful completion of this volume, which is full of suggestive criticism. Its value is enhanced by the fact that it brings the gaps in our knowledge prominently before us. Anyone wishing to advance by original research a science which is destined to clear up the secrets of molecular and atomic constitution will find Prof. Kayser's work full of promising starting points. ARTHUR SCHUSTER.

THE MAMMALS OF EGYPT.

The Zoology of Egypt—Mammalia. By the late J. Anderson. Revised and completed by W. E. de Winton. Pp. xvii + 373; illustrated. (London: Hugh Rees, Ltd., 1902.) Price 7 guineas net.

FOR many years previous to his untimely death, the late Dr. John Anderson devoted, with characteristic energy and enthusiasm, a large amount of time, labour and money to collecting the mammals of Egypt, with a view of publishing a fully illustrated description and revision of that section of the fauna of the country. And at his decease he left behind him the greater part of the manuscript for the present work, in a state verging more or less nearly on completion. It would have been a thousand pities had this labour been lost to zoological science; and Mrs. Anderson, who has herself written the preface, is entitled to the gratitude of all naturalists for her resolve that the work should be completed and published. No better memorial could indeed have been devised to perpetuate the memory of her late husband, of whom a life-like portrait is prefixed to the volume.

In the selection of Mr. de Winton to undertake the task of completion, and, where necessary, revision (for zoology is not a science that stands still), Mrs. Anderson has been thoroughly well advised, for that gentleman has for some years made the mammals of Africa a special study, in the course of which he has not only added considerably to the list of species and races, but has likewise made important contributions to our knowledge of the affinities and taxonomy of well-known forms. Without in any wise detracting from the work of the original author, it may be confidently stated that Mr. de Winton's task has been by no means an easy one, and he is to be congratulated on the manner in which he has carried it through. Certain sections of the work—notably those dealing with the shrews and the hares—are entirely the work of the editor, who has also rewritten certain other sections. Of many of the species and races recorded in the volume, he is also the first describer, although all such forms have been previously named in other publications; and with the exception of that of one race of striped polecat, no new names appear to be proposed in the book. It is highly satisfactory to learn that Mr. de Winton's labours have met with the thorough approval of Mrs. Anderson, who observes in the preface that the manner in which he has carried out his task will commend itself to zoologists generally.

A special feature of the book is formed by the fifty-five

coloured plates, all of which were drawn with great care by Mr. P. J. Smit from actual specimens, and are excellent representations of the species they portray. Special interest attaches to the reproductions of radiographs of the skeletons of three mummified baboons, as affording an instance of the author's thoroughness and perseverance. Finding that he could not obtain permission to remove the bandages from the mummies, Dr. Anderson called in the aid of the radiograph, and by this means was enabled in some instances to identify the species to which they belonged.

The mention of baboons reminds us that Dr. Anderson devoted an immense amount of labour and research to the elucidation of the complex synonymy of this puzzling group, and it is satisfactory to find that he has succeeded in clearing up several doubtful points, although others still remain for his successors.

The yellow baboon, commonly known as *Papio babuin*, he has identified with the *Simia cynocephalus* of Linnæus, and the species should consequently in future be known as *Papio cynocephalus*. If we understand him rightly, he regards the Abyssinian thoth baboon (*P. thoth*) as specifically inseparable from the former. Here we may venture to refer to what is, in our opinion, the one fault of the work, namely, its excessive verbosity, whereby it is sometimes by no means easy to arrive at the author's true meaning. A concise summary of conclusions at the end of each description, in which difficult questions are discussed at great length, would have been of inestimable value.

Several other emendations of current nomenclature occur in the course of the work, to a few of which special attention may be directed. For the wild cat of Egypt, commonly known as *Felis maniculata*, the earlier name *F. lybica* (or, correctly, *libyca* or *libica*)[1] is adopted, and it is important to notice that the so-called Kaffir cat of South Africa is regarded as nothing more than a local race of this species, under the name of *F. lybica obscura*. It may be suggested, however, that if this species be, as is commonly supposed, the progenitor of the domesticated cat of Europe, its proper title is *domestica* instead of *libyca*. That the use of a name originally applied to the domesticated representative of a species is not repugnant to the author and editor is proved by their employment of the name *asinus* instead of *taeniopus* for the wild ass of this part of Africa. Another change of more far-reaching import is the replacement of the name Dipus, in common use for the jerboas, by the earlier Jaculus, this change likewise involving the substitution of the family name Jaculidæ for the familiar Dipodidæ. Brief references may likewise be made to the replacement of the name *Halicore tabernaculi*, hitherto universally used for the Red Sea dugong, by *H. hemprichi*.

In regard to the nomenclature of the Canidæ, we notice that the fennecs and foxes are separated from the typical genus as Vulpes, whereas in a paper on the African members of that group, contributed in 1898 by Mr. de Winton to the Zoological Society's *Proceedings*, both groups are classed as Canis. We presume this is not a change of front on the part of the editor, but merely a desire not to interfere with the views of the original author.

In an earlier part of this review, we have had occasion to mention that zoology is not a stationary science. An exemplification of this is afforded by the fact that even on its publication the work under consideration is in one small detail out of date. In the text, it is considered that no distinction can be drawn between the northern and southern representatives of the African aard-wolf (*Proteles cristatus*). Mr. Rothschild, in a recent issue of *Novitates Zoologicae*, has shown, however, that three local races of this curious animal are distinguishable, namely, the large and fully striped typical Cape form, the more sparsely striped Angola race and a Somali race.

It may be added, in connection with taxonomy, that the author divides the bats into a much larger number of family groups than is the usual practice of naturalists, making the genus Noctilio the type of one family, Rhinopoma of a second and Molossus of a third.

Regarding the work as a whole, it may be safely said that not only is it an excellent and exhaustive account of the mammals of the area of which it specially treats, but that it is also a most valuable contribution to the study of mammals in general, its value in the broader sense just referred to being partly due to the character of the work itself and partly to the circumstance that Egypt forms a portion of the border-land between the Holarctic and Ethiopian regions, and thus presents a mixed fauna of more than ordinary interest. It is a subject of congratulation to all concerned that the authorities in Egypt have taken great interest in, and have done all in their power to assist the work, which will long remain the standard authority on the subject, and forms, as already stated, a worthy and lasting memorial of its learned and lamented author. R. L.

[1] In the case of this species, the author adopts the incorrect spelling of its original describer, whereas the Libyan striped polecat is termed *Ictonyx libyca*.

THE TERPENES.

The Chemistry of the Terpenes. By F. Heusler, Ph.D. Translated by F. J. Pond, M.A., Ph.D. Pp. xv + 457. (London: J. and A. Churchill, 1902.) Price 17*s.* net.

THIS work stands out as a monument to specialisation. A few years ago, the possibility of writing long memoirs upon any one branch of chemistry—especially organic chemistry—would have been out of the question, but to-day we are bombarded right and left with monographs upon this and that branch of chemical science. It is truly remarkable, considering the great array of books upon specialised subjects which are published in Germany, that publishers can be found willing to undertake the risk of bringing them out. But as the writing and publishing of these works goes on with unabated vigour, evidently they must find a sufficient circle of readers to make them a profitable investment, both from the point of view of the author and publisher. One rather wonders how it is that very few books on specialised subjects, which can to any extent be called exhaustive, are published in England. If we desire to study any special branch of science, we are bound either to go to the original publications or to consult foreign compilations

or translations of foreign works upon the subject. And again we may ask, Why is it that so many of the translations hail, not from this side of the water, but from America? The only possible reply seems to be that the scientific Englishman is not fond of writing.

The book under review, which has been translated by Dr. F. J. Pond, assistant professor in the State College of Pennsylvania, is dedicated by its author to Prof. Wallach. We are not surprised at this, because, owing to the careful and splendid experimental work of Prof. Wallach, the chemistry of the terpenes has become systematised and simplified (*i.e.* relatively simplified) in a manner which at one time seemed almost out of the question.

The book commences with an introduction of twelve pages. Naturally, the study of the camphors or oxidised compounds of the terpenes could not be left out of any work which dealt with the terpenes. Dr. Heusler explains that

"Japan camphor, while closely allied to the terpenes, has such an extremely large number of derivatives that an exhaustive description of them would demand as large a space as the derivatives of all the remaining members of the terpene group taken together."

Therefore Dr. Heusler only mentions those which are most closely related to the members of the terpene group. But at the same time, it would have been both interesting and instructive if he had seen his way—perhaps in the form of an appendix—to give a summarised discussion of some of the controversial points under consideration in the camphor problem. As it is, he only gives Bredt's formula for camphor and passes over the others, as he considers that the present state of our knowledge is scarcely sufficient to allow of criticism. If we take down the British Association notes for 1900 and study Dr. Lapworth's very able report upon the camphor question, we see that it is possible to summarise shortly the camphor literature in a lucid and satisfactory manner.

Under the heading "Hemiterpenes," there is a short description of isoprene and some of its derivatives. The connection of such vegetable products as guttapercha and the terpenes is noteworthy, isoprene being of special interest, since when acted upon by concentrated hydrochloric acid it polymerises into a rubber-like substance. On the other hand, isoprene, along with other substances, is produced when the vapour of turpentine is passed through a red-hot tube.

We then come to the study of the terpenes proper; this portion of the book occupies nearly one hundred pages. Naturally, pinene, the chief ingredient of turpentine oil and the most widely distributed of the terpenes, is first studied. Under each terpene, the preparation and properties are first given, and then their behaviour towards oxidising agents and various reagents.

Following the terpenes, we come, on p. 133, to the study of the oxidised compounds; this is divided into two parts —(1) Substances which cannot be regarded as derivatives of the hydrocymenes, analogues of pinene, camphene and fenchene; (2) substances which may be regarded as derivatives of the hydrocymenes. Camphor, which falls under the first category, is first discussed, and here again Bredt's formulæ for camphor, camphoric and camphoronic acid are given. The study of the olefinic members of the terpene series follows on p. 377; the first portion is devoted to the study of the hydrocarbons and the second part to the oxygenated compounds, such as linalool, geraniol, the pleasant-smelling constituent of Turkish and German oil of rose and citronellol. The last twenty pages are devoted to the study of the sesqui- and poly-terpenes.

Taking the book as a whole, it will be found to be a very interesting review of some of the most important work which has been carried out in connection with the chemistry of this very abstruse but exceedingly interesting branch of chemical science. At times there is a tendency to lapse into a "dictionary" style of writing, but it should be borne in mind that descriptive writing is of all writing the most difficult. The book should be of great value to all those who are engaged upon the study of the terpenes or of camphor, but when this work of 450 pages has been carefully studied, it will still be found necessary to consult the original literature. Fortunately, Dr. Heusler has given fairly full references, and for this he cannot be too highly commended.

The book can hardly be recommended to the general student, because he would be apt to lose himself in a maze of compounds a previous knowledge of which is taken for granted.

Dr. F. J. Pond has evidently taken great pains in translating the book, and he certainly deserves a word of thanks for his trouble. F. MOLLWO PERKIN.

EXPERIMENTAL PHONETICS.

The Elements of Experimental Phonetics. By Edward Wheeler Scripture. Pp. xvi + 627; 26 plates and 348 illustrations. (New York: C. Scribner's Sons; London: Edward Arnold, 1902.)

THIS handsome volume is one of a series of books issued by a number of the professors and instructors of Yale University in connection with the bicentennial anniversary of that institution. It is an effort to collect and arrange the data at present available concerning the voice in song and speech, and it is enriched by an account of much valuable work done in the field of experimental phonetics by the author himself.

During the last decade, the science of phonetics has made rapid progress, more especially in France, Germany, America and Scandinavia; it has now a nomenclature and methods of its own, and it is cultivated with much earnestness and ability by many workers, some of whom are a singular combination of physicist physiologist and philologist. The scope of the science is a study of the physical, physiological and psychical phenomena connected with language. It deals with the physical basis of the sounds of language, with the physiological mechanisms by which these sounds are produced, with the cerebral phenomena connected with the psychical processes that lie at the root of the nervous mechanisms by which ideas find expression in articulate sounds, and with the laws of emphasis and of rhythm.

In this work, Dr. Scripture surveys the whole field. He first of all deals with the physical aspect of the subject in a series of sections on the curves of speech—that is

to say, with the sound and speech curves produced by the phonautograph, phonograph and gramophone, and by the observation of the movements of vibrating flames, discs and membranes. He also describes in great detail the harmonic analysis of such curves. The next part of the work is devoted to the perception of speech, and here we find a full description of the ear, a discussion of the theories of hearing now so much debated, and, lastly, a detailed consideration of what may be termed the psychology of speech, such as the perception of speech elements, the nature of speech ideas, the laws of association, more especially the special associations of speech and the formation of such associations. Dr. Scripture rightly sees that the discussion of the nature of language must not be concerned only with the vibrations that constitute the sounds of words, or with the physiological mechanism of the articulating organs, but must take into account psychical phenomena associated therewith.

The following section deals with the production of speech, and here we find by far the most complete account that has yet been written of the action of the larynx and the movements of the tongue and pharynx. Most ingenious are the methods for determining tongue contacts, or the exact position of the tongue and soft palate in articulate speech. Here also the author treats of the tones of the vocal cavities in connection with the vexed question of the nature of vowels, and in general he supports the views of Prof. Hermann. Last of all, we have a section on the factors of speech, in which Dr. Scripture deals with vowels, consonants, melody, rhythm, accent, &c. There are three valuable appendices, the second of which, being studies of speech curves, shows magnified tracings taken by the author from gramophone records of certain admirable recitations. These tracings are by far the best that have yet been obtained, and they are carefully analysed as to varying amplitude or intensity, pitch, and period or frequency. When one looks at the long series of waves representing the sounds of spoken words, as shown in these tracings, the ultimate analysis seems almost hopeless, and more sure progress would be made if an analysis were carried out of very simple monosyllabic sounds, such as "pat," "bat," "cat," &c. Dr. Scripture also gives a table of phonetic symbols, and there is an excellent index. There are full bibliographical references to the works of all who have contributed to experimental phonetics, and the only name we miss is that of Dr. Marage, of Paris, whose recent researches are of much interest and value were it only for the fact that he has succeeded in placing the theory of vowel tones in a concrete and simple form.

It is not easy to find fault with such a work as we are considering, which, in the way of thoroughness and clearness of exposition, may take its place alongside the "Sensations of Tone" of Helmholtz. An author must be allowed to work out his subject in his own way, and if we think certain parts, such as the description of the ear and of the larynx, and the phonetic discussion of sound fusion, might have been shortened, still Dr. Scripture may not be of the same opinion. We would also observe that in dealing with psychological phenomena (and the same fault may be found with some physiologists as to the language they use in describing nervous phenomena) there is a tendency to make use of expressions which have a definite meaning in physics, but when applied to other phenomena they are words, mere words. Thus, at the beginning of chapter x., on speech ideas, we have the following sentences:—

"The current of thought in consciousness varies in its density from moment to moment. The regions of less density may be used to divide off parts of greater density; such portions of greater density are what we usually term 'ideas' or 'thoughts.' Each denser portion of the speech current in consciousness is an 'auditory idea' or—as a matter of speech—a 'phonetic unit.'"

The use of the words "density" and "current" are liable to misconception; at all events, it does not appear to us that this mode of stating the case makes it any clearer. Altogether, however, this is a great book, and we congratulate the author on its production.

JOHN G. MCKENDRICK.

OUR BOOK SHELF.

Notions fondamentales de Chimie organique. By Prof. Ch. Moureu. Pp. 292. (Paris: Gauthier-Villars, 1902.) Price 7.50 francs.

THERE is nothing calling for special remark in this little compendium of organic chemistry. It belongs to a type of scientific literature with which we are thoroughly well acquainted in this country, and has been written for the use of elementary students as an introduction to this branch of the science. The six chapters deal respectively with preliminary theoretical notions, hydrocarbons, oxygen-containing compounds, nitrogenous compounds, organometallic compounds and heterocyclic compounds. This classification will be unfamiliar to English chemists, and although it may possess certain advantages, it necessarily results in the association of the most heterogeneous groups. With the exception of this arrangement, the work follows the usual course, and the subdivisions of the chapters bring out with sufficient clearness the family resemblances arising from similarity of chemical type. Of course, the great difficulty which all writers of these short manuals have to contend with is the compression of such an enormous range of subjects into a limited number of pages without distorting the perspective view of each branch. Every original worker—and M. Moureu's contributions to synthetical chemistry entitle him to a prominent position in this capacity—has a tendency, often quite unconsciously, to give undue prominence to his own branch of the subject or his own particular theoretical views, and this is a real danger from which the elementary student cannot be too carefully guarded. No fault can, however, be found with the work from this point of view, and the author has maintained a fairly uniform balance throughout. The short treatment of stereochemistry (12 pp.) is particularly lucid so far as it goes, although the author only leaves himself half a page for the stereochemistry of nitrogen and sulphur. On the whole, this manual, regarded as a descriptive treatise to be used in association with laboratory work and lecture-room attendance, may safely be commended to the class of students for whom it is written:—

"Ouvrir l'esprit de l'élève en l'initiant graduellement au mécanisme des transformations de la matière et en lui présentant les grandes lignes de la Science avec le relief qui leur convient, le préparer ainsi à suivre avec fruit un *Cours complet* et à faire un usage profitable des *Traités* proprement dits, tel a été notre but, notre unique objectif

en écrivant ce petit ouvrage, que nous considérons comme une *Introduction à l'étude de la Chimie organique*" (Preface).

How refreshing must it seem to teachers in this country to meet with an elementary work on chemistry containing no reference to the "Syllabus" of any Board of Examinations. R. M.

Penrose's Pictorial Annual, 1902-3. The Process Year-book. An Illustrated Review of the Graphic Arts. Edited by William Gamble. Pp. xvi + 136 and 56. (London: A. W. Penrose and Co., Ltd., 1902.)

THE present issue of this very handsome and interesting year-book forms the eighth volume of this useful publication. Year by year the progress made in process work is here recorded, and at each issue the high standard of excellence of this book is raised. The rapid strides made in three-colour work and its general application to technical and artistic subjects render the present volume of especial interest, and the editor has brought together numerous articles and reproductions which will give the reader, not only a good insight into the principles involved, but a general idea of the excellence of the finished pictures.

As in former volumes, the engraver, printer, publisher, &c., have all apparently vied with each other to produce the best work, and an examination of the book down to the most minute detail shows how completely each has succeeded in his task. Printed on "perfection quality art printing" paper, the type in the text, and the illustrations, appear at their best, and in each case useful details, such as description of the original process employed, name of printer, &c., are added. The illustrations are representative of the application of process work to all types of subjects, from blocks for catalogue illustrations, such as cut-glass objects, silver work, machinery, &c., to others as reproductions of oil paintings, landscapes, portraits, birds' eggs, &c.

Although little has yet been said about the text, the articles on the various topics will be found full of useful and interesting facts and experiences. The book will be found a valuable addition, not only to the library of the amateur or professional photographer or process worker, but to those who wish to choose between different processes as judged by the finished examples. As a simple picture book, it should have many admirers.

The Zoological Record for 1901. Edited by D. Sharp. (London: Zoological Society, 1902.)

YEAR by year, this invaluable publication increases in bulk, the present volume being considerably thicker than the one for 1900, as the latter was larger than its predecessor. The task of the editor and his staff is indeed a prodigious one, and the marvel is how it is completed year by year within the allotted time. That shortcomings must occur here and there is, as the editor admits, inevitable, but all concerned are to be congratulated that they are so few and far between. At the conclusion of his preface, Dr. Sharp suggests that before many years elapse the "Zoological Record" may come to an end, owing to its place being filled by the "International Catalogue of Scientific Literature." Unless, however, the latter undertaking progresses at a more rapid pace than at present seems to be the case, naturalists will sadly miss the regular appearance of the well-known russet volume shortly before Christmas, and it would be a thousand pities if the publication were discontinued before it became absolutely superfluous. Except a certain lack of uniformity between the different sections, to which we have called attention on a previous occasion, the volume before us is so carefully edited as to call for nothing in the way of criticism.

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.*]

Biology in Universities.

IN connection with an editorial article on university development at the beginning of your issue of January 1, where you quote a pamphlet of mine called "A Survey of the Sciences," drawn up for the information of Governors of the University of Birmingham, I have received a contribution to the subject from Prof. Herdman, emphasising the separate inclusion of Biology in addition to the specific sciences of Zoology and Botany, and especially emphasising its vital importance in the scientific study of Medicine.

I would ask you, therefore, to print it as the opinion of a highly competent specialist. OLIVER LODGE.

IN NATURE of January 1, p. 193, right-hand column, middle, between ARCHÆOLOGY and BOTANY, I should like to have seen:—

BIOLOGY:—The fundamental science of medicine—which may, in fact, be regarded as applied experimental biology.

It is, therefore, an essential part of the preliminary training of every medical student.

It is the central, or basal, area of the natural sciences, containing, as it does, the facts and principles which are common to, and undergo application and further elaboration in, the sciences zoology, botany, anatomy, physiology, pathology, bacteriology, anthropology, psychology and palæontology.

It is (or should be), moreover, a subject of general culture, with many interesting applications to ordinary everyday life; and is of primary importance in philosophy both on account of its historic connection with the work of Darwin, Herbert Spencer and Huxley—biologico-philosophic work the influence of which, not only upon science, but also upon many other departments of thought it is difficult to estimate—and also because of more recent developments in connection with heredity, reproduction, &c.

All this on the pure science or educational side. In its practical applications, biology has an enormous field before it in the future in connection with arts and industries, our food supplies, fisheries, drainage and the metabolism of the ocean—matters affecting the health of man and the prosperity of the country.

Some of these points were referred to under zoology or botany, but there is so much ground common to these two sciences, and they are so interwoven both in matters of theory and in practical applications, that it is desirable to recognise these relations under the heading biology.

W. A. HERDMAN.

University College, Liverpool, January 2.

Genius and the Struggle for Existence.

IF the struggle for existence and survival of the fittest mean anything at all, they surely mean that any quality which is useful to the individual, or race, will be preserved and increased. Sir Oliver Lodge, however, in his "Survey of the Sciences," as reported in NATURE, January 1, says:—

"The struggle for existence, though doubtless a stimulating training for the hardier and sturdy virtues, is not the right atmosphere for the delicate plant called genius."

But if genius is not evolved in the struggle for existence, then it is not an advantage. In the usual phraseology of natural selection, it is considered enough to say, "Such and such a quality, or organ, is useful, *therefore* it will be evolved in the struggle for existence."

If, then, Sir Oliver Lodge is right, either (1) genius is not useful, or (2) useful qualities are not—necessarily—evolved in the struggle for existence.

And if genius is—which I take leave to doubt—the tender greenhouse plant represented by Sir Oliver Lodge, is it worth while trying to preserve it in this—more than—bracing environment we call life? So far as I can gather from the figures given, the education of *one* whose discoveries will be of

"incalculable value" involves the education on similar lines of 9999 who will not be of any special value.

13 Vicarage Drive, Eastbourne. G. W. BULMAN.

YOUR correspondent, like many other people, regards the struggle for existence, not only as a fact, but as an ideal; not only as a necessary mode of effecting improvements in low-grade organisms, but as a method which should indefinitely continue in unchecked and unaided action, in spite of the arrival on the scene of a comprehending and guiding intelligence, such as may be competent to replace it by methods more direct and rapid; for instance, the methods of artificial selection and protection of the weak, which we have learnt how to begin to practice.

He also presses his admiration for the struggle-and-survival method so far as to suppose that no properties and powers can be useful which are not fostered by it.

To me it seems that struggle and competition are more akin to those forces of nature which the human race does wisely to train and hold in check, as a maritime country might protect its coasts from the ravages of the sea, instead of sitting idle and assuming that nature alone, without the guiding hand of man, is perfect and unimprovable. Surely it is a mistake to suppose that the fostering care which after long effort has been now manifestly introduced into the scheme is useless and inoperative and subordinate to the forces which preceded it.

OLIVER LODGE.

A Pot of Basil.

MR. A. E. SHIPLEY'S interesting article (p. 205) on *Ocimum viride* and its influence on mosquitoes recalled some observations that I made upon the papaw-tree (*Carica papaia*) in China. My house, on the bank of the river at Whampoa, near Canton, was singularly free from mosquitoes, though the other houses on the same island were more or less infested with them. A line of papaw-trees stretched between my house and the river. I frequently watched these trees, yet I never saw a single insect alight on them, though flies and other insects settled in numbers upon the bamboos and banana-plants not far away. In fact, the papaw-trees seemed to keep insects at a distance and to act as a rampart guarding the house from mosquitoes. The probability of this suggestion was considerably strengthened by the increase in the number of mosquitoes entering the house after a typhoon had blown down two papaw-trees and thus made a gap in the row, and by the still further increase when a second typhoon felled another of the trees. I have questioned a number of persons living in the tropics, and one of them stated that he was familiar with the fact that papaw-trees repelled mosquitoes.

That the papaw-tree possesses some curious property—in addition to the notorious proteolytic action of its juice—is suggested by the widespread practice of hanging meat in its shade to render the meat tender. The custom is frequently regarded as a senseless one, but its wide distribution causes one to ask, Is it not possible that the papaw-tree should exhale a gaseous product which either repels meat-destroying insects or exerts an antiseptic action on putrefactive bacteria, or, finally, is a volatile ferment? The peculiar relation in regard to temperature displayed by the proteolytic ferment of the papaw juice renders the last possibility less improbable than at first impression.

PERCY GROOM.

The Mismanagement of London University Library.

Is it impossible for the powers that be at London University to abolish the scandalous regulations concerning the library, and to render this library a means of culture instead of an almost unusable and unused collection of books? A university library ought to be so managed that anyone wishing to bequeath books could put them to no better use than by leaving them to the university; but, as things are, it would scarcely be possible to more effectually *waste* books than by giving them to London University. In the first place—contrary to the practice of the learned societies and the subscription-libraries—no graduate is allowed to have books sent to him by post, which regulation at once renders the library utterly useless to the great majority of graduates. Secondly, an absolutely insane rule requires the return of all books by December 31 of each year, even though they may have been borrowed at Christmas and are required for study during the vacation! and although I interpret this rule as applying only to non-members of Convocation, a contrary interpretation has prevented me from obtaining books a fortnight ago. Thirdly, although the University has now been located in its new home for two years, a personal demand for books is met by the reply that, as "the books of the library have not yet been arranged, and the whole library is in a very disorganised state," the books either cannot be found at all or only after several days' delay! The history of a recent attempt to obtain books from this library would move the careless to laughter and the studious to anger; but I dare not trespass further on your space. F. H. PERRY-COSTE.

Polperro, R.S.O., Cornwall, January 8.

Recent Earthquakes in Guatemala.

A FEW weeks ago, I returned from a journey of severa months' duration through the western part of the republic of Guatemala, where I investigated, at the request of the Government, the causes and effects of the recent earthquakes. The principal results are the following:—

The first severe earthquake was reported to have occurred on January 16, 1902, at the south-west of Mexico, destroying Chipalzingo, the capital of the State of Guerrero.

On January 18, 5 20 p.m., a strong shock occurred on the Pacific side of Mexico and Guatemala, shaking down in the latter country the village of San Francisco Zapotitlan (near Mazatenango), and destroying buildings and masonry work in several large plantations near this village and farther west in a district south-east of the town of San Marcos. The shock came from the S.S.W., and was reported from the whole Pacific coast of Guatemala and Soconusco, but I could not get information how far inland it was perceived.

From that time on, a great many local shocks were noted in the western part of Guatemala, especially in a district called Costa Cuca.

At 8.25 p.m., April 18, the most severe earthquake occurred, being felt from Nicaragua to the city of Mexico, over all Chiapas, the whole republic of Guatemala, British Honduras and a great part of Spanish Honduras.

In my sketch (NATURE, June 12, 1902), the region in which most destructive effects occurred must be extended more to the west, taking in north-eastern Soconusco.

In Guatemala, the towns that suffered most were Quezaltenango, San Juan Ostuncalco, San Pedro Sacatepequez, San Marcos and the Port of Ocós. Great was also the damage done in the numerous coffee plantations. Enormous landslips dammed up rivers (Rio Naranjo and Rio Ixtacapa) and destroyed hundreds of thousands of coffee-trees. The total loss of human life numbered 330 to 335, of which 129 were killed in Quezaltenango and forty-nine in San Pedro Sacatepequez.

The earthquake lasted more than fifty seconds and also came from the S.S.W. This was clearly shown by the effects of the shock in the coast towns and in the coffee region; in Quezaltenango and San Marcos, there have been movements in many directions, but the initial one was also from S.S.W.

After April 18, a great number of smaller shocks of short duration and generally very restricted extension were observed, most of them again in the Costa Cuca and neighbouring districts, and on September 23 another larger earthquake shook the whole country again, but did little damage (in Quezaltenango a child was killed by a falling wall). I was then in Guatemala City, where the shock lasted sixty-five seconds. The movement was again from S.S.W. Reports about it came from the Peten, Belize, Salvador and Chiapas.

The epicentrum of the great earthquakes of January 18, April 18 and September 23 must be situated out in the Pacific Ocean; the cable which connects San José de Guatemala with the Mexican port Salina Cruz was broken during October.

The local shocks (of which I noted a great many) between the large ones came from different directions. Underground noises were frequent.

There had been wild reports about threatening eruptions or the Fajumulco Volcano (4210 m.), the highest in Central America. I ascended it in June and went around it at its base, but the volcano was quiet. Great land and rock slides had altered its slopes a little, especially to the south and around the crater. The hot springs at the town of Fajumulco were nearly in the same condition as when I had seen them in 1885.

The people of the district were also much afraid of the volcano of Santa Maria. This volcano, 3768 m. high, is in its upper

part a nearly perfect truncated cone. All sign of a crater has disappeared, the top being flat. There is no notice, not even tradition, about any eruption of the Santa Maria in pre-Columbian or historic time.

Between this volcano and the town of Quezaltenango, to the north-east, rises the volcano Cerro Quemada (burned mountain) to 3179 m., indicating a secondary fissure nearly at a right-angle to the primary volcanic fissure of Guatemala. The Cerro Quemada has a very large crater, difficult to go over on account of the big lava-boulders filling its bottom. No channel connecting with the interior of the earth is visible, but many solfataras and fumaroles exist there; they did not show any sign of renewed activity. The Cerro Quemada had its last eruption at the beginning of last century.

The deep-cut and narrow valley of the River Samalá separates these two volcanoes, Cerro Quemada and Santa Maria, eastward from the old volcano Zuñil. In the bottom of this valley, there are, near the Indian town of Almolonga, hot springs (their water had been reduced in quantity after April 18), and farther down, below the town of Zuñil, a great many fumaroles send up hot steam, and some of them show sometimes geyser-like phenomena, throwing out at intervals plenty of hot water to a height of a few feet. During the rainy season (May to October), these fumaroles produce more steam, and there is also a marked increase of their activity from the forenoon maximum of barometric pressure to the afternoon minimum.

To the north-west of the volcano Santa Maria rises the much more voluminous mountain mass of Siete Orejas (seven ears), 3361 m. high. It is a very old volcano; the upper part has disappeared and the disintegrating influences of water and air have carved out on its top a number of rounded eminences; deep barrancos cut its sides. On its southern slope, towards the Costa Cuca, exists a pretty large parasitic crater with a lake of about ½ km. diameter in it, called Chicabal. It has not yet been mentioned anywhere before.

The southern slopes of Siete Orejas and Santa Maria are separated by the barranco of the River Ocosito, which also separates the coffee districts of "Costa Cuca" and "Xoluitz." To the east of Xoluitz follows the district of "El Palmar." The highest coffee plantations here were Helvetia, San Antonio and La Sabina (1150 m.), the last one also a very popular bathing resort, with strong springs of mineral water (carbonic acid).

The region from the Costa Cuca to El Palmar was the most famous coffee district of Guatemala. Its annual production was from 250,000 to 300,000 quintals, and its plantations were provided with the best machinery and gave employment to about 40,000 labourers.

A great part of this prosperous region has been nearly annihilated by a volcanic outburst at the south-west side of the volcano Santa Maria.

Soon after midnight of October 24–25, terrific detonations announced the beginning of the volcanic activity (N.N.W. of El Palmar and at about 1800 m. elevation above sea level). These explosions were heard so far as the capital of El Salvador, over a great part of Chiapas and in the western part of Spanish Honduras. Here, near Gualan, I am about 150 km. in a straight line from the Santa Maria, but was awakened at 1 a.m. by the noise of explosions like cannon shooting at short distance. Towards morning, the louder detonations were repeated at longer intervals, but between them a nearly constant low roar could be heard. All noise ceased at about 1.30 p.m., but began again at 6 p.m. and lasted until 11.30 p.m. During the following three days, I heard detonations at different intervals.

The new volcanic vent began pouring out an immense quantity of ashes, sand and pumice-stone. The prevailing north and north-easterly winds spread the lighter material in a dense veil to the west and south-west, producing so far as Tapachula in Soconusco darkness for more than forty-eight hours. Ashes, sand and small stones fell in quantity over a large area, crushing houses, burying the vegetation, and a great many people perished. In the town of Quezaltenango (24,000 inhabitants), although the quantity of ash falling was not very dangerous, people got nervous about the terrific roar and afraid about the strong sulphurous smell, and thousands left the place. A great exodus began from the whole affected district, although heavy rains which accompanied the eruptions had swollen the rivers and destroyed every bridge. All the labourers, mostly Indians from the highland towns, ran away, but many perished under the falling ashes or were drowned in the rivers. The plantations nearest to the new crater are covered by a layer of stones and ashes 5 m. to 10 m. deep. Farther away, of course, less material fell, but still the damage done is very great. This year's coffee harvest there is completely lost (more than 200,000 quintals), and it will be very difficult to get the labourers back again to begin work to save what can be saved still.

Until a few days ago, it has been very difficult for me to get any exact information about this eruption. Dr. Carl Sapper, who arrived in Guatemala City on October 24, went afterwards to Quezaltenango. He writes me that he tried to get near the focus of eruptions, but the ashes and the sulphuretted hydrogen impregnating the air obliged him to turn back, and he could not get even a look at the new crater. In the Indian town of San Martin Chileverde, fifty-six persons killed had been buried, but as many huts are still under the ashes, more corpses will be found later. From some other places, he reports forty-eight lives lost, but the list is very incomplete.

Dr. H. Prowe writes me under date November 15 from Chocolá:—"The eruption is going on with frequent strong earthquakes, but the quantity of ejected material is diminishing greatly. The number of people who perished cannot be estimated yet, but more were killed now than by the earthquake on April 18. The new volcanic cone can be seen from San Felipe. It has an elliptic crater three miles by one mile (?) diameter."

For several years, the volcano Izalco, in El Salvador, the most active in Central America, had been very quiet. After April 18, it began its eruptions again, sending also forth a lava stream towards south-east, which nearly filled up a barranco between the volcano and the town of Izalco.

During last May, the volcano Momotombo, in Nicaragua, had a short eruption; now comes from the same country a report about the volcano Masaya being active. Dr. Sapper, who will leave San José de Guatemala on December 11 for Panamá and the West Indian Islands, intends stopping at Nicaragua to investigate these eruptions.

EDWIN ROCKSTROH.

Gualan, Guatemala, C.A., November 30, 1902.

PROF. LORENZ'S TREATMENT OF CONGENITAL DISLOCATION OF THE HIPS.

ON Wednesday, January 14, at the City Orthopædic Hospital, Prof. A. Lorenz, of Vienna, demonstrated his "bloodless" method of reduction of congenital dislocation of the hips. Before giving details of the demonstration, it may be desirable to describe plainly the nature of the affection.

Children are sometimes born with one or both hip-joints dislocated, the head of the thigh-bone being displaced either above and behind or above and in front of its socket, and sometimes in other directions. The parts of the bones forming the joint may be perfectly, or almost perfectly, formed, but are more often defective in shape; the head of the thigh-bone, instead of being a rounded projection, may be in the form of an irregular cone, and the neck of the bone, which should unite it to the shaft, may be shortened or absent. The socket in which this head should work—it is a ball and socket joint—is generally more shallow than is natural, and is very frequently deficient at its margins, especially posteriorly and above. Consequently, should it be possible to get the head back to its place, there is a great tendency to redisplacement.

It has always been the aim of those surgeons who especially study such cases (orthopædic surgeons) to retard, or arrest, or correct the deformity. It is impossible here to give the history of the surgery of this affection. It dates from the time of Hippocrates, but it was in the early part of the last century that surgeons, such as Dupuytren, Guérin and Pravez, described the affection scientifically and explained practical methods for treatin it. Pravez, jun., seems to have carried out treatment upon much the same lines as those now adopted by Lorenz, and several orthopædic surgeons in this country have, since then, followed the same plan

with more or less success. Buckminster Brown in America, William Adams, Noble Smith and others in England, have published cases in which they have been successful, not only in reducing the deformity, but in producing a permanent cure. The chief difficulty has always been the retention of the head of the bone in its normal position after reduction, and, in some of the cases so reduced, a relapse is said to have occurred. The less defective the joints, the better the prospect of success. Noble Smith recorded in the *British Medical Journal*, November 6, 1897, the case of a girl, aged six, whose left leg was affected and was two inches short in walking, but which was brought down by extension to a normal position in about three months. The patient was kept from bearing any weight on the affected limb for two years, and was then dismissed as cured. Three years later she was well, and walked perfectly, with so trifling a shortness of the limb that it was not noticeable.

Prof. Lorenz has, it seems, perfected this method of treatment. In double displacement, when the children are not more than seven years of age, and in single displacement up to the age of nine, he effects immediate reduction. He forcibly tears the contracted adductor muscles (in which operation he effects the division by manipulating and chopping the muscle with his hand), he then flexes the thigh on the body in order to stretch or tear the posterior muscles, and he extends the leg backwards in order to do the same to the anterior muscles. By these means he so loosens the joint that, by manipulation with the thigh flexed and abducted, he rotates the head of the femur into the depression of the acetabulum. He then forcibly abducts the limb in order to enlarge the anterior part of the capsule of the joint, and fixes the limb in this position. This fixation is, perhaps, the most important part of his treatment, from the demonstration of which the few English surgeons who had previously tried to follow out Dr. Lorenz's methods have learned much.

The tendency to redisplacement of the head of the femur backwards and upwards is counteracted by the extreme abduction and outward extension of the thighs.

Thus the thigh, or thighs, are held out at right angles to the body to prevent displacement upwards, and they are held more backwards than forwards to prevent displacement of the heads of the femora backwards. This position is maintained by plaster of Paris bandages encircling the pelvis and extending to just above the knees. In a few days, the child is allowed to walk in its enforced squatting position. This she—most cases are girls—can do by supporting herself with a stick held by both hands in front, or she can be seated on a stool with castors and move herself about the floor. Lorenz has found it necessary to keep up this position for six months, then to bring down the thighs to a less angular position with regard to the body, so that the child can walk more easily, while, at the same time, the heads of the femora still press inwards and help to produce stability of the joint. The whole treatment must last for two years, and this length of time has been found necessary by surgeons in the past. In older patients, Lorenz advocates preparation by continued extension and, if necessary, by division of muscles, and in all cases this preparation is helpful.

The word "bloodless" is applied to this treatment merely in comparison to the operation of opening the joint in order to replace the head of the bone. It does not indicate the slightest opposition to the use of the knife when such is desirable.

Whatever may be the view of the surgeons of general hospitals, there seems to be no doubt among the leading orthopædic surgeons, such as Mr. Robert Jones, of Liverpool, and Mr. Noble Smith and his colleagues at the City Orthopædic Hospital in London, that the treatment so ably advocated and perfected by Prof. Lorenz is, at the present moment, the most satisfactory means known for dealing with these deformities.

The objections raised by these surgeons to the "open" method are :—(1) That it is a very severe operation and dangerous to life ; (2) that the results often lead to ankylosis of the joints operated on. One stiff joint may be sustained with comparative impunity, but if two stiff joints should occur, sad, indeed, is the condition of the patient, for walking is for ever after impossible.

The accidents which Prof. Lorenz so outspokenly referred to as having happened to him in first trying his bloodless method are matters of the past, and he asserted that, with due care on the part of the surgeon, such accidents ought never to occur again.

THE EGYPTIAN MEDICAL CONGRESS.

THE increased interest which is now being taken in the diseases of warm climates was clearly shown at the medical congress held in Cairo last month. Egypt, the recognised home of epidemics in the past, is the victim of many plagues to-day which constitute it an excellent field for medical study ; and the proceedings of the congress bore ample testimony to the scientific importance of the research work which is being diligently carried on in the valley of the Nile.

Out of a large mass of communications read before the meetings, we may select as worthy of special notice the papers on cholera, and the account of recent discoveries in connection with the Bilharzia and Ankylostomum parasites.

The reports on the late outbreak of cholera showed what admirable results had attended the work of the sanitary authorities. The enlightened and up-to-date methods now employed by them in combating the epidemic stand out in strong contrast to the misdirected efforts of their predecessors. Nowhere can we see more clearly the practical benefits which have been conferred on mankind by modern progress in bacteriological science. It is now incontestably established that cholera is spread by the infected water of the Nile and by the wells and drinking-fountains in the mosques to which the natives have common access, and the measures of the sanitary authorities are mainly directed towards preserving the purity of drinking-water as the best defence against epidemics. A general opinion now prevails, founded on the latest reports, that internal supervision and hygienic measures are of more value than quarantine regulations, which so often prove ineffective, and such measures are becoming increasingly important on account of the growth of population and crowded condition of the big towns. One great difficulty still remains—the problem of educating the natives up to the reforms which are being introduced for their benefit. Their ignorance of the elementary laws of health, combined with an innate indifference, still constitutes the main obstacle with which the authorities have to contend. At the same time, the recent epidemic would never have been dealt with so successfully if there had not been a growing enlightenment among the lower classes and a readiness to cooperate with the Government in its work of sanitary reform.

The scientific importance of Prof. Looss's papers on Bilharzia and Ankylostomum, particularly for students of tropical diseases, can hardly be overestimated. The diseases produced by these parasitic worms work the most terrible havoc among the native population of Egypt, and attempts have been made for some time past to find out by what means these parasites enter the human system and lodge in the intestine. The story of Prof. Looss's remarkable discovery is of the greatest interest. While making some experiments in the cultivation of ankylostomum worms, he accidentally allowed a drop of

water containing a number of these larvæ to rest on his hand. In a few minutes, a slight irritation set in which attracted his attention, but on examining his hand under a lens he found that the larvæ had disappeared. His conviction that they had forced their way through the skin into the subcutaneous tissues was confirmed at a later date, when he discovered that his intestine contained the ova of the parasite and that he had thus infected himself with ankylostomiasis. At the time, many persons were inclined to doubt his explanation of the occurrence, but he has since then made experiments with dogs and human beings, and in each case has been able to prove that the larvæ, entering the body by the skin, have worked their way into the intestine.

His study of the Bilharzia parasite has not yet reached the same stage of advancement, but although he cannot at present demonstrate the fact, he is convinced that the mode of infection is by the skin, as in the case of ankylostomum, and not by the mouth, as has been supposed. The negative evidence in support of this theory is that if the larvæ of Bilharzia are brought even momentarily into contact with weak solutions containing acids they are at once killed, and this fact renders it impossible for them to pass the stomach if they are taken by the mouth. Positive evidence is still wanting, owing to the great danger involved.

Prof. Looss has not felt justified in making experiments on human beings until a more perfect knowledge of the larvæ is attained, and it is difficult to find animals with a skin resembling that of human beings for the purposes of experiment. But from some partial successes he has had, he considers it only a matter of time before his contention will be established, namely, that healthy persons can become infected with bilharzia merely by dipping a hand or foot into water containing larvæ. When we consider how much of their time the natives spend in wading in the Nile and in the canals, the water of which contains these parasites, we are at last within measurable distance of accounting for the extraordinary prevalence of the disease among them.

THE VACCINATION ACTS.

THERE seems good reason to hope that the legal obligation of parents to procure the primary vaccination of their children in infancy will be extended in the ensuing session of Parliament so as to include revaccination at about twelve years of age. The widely representative and weighty deputation of the Imperial Vaccination League which interviewed the President of the Local Government Board last week made out a strong case for this and other amendments of the present law as to vaccination, and they had a most sympathetic reception from Mr. Long. He, of course, spoke only for himself, and not for the Government as a whole, but being the head of the Board which has charge of the subject, and having evidently given it most careful consideration and arrived at pretty definite conclusions as to the main points requiring attention in a new Act, there seems every reasonable prospect that these conclusions will be found embodied in a Bill and submitted to Parliament in time for enactment before the session ends. It must be recollected that the question comes up this session in any case. The Act of 1898, which introduced domiciliary vaccination and the Conscience Clause, is only a temporary measure, ceasing to have effect after the end of the present year. There is no chance of its being allowed to drop so as to cause reversion to the old system, and very little chance of its simply being included in the Expiring Laws Continuance Bill. When they are at it, therefore, it is important that Government should deal with the matter with some degree of finality. The five years' experiment has been most useful in furnishing experience of the strong and weak points of the present law, so that the whole subject is ripe for legislative treatment. The aim should be to achieve, as nearly as possible, German results by English methods, and the chief points requiring attention are obligatory revaccination, the supply of glycerinated calf lymph, the adoption of a standard of efficiency of vaccination, and the transference of the administration of the Vaccination Acts from Boards of Guardians to public bodies better adapted for the work.

REV. DR. H. W. WATSON, F.R.S.

THE death, on January 11, of the Rev. H. W. Watson, Sc.D., F.R.S., has removed from the scientific world a worker who did much to elucidate one of the most difficult applications of mathematical reasoning to molecular science.

Henry William Watson was born in London in February, 1827, being the son of the late Thomas Watson, of the Royal Navy. At the age of nineteen, he gained the first mathematical scholarship at King's College, London, and two years later obtained a scholarship at Trinity College, Cambridge, where he graduated in 1850 as second wrangler and Smith's prizeman, Dr. Besant being senior wrangler. In 1851, he was elected fellow and assistant tutor of Trinity College, Cambridge, but on his marriage he was compelled by the then existing statutes to seek a livelihood elsewhere, and accordingly he obtained a mathematical mastership at the City of London School in 1854, and was appointed mathematical lecturer at King's College, London, in 1856 and assistant master at Harrow School in 1857. His work as a teacher ended after his appointment to the rectory of Berkeswell, near Coventry, where he resided until within a short time of his death. He was elected Fellow of the Royal Society in 1881.

A considerable proportion of Dr. Watson's published work was written with the collaboration of Mr. S. H. Burbury, F.R.S. Among these joint writings, we notice the treatise on generalised coordinates applied to the kinetics of a material system, published in 1879, the article "Molecule" in the ninth edition of the "Encyclopædia Britannica" and the treatise on the mathematical theory of electricity and magnetism, of which the first volume ("Electrostatics") appeared in 1885 and the second in 1889. The appearance of the latter volume occurred at a somewhat critical period in the history of electromagnetism. It was Dr. Watson's hope to clear up many of the obscure points in the deductive reasoning on which Maxwell's theory of electromagnetism was based. The same task had been undertaken about the same time in Germany by Hertz, who had, however, sought to substantiate the theory on experimental grounds, and his demonstrations of electric oscillations, followed up by the work of Fitzgerald and Lodge, diverted attention from the mathematical treatment of the subject. Dr. Watson, on the other hand, found in the course of the work that many points in Maxwell's theory could not be established by deductive reasoning alone, but he has given remarkably elegant treatments of many of the problems in which this difficulty does not occur.

The books written by Dr. Watson alone include a treatise on geometry in Longmans' Text-books of Science Series (1871), but his best-known work was the collection of propositions on the kinetic theory of gases, which for many years served as a text-book on this subject. While the second edition of 1894 was still in preparation, a controversy arose as to the validity of the Boltzmann-Maxwell law, and an apparent exception had been suggested in the case of a system of lop-sided spheres. Dr. Watson, by his investigation of the corresponding problem for circular

discs, did much to elucidate the error in the investigation in question, and to establish the result that if the distribution of coordinates and momenta, which Gibbs now calls "canonical," exists at any instant, it will exist at all future instants. He also gave considerable attention to Boltzmann's minimum theorem, putting the proof into an elegant form.

The theory of errors was a favourite study of Dr. Watson's, and in February, 1891, he read an address before the Birmingham Philosophical Society on the subject. About the year 1894, he was appointed examiner in mathematics in the University of London, but before his term of office had expired, he was compelled to resign owing to a slight paralytic stroke. Recently, owing to ill health, he gave up the rectory of Berkeswell, and migrated to Brighton not long before his death.

Dr. Watson was a representative of the old school of physicists who relied on mathematical reasoning alone, an extreme which would at the present day be as far on one side of the happy mean as the modern experimentalist who builds up mere tables of numerical results is on the other. But his chief work was done at a time when "natural philosophy" meant applied mathematics and not experimental electricity. He was a valued friend to whom the present writer has on more than one occasion been deeply indebted for help and assistance in difficulties. G. H. BRYAN

DR. H. E. SCHUNCK, F.R.S.

BY the death of Dr. Edward Schunck, the world has suffered the loss of one of that small band of men of fortune who have devoted themselves to the study of science for its own sake. Edward Schunck was born in Manchester on August 16, 1820, to which town his father, Martin Schunck, had a short time previously removed from Malta to found the business of Schunck, Mylius and Co. This, which was one of the first firms of export merchants started in Lancashire, afterwards became Schunck, Souchay and Co., and as business increased they acquired a dye works in Rochdale. As Martin Schunck was anxious that his son should eventually undertake the management of this works, he sent him to study chemistry under Liebig at Giessen, and at Berlin under Rose and Magnus, but eventually, after some years' trial, the son found that he did not care for the business, and decided to devote himself entirely to research work.

Schunck must, without doubt, be considered the most celebrated worker upon the natural colouring matters, for among these substances there is hardly one to which he has not contributed some fact of considerable importance. His elaborate investigation of madder, commenced in the 'forties and continued to 1894, constitutes an excellent example of the energy and patience which characterised him throughout the whole of his career. With our opportunities of to-day, it is not easy to appreciate fully the labour entailed by his early work in this direction, and though he was most anxious for some younger man to complete his investigation of the yellow substances contained in this plant, no one has yet attempted to face the difficulties of this subject.

It is not possible in this short notice to attempt an account of the numerous researches of his long and active career; on the subject of madder, alizarine and various anthraquinone derivatives, he published more than thirty papers, and his contributions to the chemistry of the lichens, indigo, cochineal and chlorophyll have been of the highest importance. His early predilection for the study of natural products remained with him to the last, and until quite recently he was engaged upon the investigation of the colouring matter which is present in the common blackberry. The difficulty of the many subjects which he undertook and the elaborate care which he bestowed upon even the smallest operation account for the fact that he was less prolific than many of his contemporaries, but this, on the other hand, has added to the more permanent value of his researches. His dislike for slovenly or untidy work was characteristic of the man, and he frequently stated his inability to work in comfort should more than four glass vessels be upon the bench before him. Shortly after his father's death, which occurred in 1872, he erected his private laboratory at Kersal; this, which is probably the finest in the kingdom, he bequeathed to the Owens College, Manchester.

He was a Fellow of the Royal Society, for some years president of the Manchester Literary and Philosophical Society, a vice-president of the Chemical Society, and, from 1896–7, president of the Society of Chemical Industry, and in 1887, at the Manchester meeting, was president of the Chemical Section of the British Association. In 1898, he received the Dalton medal of the Manchester Literary and Philosophical Society; in 1899, the Davy medal of the Royal Society, and in 1900, the gold medal of the Society of Chemical Industry. He married, in 1851, Judith, the daughter of John Brooke, of Stockport, who survives him, and of his eight children four are now living. A. G. P.

NOTES.

ALL who are interested in scientific progress will welcome the suggestion that the time has now fully arrived for obtaining a public portrait of Lord Rayleigh, whose work and influence have contributed greatly to the advancement of natural knowledge. The eminence of Lord Rayleigh as a scientific discoverer renders such a form of commemoration most desirable, and his public services in many capacities, including that of chairman of the board of the National Physical Laboratory, supply additional reasons. The proposition that steps should be taken to give effect to this project has already received the assent of a number of leaders in the scientific world, and Sir Andrew Noble, Sir Oliver Lodge and Prof. Arthur Schuster have consented to act as joint treasurers for this purpose. It is intended to circulate a first formal list of subscribers after the end of January. It is therefore desired that those who wish to participate will signify their intention to one of the treasurers, by name, at the address of the Royal Society. A meeting of subscribers will be called hereafter to decide upon the next steps to be taken.

THE successful inauguration of wireless telegraphic communication between the United States and England was accomplished by Mr. Marconi at the beginning of this week, which is less than a month after the first message was sent from Cape Breton, Canada, to this country. The distance from the United States station at Cape Cod to Cornwall is about 3000 miles, and is, therefore, greater than that from Cape Breton. The first message was sent from President Roosevelt to the King, and was dispatched by Mr. Marconi himself. The message read as follows:—"His Majesty King Edward VII., London. In taking advantage of the wonderful triumph of scientific research and ingenuity which has been achieved in perfecting the system of wireless telegraphy, I extend on behalf of the American people the most cordial greetings and good wishes to you and all the people of the British Empire. (Signed) THEODORE ROOSEVELT." Later in the day, His Majesty replied in the following terms:—"To the President, White House, Washington. I thank you most sincerely for the kind message which I have just received from you through Signor

Marconi's Transatlantic wireless telegraphy. I sincerely reciprocate, in the name of the people of the British Empire, the cordial greetings and friendly sentiment expressed by you on behalf of the American nation, and I heartily wish you and your country every possible prosperity. (Signed) EDWARD R.' We heartily congratulate Mr. Marconi on this fresh success and hope that both the Transatlantic systems will soon be in continuous and useful operation.

As an example of the way in which wireless telegraphy can contribute to the pleasantness, if not to the safety, of travelling by sea, we may call attention to the chess match which took place between two Atlantic liners whilst both were at sea. The *Lucania* started a match by wireless telegraphy with the *Minnetonka*, but after a few moves the communication was broken; later, however, the *Lucania* got into communication with the *Philadelphia*, and a second game was started, which was played out to a finish; the game lasted for three hours, and ended in a victory for the American team over the English. The ships were about fifty miles apart during the playing of the game.

ACCORDING to the *Daily Mail*, Mr. Marconi's system of wireless telegraphy is to be utilised to help forward the through telegraphic communication from the Cape to Cairo. A definite scheme, it is stated, is to be prepared at once, and in the meantime the African Transcontinental Telegraph Company will stop all further extensions from the south. At present, wires have been erected as far north as Lake Tanganyika, and it is expected that the final link between Cairo and Fashoda will be open very soon. Wireless telegraphy, it is hoped, will enable some of the difficulties of the country north of Lake Tanganyika to be surmounted successfully.

MR. QUINTIN HOGG, whose death we regret to record, was one of the few wealthy men in England who are sufficiently interested in educational work to devote their time and means to its advancement. He founded the Polytechnic Institution in Regent Street, London, in 1881, and is said to have spent about 100,000*l.* upon his scheme. The place was designed for 2000 members, but during the first winter the number reached 6800, and there are now between 17,000 and 18,000 members and students of both sexes. For quite twenty years (says the *Times*), Mr. Hogg devoted a large portion of his time, and much of his wealth, to this institution, the object of which was to provide evening teaching, technical training, gymnastics, music and rational amusement to the young men and girls of the commercial class in central London. The success of the Polytechnic was immense, and it provided the model on which all the others in London were formed in later years. No one can say how much the Polytechnic cost him in actual money, but it is believed that 6000*l.* a year is a moderate estimate, up to the date when the institution (with those newly founded on the same model) began to receive grants of public money. Mr. Henry Cunynghame points out in the *Times* that but for Mr. Hogg, London might still be without its polytechnics. It appears that an Act passed in 1883 enabled the Charity Commissioners to schedule the obsolete charities of the City of London and devote them to education. The Commissioners' attention was called to the Regent Street Polytechnic, "and ultimately on this model there arose that group of polytechnics which accommodate in London over 30,000 boys, and stand like forts in the sea of London temptations to youthful dissipation, ignorance and idleness."

THE article which Dr. A. R. Wallace contributes to *Black and White* of January 17, on his relations with Darwin in connection with the theory of natural selection, is a historical document of great scientific interest. Dr. Wallace was introduced to Darwin in the insect-room of the British Museum in 1854. While living in Borneo in 1854, Dr. Wallace wrote a paper "On the Law which has Regulated the Introduction of new Species," which was published in the *Annals of Natural History* in the following year. Hearing that Darwin was preparing some work on varieties and species, Dr. Wallace sent him a copy of his paper and received a long letter in reply, but no hint was given by Darwin of his having arrived at the theory of natural selection. Darwin had, however, actually written out a sketch of his theory in 1842, and in 1844 this sketch was enlarged to 230 folio pages, giving a complete presentation of the arguments afterwards set forth in the "Origin of Species." Dr. Wallace arrived at the idea of the survival of the fittest as the operating cause in evolution in 1858, and immediately sent the outlines of this theory to Darwin, who brought the communication before Sir C. Lyell and Sir Joseph Hooker, and urged that it should be printed at once. Upon their advice, however, he consented to let an extract from his sketch of 1844 be presented to the Linnean Society with Dr. Wallace's paper on July 1, 1858. "In conclusion," Dr. Wallace says, "I would only wish to add that my connection with Darwin and his great work has helped to secure for my own writings on the same questions a full recognition by the Press and the public; while my share in the origination and establishment of the theory of natural selection has usually been exaggerated. The one great result which I claim for my paper of 1858 is that it compelled Darwin to write and publish his 'Origin of Species' without further delay." The story reflects great credit upon both Dr. Wallace and Darwin, and many naturalists will be glad to read it. We congratulate Dr. Wallace upon having presented the world with such an interesting record after attaining his eightieth birthday.

THE death is annouced of Prof. Sirodot, correspondant of the section of botany of the Paris Academy of Sciences, and of Prof. Charles J. Bell, professor of chemistry in the University of Minnesota.

REUTER'S agency reports that a sharp shock of earthquake of vertical direction and lasting two seconds was experienced at Davos on Monday afternoon.

PROF. J. H. LONG, of Northwestern University, has been elected president of the American Chemical Society, in succession to Prof. Ira Remsen.

THE report of the committee appointed by the Board of Agriculture to consider the question of forestry as regards Great Britain has been issued as a Blue-book.

A MANCHESTER telegram states that Dr. Schunck's bequest to Owens College, Manchester, does not include an endowment of 40,000*l.* as reported. It is confined to his valuable laboratory and laboratory buildings.

PROF. GUSTAV BISCHOF, formerly professor of technical chemistry at Anderson's College, Glasgow, died in London, on January 13, in his sixty-ninth year. He was known as an analytical chemist, principally in connection with water analysis.

MR. THOMAS SUTTON TIMMIS, of Allerton, near Liverpool, has vested in trustees a sum of 10,000*l.* to initiate systematic research into the origin and cure of cancer. The investigations will be conducted at the Liverpool Royal Infirmary and the new laboratories of experimental medicine in University College, Liverpool.

A CENTRAL NEWS telegram states that the tests of the new 16-inch gun, just mounted at Sandy Hook, took place on January 17 with complete success. Three shots were fired, one with the full service charge of 640 lb. of smokeless powder, said

to be the largest yet fired, and a projectile weighing 2400 lb. The shot struck the sea three miles from shore. The gun will have a range of twenty miles.

THE Paris correspondent of the *Times* states that at a meeting of the Academy of Moral and Political Sciences on January 17, the incorporation of the British Academy with the International Association of Academies was agreed to unanimously. Lord Reay, the first president of the British Academy, who is a correspondant of the Institute, expressed his thanks for the decision.

WE learn from *Science* that the Carnegie Institution of Washington has made a grant to the Marine Biological Laboratory, and now has at its disposal twenty tables in the laboratory at Woods Hole, Mass., for the season of 1903. These tables are intended for the use of persons engaged in original research in biology, and carry with them the right to be furnished with the ordinary supplies and material of the laboratory.

ACCORDING to the *Daily Mail*, Mr. Edward Baily, of Penzance, formerly of Mansfield, Notts, has presented to the Mansfield Town Council, in trust for his native town as a nucleus of a museum, a large and valuable collection of natural history specimens and scientific apparatus, collected by him during the past twenty years.

THE protection of the coasts from the inroads of the sea has become a matter of great importance in Norfolk and Suffolk. A meeting to consider what action should be taken was held at Norwich on Saturday last, many representatives of local bodies and public companies being present. Sir Samuel Hoare, M.P., wrote that he would like to see the Government appoint an experienced commissioner for Norfolk and Suffolk, or better still, one for each county, to report on the present encroachments, after some months' work and experiments, and to have under him officers in charge of certain portions of the coast who should keep records of daily, weekly and monthly observations. The following resolutions were adopted :—(1) "That the inroads of the sea upon the coasts of Norfolk and Suffolk have increased so much as to become a national danger; that the existing powers of the local authorities and the financial resources at present available are insufficient for the construction and maintenance of adequate works of sea defence, and that the time has arrived when measures should be taken with the least possible delay to bring the subject, by petition or otherwise, to the notice of His Majesty's Government with the view of obtaining a Government inquiry, and some relief towards, or allowance in respect of, the cost of maintenance of such protection works." (2) "That a committee be formed, consisting of the members appointed by each of the local authorities concerned, with power to add to their number, together with their representatives in Parliament, to consider the best means for giving effect to the foregoing resolution, and, if considered advisable, to confer with other districts in the country similarly affected, and to report thereon to the respective local authorities, and that when necessary another conference be convened upon the subject."

A NEW system of telegraphic time-signals has been adopted by the U.S. Naval Observatory, Washington, and has many advantages over the method followed in this country. Instead of sending one signal at noon, as is done here for the noon signal from Greenwich, a series of signals, beginning at five minutes before noon and ending at noon, is sent out from the Observatory. This series agrees with that in use on the Pacific coast, so that the same system is now employed throughout the United States. During the interval over which the time-signals extend, every tick of the transmitting clock is signalled electrically, except the twenty-ninth second of each minute, the last five seconds of the first four minutes and the last ten seconds of the last minute. After this final break of ten seconds' duration, the noon signal is given. The electric connections of the transmitting clock at the Observatory emit certain sounds which can be easily distinguished by anyone listening to a sounder in a telegraph or telephone office. It is thus possible to recognise, by means of the breaks in the record, the middle and end of each minute, and especially the end of the minute which terminates at noon. As the signal is seldom in error to an amount greater than one- or two-tenths of a second, and electric transmission over a continuous wire is practically instantaneous, the series of noon signals provide a convenient means of accurately regulating clocks to standard time throughout the United States. The system is much to be preferred to that of sending a single signal at noon, as is done in this country for Greenwich time.

DURING the greater part of the week ended January 17, the British Isles were under the influence of an area of high barometric pressure, and experienced very cold *northerly* and *easterly* winds, the temperature being much below the average. The *Weekly Weather Report* just issued by the Meteorological Office states that the temperature was as much as 10° below the normal in the midland counties, 9° in Scotland W. and the western half of England, and between 8° and 6° in other parts of the kingdom. The highest of the maxima were recorded, as a general rule, towards the end of the period, and ranged from 50° in the Channel Islands and 49° in Ireland S. to 40° in Scotland E., England N.E. and the midland counties. At inland stations, the daily maxima during the week were frequently below 32°, and at Lairg on January 13 the highest reading was no more than 20°. The lowest of the minima were mostly recorded about the middle of the week. In Scotland N. (at Braemar on January 13), the screened thermometer registered a minimum of 1°, and on the following day, that at Lairg, Scotland N., fell to 6°. Elsewhere, however, the minima ranged from 12° in England N.W. and 13° in the midland counties to 20° in Ireland S. and 26° in the Channel Islands. In the neighbourhood of London, the greatest cold during the present winter, 24° in the screen, occurred on the night of Thursday to Friday, while at Greenwich the exposed thermometer on grass registered 12°. On Saturday a sudden thaw set in with snow and rain, which froze on touching the cold ground and formed a layer of ice known as silver thaw, owing to which very many accidents occurred to pedestrians.

IN his presidential address to the Institution of Engineers and Shipbuilders in Scotland, reported in the *Transactions*, Mr. William Foulis stated that several important changes had been made. The number of members of council was increased, the class of students was placed on a more satisfactory basis and a class of associate members was formed. The most important points for future improvement were, first, that a member of council should preside at students' meetings; secondly, that a research committee should be formed; and, thirdly, that more and better accommodation should be provided for the Institution and especially its library.

A MATHEMATICAL investigation of the theory of railway brakes is given by Prof. A. Sommerfeld in the *Denkschrift* of the Technical College at Aachen, published in connection with the Düsseldorf Exhibition. Prof. Sommerfeld divides the action of the brake into three phases, the first characterised by pure rolling of the wheels on the rails, the second by a mixture of rolling and slipping, while in the third phase the wheels slip along the rails without rolling. A consideration of the three phases leads to an explanation of the property that an increase of brake pressure sometimes reduces the efficacy of the brakes.

instead of increasing it. In the investigation, account is taken of the dependency of the coefficient of friction on the velocity based upon experimental determinations.

SOME estimates of the stresses in the riveted attachments in ships are given in the December number of the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland by Dr. J. Bruhn. Taking ships of various dimensions, the author calculates the stresses at the gunwale amidships from the ordinary theory of bending, and the stresses in the rivets are obtained from the assumption that the stress is increased above that on the solid plate in proportion to the reduced sectional area. By drawing curves showing the relation between the stresses so calculated and the lengths of the ships, it is shown how the stresses on the edge riveting are being rapidly increased by the increase in the size of vessels and also by the tendency to let full-formed vessels proceed to sea in light or comparatively light conditions, particularly when water ballast has been added. Practically the only way of reducing the stresses is by increased rivet area. In some cases, this may be obtained by closing up the spacing of the rivets, but eventually, as the size of the ship increases, an additional row of rivets must be fitted.

AN interesting report on the plasticity of clays is presented to the *Bulletin de la Société d'Encouragement* for November 30, 1902, by M. B. Zschokke. Of the various theories of plasticity, the author attaches much importance to that of A. Rejtö, according to which the peculiar properties of clay are due in the main to the fact that the cohesion of its particles exceeds the internal friction. A number of experiments are described in which the tenacity of various samples of clay was tested by submitting cylinders to longitudinal traction. One remarkable result of these experiments is that the elongation previous to rupture is greater when the traction is applied rapidly than when it is applied slowly. With rapid tractions, the diagrams obtained show that the separated portions taper to sharp, almost conical, points (Fig. 1), whereas with tractions applied gradually to the same samples of clay the breakage seems to take place abruptly before the constriction at the middle of the bar has become great (Fig. 2). This remarkable property is the exact opposite of that met with in the majority of substances, such as metals. The attempt to explain the phenomena has led M. Zschokke to a study of the microscopic structure of different samples of clay, in illustration of which several diagrams are given. Finally, the author defines plasticity as that property of a body, possessing as great a cohesion as possible, of undergoing, under the action of external forces, very great permanent deformations without the deformed body exhibiting any change in its cohesion relatively to the original body. Plasticity, it is pointed out, depends largely on the absorbing power of the clay and its attraction for the absorbed water, and the latter depends partly on the size of the particles and partly on the physical or chemical affinity between these particles and the water.

FIG. 1.

FIG. 2.

THE *Annales de l'Observatoire Astronomique* of Moscow (vol. iv., second series), which is published under the direction of Prof. W. Ceraski, contains some valuable contributions to astronomy. The volume opens with the reductions of the meridian observations made by M. Modestow of stars in the zone 0° to +4° declination, the object being to determine the positions of all stars down to magnitude 8. This is followed by three contributions by M. S. Blakjo on the calculation of occultation of stars by the moon, containing tables to facilitate reduction, observations of the Leonids in 1897, 1898 and 1899, and of the planet Mars in 1896–1897 (with plates). Prof. Ceraski gives a valuable photometric study of a certain number of stars in the constellation of Coma Berenices, and adds a process plate showing a portion of the region.

MR. H. A. BRYDEN contributes to the *Fortnightly Review* for January an article on the decline and fall of the South African elephant. It appears that the wild elephant has now practically ceased to exist south of the Cunene and Zambesi rivers. About the year 1830, elephant hunting in Cape Colony was prohibited by the British Government. Since that time, remaining herds have been carefully protected, and they still roam the dense jungles of the Knysna Forest and the Addo Bush in large numbers. It is a curious illustration of what a little timely preservation will do for wild creatures that often within a few miles of Port Elizabeth and Mitenhage there are strong troops of these animals, while one may travel elsewhere fifteen hundred miles up country and not succeed in finding a single wild elephant.

IN his recent report on the trade of Würtemberg for the year 1901 and part of 1902, Dr. F. Rose, H.M. Consul at Stuttgart, refers to the heavy fall in the price of carbolic acid owing to the manufacture of this substance by a synthetic process. The commencement of the manufacture of synthetic carbolic acid in Germany was, the report points out, the direct result of the prohibition of the export of carbolic acid from the United Kingdom in January, 1900. In a former report, Dr. Rose, in the course of some remarks on the production of synthetic carbolic acid, said that "the high prices for phenol, caused by the prohibition and the low price of benzol in Germany, were instrumental in giving a great impetus to the endeavours of German chemists to discover a cheap working method of preparing phenol synthetically from benzol, and thus rendering Germany independent of the export from the United Kingdom. The danger to the British export trade of carbolic acid then foreshadowed has now become an actual fact."

IN a reprint of a pamphlet from the *Humane Review* entitled "The Fate of the Fur-Seal," the author, Mr. J. Collinson, directs attention to the cruelties connected with the driving and slaughter of these animals on the Pribiloffs, as well as to the evils of pelagic sealing.

A RECENT fasciculus (No. 1310) of the *Proceedings* of the U.S. National Museum is devoted to materials for a monograph of the North American insects of the order Thysanoptera. At the conclusion of the memoir, the author, Mr. W. E. Hinds, discusses the phylogeny of the different sections of the group.

WE have received a copy of a second lecture on "Thoroughbreds and their Grassland," by the Rev. E. A. Woodruffe-Peacock, forming No. 2 of the *Rural Studies Series*, in which the nature of soils and the best kinds of grass with which to sow them are discussed.

THE *American Naturalist* for December contains an important paper, by Prof. A. W. Grabau, on the morphology and growth of the gastropod shell, with especial reference to the protoconch, or embryo-shell. Attention is called to the fact that several of the modern limpet-like shells, such as Acmæa and Crepidula, have coiled protoconchs, whence it is inferred that this type of shell is probably not, as might at first sight

have been supposed, primitive. The subject is largely treated from the palæontological aspect.

CAPTAIN BARRETT-HAMILTON has sent us a copy of his paper, from the November number of the *Zoologist*, on the origin of sexual dimorphism and nuptial weapons and ornament. It is stated that the recent investigations into the life-history of the salmon, published by the Scotch Fishery Board, confirm the author's view as to the setting free of proteids and other compounds in the breeding salmon, and their transference to various parts of the body.

As is well known, the typhoid bacillus produces little or no toxin in artificial cultivations, and all attempts to obtain a typhoid antitoxin have hitherto proved failures. Chantemesse, however, by growing the typhoid bacillus in a special culture medium prepared from spleen and bone marrow, claims to have obtained a toxin with which he has been able to immunise horses and to prepare a typhoid antitoxin. Of 179 cases treated with the latter, seven died, a case-mortality of only 3·7 per cent., whereas of 1192 cases treated during the same period on general principles, 286 died, a case mortality of 19·3 per cent. (*La Presse Médicale*, December 24, 1902, p. 1227).

THE function of the flagellated body of the malaria parasite was for a long time a disputed question. In 1898, MacCallum found that in the Halteridium, a malaria-like parasite of birds, there were two varieties of the parasite, a granular and a non-granular, and he observed that it was only the latter that developed flagella. He had the good fortune to observe a flagellum from a non-granular parasite enter and fuse with a granular one, and therefore concluded that the flagellum was a fertilising element. It was suggested that the same would hold good for the malaria parasite, and MacCallum stated that he had actually observed this to be the case. Dr. Moore, of the University of Texas, announces that he has been fortunate enough to observe the phenomenon in a case of æstivo-autumnal fever. A hyaline or non-granular body was seen to be in active movement, and in a moment four active flagella were extruded. One of these became separated and happened to come in contact with a granular body, and after several attempts entered into this and became fused with it (*Johns Hopkins Hosp. Bull.*, October, 1902, p. 235).

FOLLOWING closely upon the revised list of herbaceous plants which was issued last June, a welcome addition to the literature originating from the Royal Botanic Gardens, Kew, is furnished by a new edition of the "Hand List of Trees and Shrubs Grown in the Arboretum." This does not include the Coniferæ, which are undergoing revision. Previously produced in two parts, the present list includes in the single volume the monocotyledons and all the dicotyledons to the number of about four thousand five hundred.

THE second fasciculus of the supplement to the "Index Kewensis" has been presented by M. T. Durand and Mr. B. Daydon Jackson, having been published, like the first, at Brussels. Included are genera from Cymbidium to Iriha, either new genera or those to which new species or synonyms were added during the decade commencing with the year 1886. Cypripedium and Dendrobium are considerably enlarged, chiefly owing to the enumeration of new hybrids; the additions to Hieracium are principally European, which is accounted for by the fact that during the era many investigators, notably Hanbury in Britain, were working out the variations of this polymorphic genus throughout the continent.

THE development of a somewhat rare Gasteromycete is described by Mr. J. R. Johnston under the name of *Cauloglossum transversarium*. A central columella runs throughout, the gleba contains chambers which are lined with basidia, and the periderm is very thin and ruptures irregularly, exposing the glebal folds. Cauloglossum may be regarded as a synonym for Podaxon, hence the author proposes the name Rhopalogaster and favours affinity with the Hysterangiaceæ. The paper appears in the *Proceedings* of the American Academy of Arts and Sciences, from which source comes also a fifth list of new species of Laboulbeniaceæ, with diagnoses contributed by Prof. Roland Thaxter. These are forms which were found growing on the bodies or appendages of insects.

ONE of the last reports issued by the Weather Bureau in Manila describes "the seismic and volcanic centres of the Philippine Archipelago." The author of this report, M. Saddera Masó, S.J., divides the Archipelago into four districts or sections, and for each of these gives, in chronological order with short descriptions, lists of large earthquakes and volcanic eruptions. In looking over these records, the earliest of which refers to the year 1599, it is interesting to note the instances in which these two phenomena have agreed in time. The relative frequency of earthquakes in the Archipelago is shown by a coloured map, by tables and by curves. Since 1880, maxima occurred in 1881 and 1897, with a minimum in 1886. The distribution of earthquakes in the rainy season (June to October), the dry cold season (November to February) and the dry hot season (March to May) are in the ratios 100 : 73 : 53. Other tables and diagrams refer to distribution of shocks according to years, months and hours, but it cannot be said that they show any marked periodicities.

MESSRS. A. E. STALEY AND CO. (35 Aldermanbury, E.C.) have sent us a small pamphlet entitled "Mahomet and the Mountain, a Modern Miracle," which they have just published The text is devoted to the elucidation of many points connected with the use of the telephotographic lens, and should be found serviceable to those who are commencing the use of this form of lens. Several typical illustrations are inserted. Those who wish to read this booklet can obtain one from the publishers post free on application.

THE twentieth volume of the *Geographical Journal*, containing the monthly issues from July to December, 1902, is now available. It commences with the address delivered by the president, Sir Clements Markham, F.R.S., to the Royal Geographical Society at the anniversary meeting. In addition to numerous other articles of interest, the volume contains a summary of the results of his latest journey in Central Asia by Dr. Sven Hedin; contributions by Mr. Ellsworth Huntington, on a journey through the great cañon of the Euphrates River; by Mr. Oscar Neumann, on an expedition from the Somali coast through southern Ethiopia; and by Dr. M. A. Stein, on a journey of geographical and archæological exploration in Chinese Turkestan. Interesting particulars are also to be found concerning the departure of the *Morning* in search of the *Discovery* in connection with the National Antarctic expedition. The liberal supply of illustrations, charts and maps make with the papers an instructive and interesting record of geographical work.

THE additions to the Zoological Society's Gardens during the past week include a Binturong (*Arctictis binturong*) from the Malay Peninsula, presented by Mr. M. A. Hawes; an Indian Crow (*Corvus splendens*) from India, presented by Mr. D. Asbury; an American Golden Plover (*Charadrius americanus*), captured at sea, presented by Mr. G. Carrick; a Blackbird, var. (*Turdus merula*), a Long Thrush (*Turdus musicus*) British, presented by Miss Alice Ellis; a Coquerel's Mouse Lemur (*Chirogaleus coquereli*) from Madagascar, six Himalayan Monauls (*Lophophorus impeyanus*) from the Himalayas, two Brush Turkeys (*Talegalla lathami*) from Australia, three South Island Robins (*Mira albifrons*) from New Zealand, deposited.

OUR ASTRONOMICAL COLUMN.

NEW COMET 1903*a* (GIACOBINI).—A telegram from the Kiel Centralstelle states that M. Giacobini, observing at Nice, has discovered another new comet, the position of which at 6h. 28m. 9 (Nice M.T.) on January 19 was as follows:—

R.A. = 22h. 57m. 48s.
Dec. = + 2° 16′ 24″

that is, between the stars β and 2 Piscium, about one-third the distance from β.

The daily movements in R.A. and Dec. are + 17′ (arc) and − 12′ respectively.

COMET 1902 *d*.—No. 3838 of the *Astronomische Nachrichten* contains several sets of observations of this comet, and the elements and ephemeris given below. The latter have been calculated by Herr F. Ristenpart from the means of three observations made on December 3, three observations made on December 11 and of two observations made on December 23, all of them having been made by different observers:—

T = 1903 March 25·32785 M.T. Berlin.

ω = 6° 33′ 43″·1
Ω = 117° 26′ 47″·3 } 1903·0
i = 43° 51′ 2″·1
log q = 0·440250

Ephemeris 12*h*. *M.T. Berlin.*

Date	α 1903·0 (h. m. s.)	δ 1903·0 (° ′ ″)	log Δ
Jan. 22 ...	6 47 20·87 ...	+10 37 21·8	
24 ...	6 46 3·56 ...	+11 17 30·7 ...	0·2791
26 ...	6 44 49·64 ...	+11 57 47·6	
28 ...	6 43 39·45 ...	+12 38 7·3 ...	0·2816
30 ...	6 42 33·42 ...	+13 18 24·3	
Feb. 1 ...	6 41 31·88 ...	+13 58 33·9 ...	0·2852

THE RELATION BETWEEN FACULÆ AND PROMINENCES.—In No. 11, vol. xxxi., of the *Memorie della Societa degli Spettroscopisti Italiani*, Signor Mascari submits a large number of arguments and data in order to show that there is no real connection between the solar hydrogen prominences and faculæ, but that where faculæ are attended by other outbursts, these outbursts are of the eruptive prominence type.

For instance, in 1895, the prominences had a maximum frequency at +30° to +40° and −20° to −30° (heliographic latitudes), and strong minima at ±60° to ±90° respectively, whilst the groups of faculæ showed an almost symmetrical arrangement with regard to the solar equator, having only slight maxima of frequency at +10° to +20° and ±70° to ±80°; the same relations held during 1896, and many similar cases are quoted by the writer for other years.

Again, out of two hundred and ninety-six groups of faculæ observed in 1900, only fourteen were coincident with ordinary prominences, whilst ninety-nine coincided with eruptive prominences having bases of small extent.

Signor Mascari therefore arrives at the conclusion that the hydrogen prominences, such as are commonly observed on the sun's limb, and faculæ are two distinct and completely independent phenomena.

SPECTROGRAPHIC DETERMINATION OF THE ROTATION PERIOD OF JUPITER.—Two excellent spectrograms of Jupiter, obtained by Mr. V. M. Slipher, of the Lowell Observatory, Flagstaff, Mexico, are reproduced in No. 101 of *Popular Astronomy*. No. 1 was taken in such a position that the dispersion was parallel to the equatorial diameter of the planet, whilst in No. 2 the dispersion was parallel to the polar diameter.

No. 1 shows a very distinct displacement or inclination of the lines in the planet's spectrum as compared with the lines in the lunar spectrum, which was photographed as a comparison spectrum on both sides of it. In No. 2, this displacement was non-existent. Measurements of the displacement in spectrogram No. 1 were made, and, on applying Doppler's principle to them, values for the rotation period which are well in accordance with the accepted values were obtained.

THE PHOTOGRAPHY OF STELLAR REGIONS.—In a paper recently communicated to the Vienna Academy of Sciences, Herr Egon von Oppolzer discusses the question as to how the greatest number of star images may be obtained when photographing stellar regions.

He points out that in an objective uncorrected for curvature of the focal surface, this surface is a sphere having its centre in the centre of the objective, and it will only be on the intersection curve (a circle) of this sphere and the photographic plate that the star images will be in focus, and therefore it will only be on this curve that images of the fainter stars will be obtained. The further from the curve the star image happens to fall, the greater will have to be the magnitude of the star in order that its image may be photographed.

Herr Oppolzer then establishes a relation connecting the distance of a star image from this focal circle, the radius of the focal circle and the focal length of the objective, and finally arrives at the conclusion that the formula $\delta_0 = L2/16f$ (where L = the length of the side of the square plate and f = the focal length of the objective) gives the best distance (δ_0) that the plate must be pushed in from the axial focus in order that the maximum number of stars may be photographed. Applying this formula to the Potsdam astrographic refractor, we find that the plate should have been pushed in 0·47 mm., whereas we see, from the Potsdam plates for the "Carte Celeste," that it was only pushed in 0·13 mm., and Herr Oppolzer deduces from this that an unnecessary loss, amounting to as much as 6 per cent., has occurred in the number of stars photographed (*Astrophysical Journal*, No. 5, vol. xvi.).

THE FORMATION OF PEARLS.[1]

BY far the greater number of recent writers on pearls, whether scientific or otherwise, when discussing the cause of pearl-formation, have contented themselves with recapitulating what has already been written on the subject, without attempting to verify or refute the various hypotheses that have been propounded. The question is one which has called forth speculative theories since the earliest times of which we have any records; but, with the exception of the brilliant researches of Filippi and a few of his contemporaries, theory has prevailed to the almost complete exclusion of practical investigation.

In a recent paper,[1] based upon an examination of large quantities of material comprising a number of the pearl-producing species of mollusca, I have tried to place our knowledge of the matter upon a more satisfactory basis.

By observations upon pearl-bearing examples of the common mussel, *Mytilus edulis* (which were confirmed in the case of all other species examined), I proved that the formation of the pearl takes place in exactly the same way as that of the shell, except that a true pearl is laid down in a closed sac of the shell-secreting epithelium, embedded in the subepidermal tissue of the mantle and completely cut off from the outer epithelium itself. Inside this spherical epithelial sac, the shell substance is laid down in the concentric layers that are so characteristic of the pearls, instead of in the parallel lamellæ which are found in the shell itself. Such a sac, with its contained pearl, may be compared to a human atheroma cyst.

This makes it necessary for us to draw a sharp distinction between pearls proper and blisters or pearly excrescences of the shell lining, which are secreted by the outer (shell-forming) mantle epithelium, to cover over foreign bodies that have intruded themselves between the mantle and the shell or to repair the damages done by shell-boring domiciliaries. "Concretions" are, again, distinguished from pearls as calcosphæritic bodies which have not a cuticular origin from an epithelium, but seem to arise by free crystallisation in the mantle or other tissues. The term "attached pearl" should be applied only to pearls which have become secondarily fused to the shell by absorption of the intervening tissues.

From the facts of pearl-formation, it is easy to understand why the pearl presents the special characters of the particular species of shell from which it is taken, and also why, in the same mollusc, the characters of the pearls produced are determined by the part of the mantle in which they are formed. Thus, pearls formed in the extreme mantle margin are composed mainly of periostracum, *e.g.* the leathery pearls of *Modiola modiolus*, while those which occur in the part of the mantle concerned in depositing the prismatic substance are made up of

[1] "On the Origin of Pearls." By Dr. H. Lyster Jameson (*Proceedings* of the Zoological Society of London, 1902, vol. i., pp. 140–166, pl. xiv–xvii.).

concentric layers of rod-like prisms, as in the brown or "black" pearls of the Scotch river mussel, *Margaritana margaritifera* (Fig. 1).

By far the greater part of the mantle epithelium deposits the nacre, and pearls which arise in this part of the mantle are the typical nacreous ones, to which the great majority of the marketable gems belong. Even the uncalcified substance of the hinge ligament of the shell may be represented in the pearl; for example, in the great Australian mother-of-pearl oyster, *Margaritifera maxima*, Jameson, black leathery pearls are sometimes found in the dorsal body-wall.

I next proceeded to investigate the origin of the sac in which the pearl arises, and also the nature and origin of the "nucleus" which is so often to be found in the centre of the pearl. In a great many molluscs, among which were several of the pearl-oysters proper, the remains of trematodes were found to form the nuclei, a discovery which confirmed the observations of Filippi, Möbius and others. In one or two cases, however, other parasites played the same part. By confining my attention to the common mussel, I proved that the epithelial sac, which is all-important for pearl formation, is first formed around the live trematode which enters upon a resting stage in the tissues of Mytilus. A similar sac, surrounding a trematode, was found in an example of the Ceylon pearl-oyster, *Margaritifera vulgaris*, Schumacher, which I examined. For the formation of the pearl, it is not necessary for the trematode to persist as nucleus, for it often happens that it migrates out of the sac; but the sac, caused primarily by the

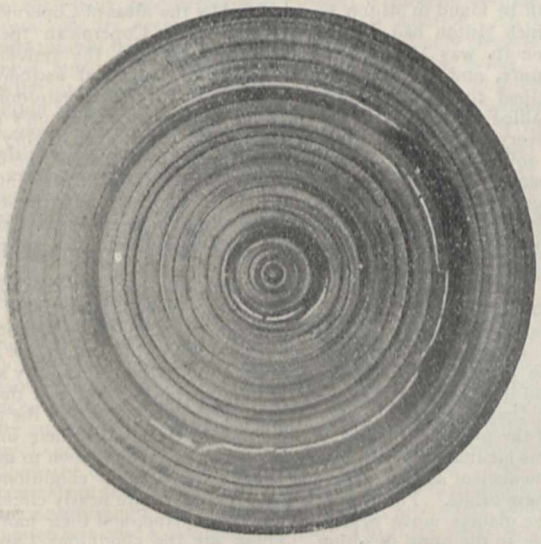

FIG. 1.—Section ground from a brown Scotch River Pearl, showing it to be composed of the Prismatic Substance, × 25.

specific stimulation of the parasite, is essential to pearl production. In *Modiola modiolus*, and probably in some other forms, similar sacs are formed around Sporozoa.

The next subject to be investigated was the origin and life-history of the parasite that causes the pearl-sac. The common mussel was found to be the most convenient species on which to study this, and the pearl-bearing mussel-beds of Billiers, in Brittany, and Piel, in the Barrow Channel, were selected as suitable sites in which to begin the observations (Fig. 2).

The parasite, like most trematodes, passes through a regular cycle of three hosts, two of which are invertebrates and the third a vertebrate. It arises in sporocysts in the "tapestry shell," *Tapes decussatus*, and the cockle, *Cardium edule*, the former acting as first host at Billiers, the latter at Piel, where Tapes does not occur. The young tailless Cercariæ or trematode larvæ leave the mother sporocysts in the first host and migrate into the mussel.

The transmission of the parasites from Tapes to Mytilus was proved experimentally in a tank at the Brighton Aquarium. In the mussel, the parasite enters into a resting stage, in the sub-epidermal connective tissue, and gives rise to the epidermal sac or "epithelioma" in which the pearl arises (Fig. 3). If the parasite dies in this sac, a pearl is formed around its remains, or, if it migrates to another part of the tissues, a pearl may be developed in the empty sac.

Although it was found impossible to secure live uninfected material of the fina host for experiment, it is almost certain that the adult stage of the parasite is *Distoma* (*Leucithodendrium*) *somateriae*, Lev., a worm which occurs in the intestine of the eider duck, *Somateria mollissima*, and the black duck or scoter, *Oedemia nigra*. Both these birds feed almost exclusively on mussels. A number of scoters caught or shot in the immediate vicinity of the Billiers pearl-beds were found swarming with

FIG. 2.—The Pearl-bearing Mussel-beds at Piel, in the Barrow Channel.

this worm. Indeed, one example of the worm, in an immature condition, quite indistinguishable from the resting stage which occurs in Mytilus, was taken from the intestine of a scoter. Our knowledge of the life-histories of other trematodes, or "flukes" as they are popularly called, enables us to fill in the life-history of this parasite with considerable detail. The worm reaches maturity in the intestine of the scoter and eider, and the eggs pass out with the fæces. These eggs, or possibly "Miracidium" larvæ derived from them, enter Tapes or the cockle and there give rise to sporocysts, in which the young flukes

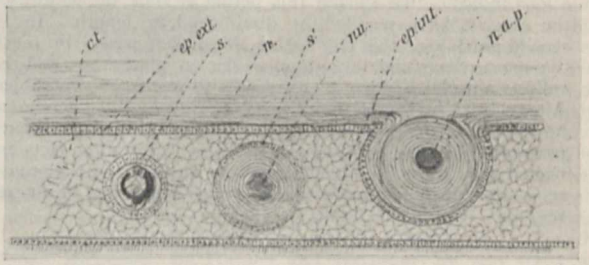

FIG. 3.—Diagrammatic section of part of the shell and mantle of Mytilus, showing a trematode in its sac, a pearl in a similar sac and a secondarily attached pearl; *n.*, nacreous substance of the shell; *ep. ext.*, external nacre-secreting epithelium of the mantle; *c.t.*, connective tissue; *s.*, sac containing live trematode; *s'*, sac containing pearl; *nu.*, nucleus of pearl; note also the sac of an "attached" pearl, which has become continuous with the external epithelium of the mantle; *n.a.p.*, nucleus of the attached pearl; *ep. int.*, internal ciliated epithelium of mantle, which lines the branchial cavity.

or Cercariæ are formed. These larvæ, unlike typical Cercariæ, are tailless, and when they escape from Tapes reach the mussel chiefly by drifting with the tidal currents. On entering the mussel, they pierce the body wall and settle down in the subcutaneous tissues, in which they become surrounded by the pearl-sacs. If the mussel lives long enough, pearls will be formed in these sacs. If, on the other hand, a mussel containing these resting Cercariæ is eaten by an eider duck or scoter, the Cercariæ develop into the mature worms, which produce eggs, and the life cycle is repeated.

As an economic result of these investigations, it would seem

that the artificial production of marketable pearls in large quantities should present no great difficulties, if the conditions essential to pearl production in the particular cases be intelligently investigated. The fact that trematodes have been ascertained to be *at least* one cause of pearl formation in several of the molluscs that produce the marketable gems gives us every reason to hope that, by learning the life-histories of these parasites, we may be able to infect any number of pearl-oysters or pearl-mussels to any desired extent, without any operation on the individual molluscs, by simply placing them in the proper surroundings, in company with infected examples of the first host. Once infected, the molluscs could be bedded out on suitable grounds, and left to care for themselves, until the pearls formed in them were of marketable size.

These observations show the futility of the proposal that has so often been made, viz., that young pearl-oysters should be transferred from their native grounds to more accessible in-shore waters, as it must obviously be the first object of the scientific expert, before laying down the beds of young pearl-oysters, to assure himself either that they are already infected or that the conditions essential to speedy infection are present on the grounds to which the oysters are to be transplanted.

H. LYSTER JAMESON.

THE MOVEMENTS OF GLACIERS.

THE study of the movements of glaciers is, we are glad to say, being steadily pursued, judging from the two reports which are to hand. The first is a publication of the International Commission on Glaciers, and is the seventh report (1901) prepared by Dr. Finsterwalder and M. E. Muret (extract from *Archives des Sciences physiques et naturelles*, t. xiv., 1902). The report is divided into five parts, dealing with observations made in the Alps of Central Europe, Scandinavia, Spitsbergen and Greenland, Russia and, lastly, the United States. In each case, a brief summary is given of the results of the 1891 observations published during the past year, and most of these show that, on the whole, the glaciers have decreased in length.

The second publication contains, not only a report on the variations of French glaciers from 1900 to 1901, presented to the French Commission by M. W. Kilian, but a review of glaciology, by M. Charles Rabot (extract from the *Annuaire du Club Alpin Français*, vol. xxviii., 1901). Detailed observations are given at some length, and in a few instances reproductions of photographs of glaciers accompany the text. The observations indicate that during this period of time the majority of the glaciers have recoiled or diminished in length. In the second portion of this publication, M. Rabot passes in review the most recent and important works on glaciology, and thus collects a useful number of references to works on this subject. After a brief survey of the physical and geological phenomena, he makes a *résumé* of the explorations of glaciers in different parts of the earth, pointing out the more interesting facts connected with them, and finally gives an account, with numerous references, of the variations of the length of glaciers in different regions.

THE SCIENCE OF ASTRONOMY.[1]

I TAKE for the subject of my address the science of astronomy, and propose to give a brief historical sketch of it, to consider its future development and to speak of the influence of the sciences on civilisation.

The science of astronomy is so closely connected with the affairs of life, and is brought into use so continuously and in such a systematic manner, that most people never think of the long labour that has been necessary to bring this science to its present condition. In the early times, it was useful to the legislator and the priest for keeping records, the times of public ceremonies and of religious festivals. It slowly grew into the form of a science and became able to make predictions with some certainty. This was many centuries ago. Hipparchus, who lived 150 B.C., knew the periods of the six ancient planets with considerable accuracy. His periods are :—

	Period. d.	Error × 100. Period. d.
Mercury	87·9698	+0·0007
Venus	224·7028	+0·0009
Earth	365·2599	+0·0010
Mars	686·9785	−0·0002
Jupiter	4332·3192	−0·0061
Saturn	10758·3222	−0·0083

These results indicate that more than two thousand years ago there existed recorded observations of astronomy. Hipparchus appears to have been one of those clear-headed men who deduce results from observations with good judgment. There was a time when those ancient Greek astronomers had conceived the heliocentric motions of the planets, but this true theory was set aside by the ingenious Ptolemy, who assumed the earth as the centre of motion, and explained the apparent motions of the planets by epicycles so well that his theory became the one adopted in the schools of Europe during fourteen centuries. The Ptolemaic theory flattered the egotism of men by making the earth the centre of motion, and it corresponded well with old legends and myths, so that it became inwoven with the literature, art and religion of those times. Dante's construction of Hell, Purgatory and Paradise is derived from the Ptolemaic theory of the universe. His ponderous arrangement of ten divisions of Paradise, with ten Purgatories and ten Hells, is said by some critics to furnish convenient places for Dante to put away his friends and his enemies, but it is all derived from the prevailing astronomy. Similar notions will be found in Milton, but modified by the ideas of Copernicus, which Milton had learned in Italy. The Copernican theory won its way slowly, but surely, because it is the system of nature, and all discoveries in theory and practical astronomy helped to show its truth. Kepler's discoveries in astronomy, Galileo's discovery of the laws of motion and Newton's discovery of the law of gravitation put the Copernican theory on a solid foundation. Yet it was many years before the new theories were fully accepted. Dr. Johnson thought persecution a good thing, since it weeds out false men and false theories. The Copernican and Newtonian theories have stood the test of observation and criticism, and they now form the adopted system of astronomy.

The laws of motion, together with the law of gravitation, enable the astronomer to form the equations of motion for the bodies of our solar system; it remains to solve these equations, to correct the orbits, and to form tables of the sun, moon and the planets. This work was begun more than a century ago, and it has been repeated for the principal planets several times, so that now we have good tables of these bodies. In the case of the principal planets, the labour of determining their orbits was facilitated by the approximate orbits handed down to us by the ancient astronomers, and also by the peculiar conditions of these orbits. For the most part, the orbits are nearly circular; the planets move nearly in the same plane, and their motions are in the same direction. These are the conditions Laplace used as the foundation of the nebular hypothesis. With approximate values of the periods and motions, and under the other favouring conditions, it was not difficult to form tables of the planets. However, the general problem of determining an orbit from three observations, which furnish the necessary and sufficient data, was not solved until about a century ago. The orbits of comets were first calculated with some precision. Attention was called to these bodies by their threatening aspects and by the terror they inspired among people. It was, therefore, a happy duty of the astronomers to show that the comets also move in orbits around the sun and are subject to the same laws as the planets. This work was easier, because the comets move nearly in parabolas, which are the simplest of the conic sections. Still, the general problem of finding the six elements of an orbit from the six data given by three observations remained to be solved. The solution was given by Gauss a century ago in a very elegant manner. His book is a model, and one of the best ever written on theoretical astronomy. No better experience can be had for a student than to come in contact with such a book and with such an author. The solution of Laplace for the orbit of a comet is general, but demands more labour of computing than the method of Olbers, as arranged by Gauss. It is said by some writers that the method of Laplace is to be preferred because more than three observations can be used. In fact, this is necessary in order to get good values o.

[1] Address delivered by Prof. Asaph Hall, on December 29, 1902, as president of the American Association for the Advancement of Science, Washington meeting.

the derivatives of the longitudes and latitudes with respect to the time, but it leads to long and rather uncertain computations. Moreover, it employs more data than are necessary, and thus is a departure from the mathematical theory of the problem. This method is ingenious, and by means of the derivatives it gives an interesting rule for judging of the distance of a comet from the earth by the curvature of its apparent path, but a trial shows that the method of Olbers is much shorter. Good preliminary orbits can now be computed for comets and planets without much labour. This, however, is only a beginning of the work of determining their actual motions. The planets act on each other and on the comets, and it is necessary to compute the result of these forces. Here again the conditions of our solar system furnish peculiar advantages. The great mass of the sun exerts such a superior force that the attractions of the planets are relatively small, so that the first orbits, computed by neglecting this interaction, are nearly correct. But the interactions of planets become important with the lapse of time, and the labour of computing these perturbations is very great. This work has been done repeatedly, and we now have good numerical values of the theories of the principal planets, from which tables can be made. Practically, therefore, this question appears to be well toward a final solution. But the whole story has not been told.

The planets, on account of their relative distances being great and because their figures are nearly spherical, can be considered as material particles, and then the equations of motion are readily formed. In the case of n material particles acting on each other by the Newtonian law, and free from external action, we shall have $3n$ differential equations of motion, and $6n$ integrations are necessary for the complete solution. Of these only ten can be made, so that in the case of only three bodies there remain eight integrations that cannot be found. The early investigators soon obtained this result, and it is clearly stated by Lagrange and Laplace. The astronomer, therefore, is forced to have recourse to approximate methods. He begins with the problem of two bodies, the sun and a planet, and neglects the actions of the other planets. In this problem of two bodies, the motions take place in a plane, and the integrations can all be made. Two constants are needed to fix the position of the plane of motion, and the four other constants pertaining to the equations in this plane are easily found. This solution is the starting point for finding the orbits of all the planets and comets. The mass of the sun is so overpowering that the solution of the problem of two bodies gives a good idea of the real orbits. Then the theory of the variation of the elements is introduced, an idea completely worked out into a practical form by Lagrange. The elements of the orbits are supposed to be continually changed by the attractions of the other planets. By means of this theory, and the mathematical machinery given by Lagrange, which can be applied to a great variety of questions, the observations of the planets can be satisfied over long intervals of time. When this theory of the motions was carried out a century ago, it appeared that the great problem of planetary motion was near a complete solution. But this solution depends on the use of series, which undergo integrations that may introduce small divisors. An examination of these series by Hansen, Poincaré and others indicates that some of them are not convergent. Hence the conclusions formerly drawn about the stability of our solar system are not trustworthy and must be held in abeyance. But looking at the construction of our system, and considering the manner in which it was probably evolved, it appears to be stable. However, the mathematical proof is wanting. In finding the general integrals of the motions of n bodies, the assumption that the bodies are particles gets rid of the motions of rotation. These motions are peculiar to each body and are left for special consideration. In the case of the earth, this motion is very important, since the reckoning of time, one of our fundamental conceptions, depends on this motion. Among the ten general integrals that can be found, six belong to the progressive motion of the system of bodies. They show that the centre of gravity of the system moves in a right line and with uniform velocity. Accurate observations of the stars now extend over a century and a half, and we are beginning to see this result by the motion of our sun through space. So far, the motion appears to be rectilinear and uniform, or the action of the stars is without influence. This is a matter that will be developed in the future. Three of the other general integrals belong to the theory of areas, and Laplace has drawn from them his theory of the invariable plane of the system. The remaining integral gives the equation of living force. The question of relative motion remains, and is the problem of theoretical astronomy. This has given rise to many beautiful mathematical investigations and developments into series. But the modern researches have shown that we are not sure of our theoretical results obtained in this way, and we are thrown back on empirical methods. Perhaps the theories may be improved. It is to be hoped that the treatment of the differential equations may be made more general and complete. Efforts have been made in this direction by Newcomb and others, and especially by Gyldèn, but so far without much practical result.

The problem of three bodies was encountered by the mathematicians who followed Newton, and many efforts were made to solve it. These efforts continue, although the complete investigations of Lagrange appear to put the matter at rest. The only solutions found are of very special character. Laplace used one of these solutions to ridicule the doctrine of final causes. It was the custom to teach that the moon was made to give us light at night. Laplace showed by one of the special solutions that the actual conditions might be improved and that we might have a full moon all the time. But his argument failed, since such a system is unstable and cannot exist in nature. But some of the efforts to obtain partial solutions have been more fruitful, and G. W. Hill has obtained elegant and useful results. These methods depend on assumed conditions that do not exist in nature, but are approximately true. The problem of two bodies is a case of this kind, and the partial solutions may illustrate, but will not overcome, the fundamental difficulty.

The arrangement of our solar system is such that the distances of the planets from one another are very great with respect to their dimensions, and this facilitates very much the determination of their motions. Should two bodies approach very near each other, the disturbing force might become great, even in the case of small masses. In the case of comets, this condition happens in nature, and the comet may become a satellite of a planet and the sun a disturbing body. In this way, it is probable that comets and meteoric streams have been introduced into our solar system. We have here an interesting set of problems. This question is sometimes treated as one of statics, but since the bodies are in motion it belongs to dynamics. Further study may throw light on some relations between the asteroids and the periodical comets.

The great question of astronomy is the complete and rigorous test of the Newtonian law of gravitation. This law has represented observations so well during a century and a half that it is a general belief that the law will prove true for all time and that it will be found to govern the motions of the stars as well as those of our solar system. The proof is cumulative and strong for this generality. It will be a wonderful result if this law is found rigorously true for all time and throughout the universe. Time is sure to bring severe tests to all theories. We know that the law of gravitation is modified in the motions of the matter that forms the tails of comets. There is an anomaly in the theory of Mercury which the law does not explain, and the motion of our moon is not yet represented by theory. The lunar theory is very complicated and difficult, but it does not seem probable that the defect in Hansen's theory will be found by recomputing the periodical coefficients, that have been already computed by many mathematicians and astronomers, and with good agreement by Hansen and Delaunay, by very different methods. Hansen was a computer of great skill, but he may have forced an agreement with observations, from 1750 to 1850, by using a coefficient of long period with an erroneous value. No doubt the error of this theory will be discovered. Back of all theories, however, remains the difficulty of solving the equations of motion so that the result can be applied with certainty over long periods of time. Until this is done, we shall not be able to subject our law to a crucial test.

The constants that enter the theories of the planets and moon must be found from observations. In order to compare observations made at distant epochs, the motions of the planes of reference must be known with accuracy, and also the motion of our solar system in space. As the stars are our points of reference, their positions and their proper motions must be studied with great care. This department of astronomy was brought to a high degree of order by the genius of Bessel, whose work forms an epoch in modern astronomy. The recent progress made in determining the positions of the stars in all parts of the heavens will be a great help to the investigations of the future.

We must have observatories where accurate and continuous observations are made. Our country is well situated to supplement the work of Europe, and we hope it will never fail to add its contribution to the annals of astronomy. American astronomers should keep pace in the improvements for increasing the ease and accuracy of making observations. The spectroscope has given a new element in the motions of the stars, not to speak of the interesting physical results obtained by its use. Photography will give great aid in determining the relative positions of the stars and in forming maps of the heavens. All new methods, however, will need examination and criticism, since they bring new sources of error. Fifty years ago, it was thought the chronograph would increase very much the accuracy of right ascensions. It has not done this directly to any great extent, but it has increased the ease and rapidity of observing. We must remember that astronomical results finally depend on meridian observations, and that it is the duty of astronomers to make these continuous from generation to generation. In this way, we shall gain the powerful influence of time to help control and solve our problems. There is one point where a reform may be needed from the dead weight of the large and expanding volumes sent forth by observatories and scientific institutions. The desire for publication is great, but the results should be well discussed and arranged, so that the printing may be shortened. Otherwise our publications may become burdensome, and when they are piled up in libraries some future Caliph Omar may be tempted to burn them. Even mathematics appears to labour under a similar oppression, and much of its printed matter may be destined to moulder to useless dust.

In the not distant future, stellar astronomy will become a great and interesting field of research. The data for the motions of the stars are becoming better known, but these motions are slow, and the astronomer of to-day looks with envy on the astronomer of a thousand years hence, when time will have developed these motions. Much may be done by the steady and careful work of observation and discussion, and the accumulation of accurate data. Here each one of us can add his mite. But the great steps of progress in science have come from the efforts of individuals. Schools and universities help forward knowledge by giving to many students opportunities to learn the present conditions, and from them some genius like Lagrange or Gauss may come forth to solve hard questions and to break the paths for future progress. This is about all the schools can do. We need a body of men who can give their lives to quiet and continuous study. When the young Laplace was helped to a position where he could devote his life to research, D'Alembert did more for the progress of astronomy than all the universities of Europe.

One needs only to glance at history to see how useful astronomy has been in the life of the world. It has wonderfully enlarged the universe and widened the views of men. It shows how law and order pervade the world in which we live; and by the knowledge it has disseminated and by its predictions it has banished many superstitions and fears. The sciences will continue to grow, and they will exert the same influence. The erroneous and dogmatic assertions of men will be pushed aside. In our new country, the energies of the people are devoted chiefly to commercial and political ends, but wealth is accumulating, leisure and opportunity will come, and we may look forward to a great development of scientific activity. We must be patient. Men do not change much from generation to generation. Nations that have spent centuries in robbery and pillage retain their dispositions and make it necessary for other nations to stand armed. No one knows when a specious plea for extending the area of civilisation may be put forth, or when some fanatic may see the hand of God beckoning him to seize a country. The progress of science and invention will render it more difficult for such people to execute their designs. A century hence it may be impossible for brutal power, however rich and great, to destroy a resolute people. It is in this direction that we may look for international harmony and peace, simply because science will make war too dangerous and too costly.

The influence of the sciences in bringing men of different nationalities into harmony is great. This is done largely by the common languages that are formed in each science. In mathematics, the language is so well formed and generally adopted that mathematicians all over the world have no trouble in understanding one another. It may be difficult to read Russian, but everyone can read the formulas of Tchebitchef and Lobaschewsky. In astronomy, the common language is nearly as well established, so that there is little difficulty in understanding the astronomy of different nations. A similar process is going on in chemistry, botany and in the other sciences. When men are striving for the discovery of truth in its various manifestations, they learn that it is by correcting the mistakes of preceding investigators that progress is made, and they have charity for criticism. Hence persecution for difference of opinion becomes an absurdity. The labours of scientific men are forming a great body of doctrine that can be appealed to with confidence in all countries. Such labours bring people together, and tend to break down national barriers and restrictions. The scientific creed is constantly growing and expanding, and we have no fears, but rejoice at its growth. We need no consistory of bishops, or synod of ministers, to tell us what to believe. Everything is open to investigation and criticism.

In our country we have one of the greatest theatres for national life that the world has ever seen. Stretching three thousand miles from ocean to ocean, and covering the rich valleys of the great rivers, we have a land of immense resources. Here is a vast field for scientific work of various kinds. No doubt the men of the future will be competent to solve the problems that will arise. Let us hope that our national character will be just and humane, and that we may depart from the old custom of robbing and devouring weak peoples. Anyone who saw the confusion and waste in this city in 1862 might well have despaired of the Republic; and he who saw the armies of Grant and Sherman pass through the city in 1865 felt that he need fear no foreign foe: neither French emperor, nor English nobleman nor the sneers of Carlyle. To destroy a democracy by external force, the blows must be quick and hard, because its power of recuperation is great. The danger will come from internal forces produced by false political and social theories, since we offer such a great field for the action of charlatans. Our schools and colleges send forth every year many educated people, and it is sometimes disheartening to see how little influence these people have in public life. Those who are trained in the humanities and churches ought to be humane in dealing with other people, ready to meet great emergencies and powerful to control bad tendencies in national affairs. But this is rarely the case. On the other hand, the most unscrupulous apologists and persecutors have been educated men, and the heroes of humanity have come from the common people. This anomaly points to something wrong in the system of education, which should disappear. The increase and teaching of scientific ideas will be the best means of establishing simple and natural rules of life. Nature, and science her interpreter, teach us to be honest and true, and they lead us to the Golden Rule.

THE ASSOCIATION OF PUBLIC SCHOOL SCIENCE MASTERS.

ON Saturday last, the Association of Public School Science Masters held its annual meeting at the University of London. Sir A. W. Rücker, the president, took the chair, and in the morning the proceedings were of a business character. Rules were revised, officers and committee elected and reports read. It was decided that, in order to preserve the original intentions of the society, its members should consist of teachers of natural science in secondary schools and of not more than twenty others interested in such teaching. It transpired that the present membership is ninety-six and that the only large public school still unrepresented is St. Paul's.

The report of the subcommittee appointed to consider the question of entrance scholarships at Oxford and Cambridge was presented, and Mr. H. B. Baker announced that the suggestions to be offered to the universities, by invitation at a very early date, had been submitted to every member of the Association, with the result that an objection had been raised by but one member.

Prof. Tilden was elected president for the year 1904, Mr. C. E. Ashford was re-appointed secretary, while in order to lessen his work a new office of treasurer was created and filled by the election of Mr. J. Talbot, one of Mr. Ashford's colleagues, who will be able to render him useful assistance. It was arranged that the members of committee should retire by rotation and are not eligible to re-election until three years afterwards, this step being taken in order that the smaller schools might be represented upon the committee.

It will be remembered that the Association grew out of a

conference, and in the afternoon a similar one—the third of its kind—was opened. Three papers were read, the first of which, on the tyranny of Greek, was by Mr. J. Talbot, of Harrow. He said that the amount of Greek which boys did at school was too small to be of any use, and he suggested that its place should be taken by English and by science, though from the latter alone he considered that it was impossible to obtain literary style. Sir Michael Foster pleaded for elasticity of curriculum and no compulsory Greek, though he did not define what he would substitute for it. Prof. Armstrong argued that if science was studied, literary style could be acquired at the same time. In the end, the meeting agreed that compulsory Greek should not be required of candidates for entrance examinations at the universities.

Mr. E. C. Sherwood, of Westminster, in his address dealt with how to make practical work of any use in "a low big form." He was of opinion that lectures should be used to sum up and criticise the work of the previous lesson. Text-books in the laboratory he considered a snare and a delusion, and he maintained that notes should be roughly written at the time and copied out carefully in ink afterwards. In the discussion, however, a number of speakers characterised it as a mistake for any notes to be made away from the laboratory. Furthermore, Mr. Sherwood laid down that the aim of the very earliest course of chemistry and physics, especially if not preceded by a course of "nature-study," should be to train the powers of observation and description, as well as to give a familiarity with the nature and properties of the commoner substances and materials, and the object and application of the easier methods of manipulation. The "problem" and the heuristic element should not be prominent features.

The third paper consisted of a criticism, by Dr. T. J. Baker, of Birmingham, on the new syllabus for science in the matriculation examination of the University of London. In this contribution, it was pointed out that it is now possible to matriculate at London without offering any science at all. It was contended that a matriculation examination should test the grounding of candidates in this as well as in literary subjects. At the same time, there should be no incentive to specialisation as in the new science syllabus under consideration.

This contention was borne out by the fact that chemistry has been separated from physics and the latter divided into two sections each of which counts as a distinct subject. The standard of attainment required is too high and directly encourages specialisation. Dr. Baker would retain only chemistry and mechanics, the syllabus in the first case being limited in scope, but insisting upon thoroughness of treatment.

Sir A. W. Rücker, in the course of a well-considered speech, explained that the syllabus complied with Sir Michael Foster's desire for elasticity. He alluded to the difficulty of examining 2500 candidates practically at a fixed centre, and showed how the University had arranged to test the pupils of a school on the spot by means of the leaving examination recently devised.

WILFRED MARK WEBB.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SIR MICHAEL FOSTER has decided to retain his seat in Parliament as member for the University of London. In a letter to Sir John Rotton, he says:—"The answers which you have received to the inquiry which you kindly made on my behalf give me so fully the assurance which I needed in order that I should feel justified in renouncing my intention to resign that I have decided to do so."

SIR WILLIAM TURNER, K.C.B., F.R.S., who has held the chair of anatomy in the University of Edinburgh since 1867, has been elected principal of the University.

THE *Lancet* states that the Bristol Health Committee has decided that the bacteriological work which has been done hitherto in the medical officer's department shall be for one year transferred to the University College, where it will be carried on by Prof. Stanley Kent at a cost of 200*l*.

A LABORATORY has been opened in the gardens of the Royal Botanic Society at Regent's Park, in which classes for instruction in botany and horticultural chemistry are held three days a week. Mr. E. J. Schwartz, demonstrator in botany at King's College, has been appointed director, and has now completed arrangements for the reception of pupils. The laboratory has been erected and equipped under the auspices of the Technical Education Board.

THE Carnegie Institution of Washington has adopted, *Science* says, a plan to encourage exceptional talent by appointing a certain number of research assistants. As a rule, the annual emolument will not exceed 200*l*., and no limitations are prescribed as to age, sex, nationality, graduation or residence. A person appointed will generally be expected to work under the supervision of a man of science known to the authorities of the Carnegie Institution. Applications for appointments may be presented by the head of a college, or by a professor, or by the candidate; they should be accompanied by a statement of the qualification of the candidate, of the research work he has done and of that which he desires to follow; also of the time for which an allowance is required.

IN a speech made at the opening of the Indian Industrial Exhibition in connection with the eighteenth Indian National Congress, the Gaekwar of Baroda referred to the question of education in India. The *Pioneer Mail* says that his Highness founded an institution called the Kala-Bhavan with departments in dyeing and weaving, carpentry and mechanical engineering, and with the object of diffusing technical education had branches of it set up in the various parts of the Raj; but the response among the people was so faint that after a time the institution had to be contracted within narrower limits. Until the means of the people and the material wealth of the country expand, there can be but little demand for the work which such institutes turn out. So far, the Kala-Bhavan has done but little beyond providing skilled dyers for Bombay mills.

SCIENTIFIC SERIAL.

Journal of Botany, January.—Mr. E. S. Salmon traces out the characters and history of several mosses which, after a careful examination, he considers should be included under the species *Calyptopogon mnioides*, Schwaeg. The type specimen was collected in Chili, but others were obtained in Ecuador, Patagonia, New Zealand, Tasmania and Australia. This distribution is paralleled in the case of several other mosses, and a similar range was described for certain phanerogamous plants by Sir W. J. Hooker. The identity of these variously named forms receives confirmation by the presence of gemmæ which arise on the leaves.—Mr. E. G. Baker discusses Turræa, a genus belonging to the Meliaceæ, and in the main follows the classification laid down by Dr. Harms in the "Pflanzenfamilien." The African and Mascarene species are arranged separately, and in the former appear descriptions of two new species.—Two Hepatics new to Britain are recorded. *Kantia submersa* was gathered by Messrs. A. Wilson and J. A. Wheldon on Cockerham Moss, west Lancashire, and *Geocalyx graveolens* was discovered by Mr. S. M. Macvicar, in west Ross-shire.—Miss A. L. Smith, in the course of her description of a gooseberry disease caused by a form of Botrytis, mentions the appearance of a Peziza growing from a sclerotium, which also gave rise to *Sclerotinia Fuckeliana*.—A note on the localities of *Acorus Calamus* is contributed by Mr. Arthur Bennett.—A supplement to the *Journal* is devoted to notes on the drawings for "English Botany," by Mr. F. N. A. Garry. This work, generally known as Sowerby's "English Botany," bears tribute to the artist who drew the plates; the descriptions of the first edition were almost entirely written by Sir James E. Smith.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 11, 1902.—"On Certain Properties of the Alloys of the Gold-Silver Series." By the late Sir William **Roberts-Austen**, K.C.B., F.R.S., and Dr. T. Kirke **Rose**.

The earliest trial plate for testing the composition of the gold coinage was made in 1527, the year following the first introduction of the standard 916·6. This plate contained only 6·2 parts per 1000 of copper and was probably intended to consist of gold and silver only. All subsequent plates, however, down to that made in 1829, contained much larger amounts of copper.

In 1873, it was determined to omit the silver and to use only copper as the alloying metal, but Sir W. C. Roberts-Austen expressed some doubts at the time whether plates consisting of alloys of gold and copper were uniform in composition, and proposed the use of trial plates of pure gold. There are, however, objections to this method of procedure, and the law enjoining the use of standard plates was not altered.

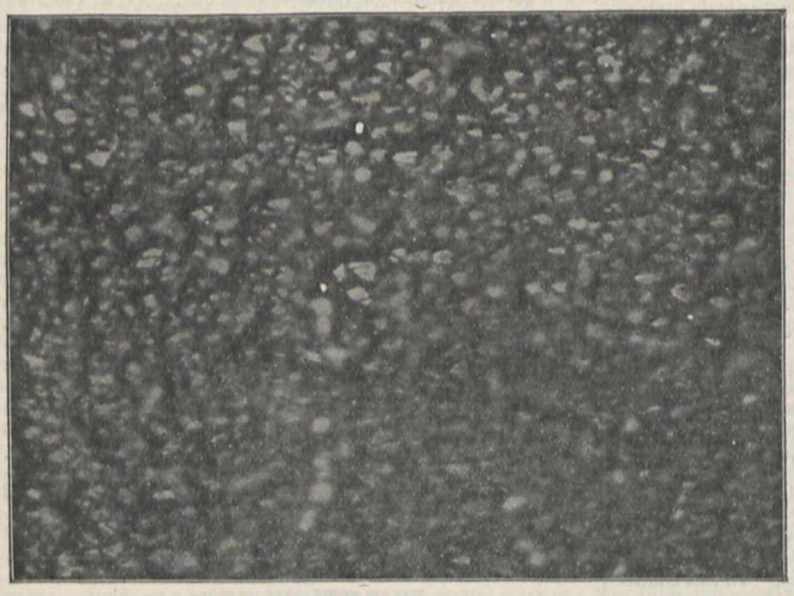

FIG. 1.—Alloy consisting of gold 91·6 per cent., silver 8·3 per cent. Cast. ×1500.

In 1900, the authors of this paper showed that, as had been feared, the gold-copper alloys were not homogeneous (*Roy. Soc. Proc.*, vol. lxvii., 1900, p. 105), and experiments on the gold-silver series were then made. Cooling curves of the alloys were taken by the Roberts-Austen recording pyrometer, with the result that all the alloys were found to solidify without passing through a pasty stage and no traces of a eutectic alloy were observed. The first additions of silver to gold do not lower its point of solidification, and the freezing-point curve was shown to be horizontal in passing from pure gold to the alloy containing 50 atoms of silver to 50 of gold. With further additions of silver, there is a steadily increasing fall in the freezing point until the lowest point is reached at pure silver. There is accordingly no reason to suppose that, when alloys rich in gold are allowed to cool from a molten state, the first portion of metal solidified would be different in composition from the mother liquor.

FIG. 2.—Same as Fig. 1. Annealed for two months. ×1500.

The alloys all consist of large grains built up of minute secondary crystals, shown in Fig. 1, in which the alloy containing 916·6 parts of gold and 83·3 of silver is shown under a magnification of 1500 diameters. An ingot of this composition was heated for two months in an annealing furnace at a low red heat, but although the size of the crystals was greatly increased, as shown in Fig. 2, in which the magnification is the same as in Fig. 1, no true segregation could be detected in the ingot either by assay or with the aid of the microscope. Plates prepared by rolling out ingots of standard fineness were found on analysis to be uniform in composition, and they have been used throughout the year 1902 for checks in the assay of standard bars and coin. In view of the minute accuracy with which the operations of coinage have to be conducted, this is a matter of much practical importance.

Royal Astronomical Society, January 9.—Dr. J. W. L. Glaisher, F.R.S., president, in the chair.—Prof. H. H. **Turner** read a preliminary note by Mr. **Bellamy** and himself on the possible existence of two independent stellar systems. The investigation described in a previous paper had been extended to the southern hemisphere and the number of stars in each square degree had been counted; the differences of distribution were apparently best explained by assuming the existence of a belt of stars. This seemed to point to the existence of two superposed stellar systems. It was proposed to make a further study of the solar motion in space, first from stars in the suggested belt and then from stars in the Milky Way.—Mr. A. R. **Hinks** read a paper on a graphical method of applying to photographic measures the terms of the second order in the differential refraction. It appeared that Prof. Turner's method of reducing measures in linear coordinates had the advantage that the small differences (refraction, &c.) are linear functions of the coordinates, but the method loses its simplicity when corrections involve terms of the second order. A graphical method was suggested for finding separately and applying to the measures such parts of the reductions as are of the second order. The author had succeeded in constructing diagrams by means of which these small terms can be quickly found for any plate.—The secretary partly read a paper by Mr. J. E. **Gore** on the sun's stellar magnitude, obtained from a consideration of binary stars the orbits of which were well determined and the spectra of which were of the solar type.—The secretary also gave an account of a paper which had been communicated by the **Astronomer Royal** on statistics of stars in a zone of 5°, from +65° to +70° declination, counted on photographs taken for the Astrographic Chart and Catalogue at the Royal Observatory, Greenwich. The paper gave a comparison of the number of stars for each square degree on the photographs with those of the Bonn Durchmusterung, and an analysis of the number of stars in each square degree in terms of duration of

exposure.—The **Astronomer Royal** read a paper describing his proposals for the reproduction and publication, on a scale twice that of the original plates, of the photographs for the Astrographic Chart made at the Royal Observatory, Greenwich. —The **Astronomer Royal** also read a note on photographs of Giacobini's comet taken at the Royal Observatory.—Mr. H. C. **Plummer** briefly described the object of his paper on the use of Mr. Aldis's tables of the function $\frac{1}{2}(\theta + \cos\theta)$ in determining the elements of an orbit.—Other papers were taken as read.—A photograph of a Leonid meteor taken by Mr. W. W. Payne at Carleton College Observatory, Northfield, Minnesota, was exhibited on the screen.

Geological Society, January 7.—Prof. C. Lapworth, F.R.S., president, in the chair.—On the discovery of an ossiferous cavern of Pliocene age at Dove Holes, Buxton (Derbyshire), by Prof. W. Boyd **Dawkins**, F.R.S. The Carboniferous Limestone, in the neighbourhood of Dove Holes, has from time to time yielded remains of extinct Mammalia of Pleistocene age. The latest discovery is of a group of Mammalia of far higher antiquity than the Pleistocene. The Victory Quarry, Bibbington, in which the discovery was made, is excavated in a rolling plateau of Carboniferous Limestone. In the course of working the quarry, a cave was discovered. It ran nearly horizontally north and south, and consisted of a large chamber and a small passage, both eroded in a master-joint. It was filled with a horizontally stratified red clay, containing angular and rolled pebbles of limestone, and a few sandstone-pebbles from the Millstone Grit and Yoredale rocks. Scattered through the mass were mammalian bones and teeth, some waterworn and others with sharp fractures. The contents had clearly been introduced into the cave by water, flowing under geographical conditions which no longer exist. The mammalian remains belong to the following species:—*Machairodus crenatidens*, Fabr.; *Hyaena*, sp.; *Mastodon arvernensis*, Croiz. and Job.; *Elephas meridionalis*, Nesli.; *Rhinoceros etruscus*, Falc.; *Equus stenonis*, Nesli.; *Cervus etueriarum*, Croiz. and Job. All these species are found in the Upper Pliocene deposits of France and Italy, and undoubtedly belong to that age. Some of the bones present the characteristic teeth-marks of the hyænas. The author concludes that the animal-remains have been washed out of a hyæna-den, which then existed at a higher level, and carried down deep into the rock, into the cave in which they were found, along with the clay and pebbles brought down in flood-time from the Yoredale and Millstone-Grit hills. The author appends a map illustrating the physical geography of the British Isles in Upper Pliocene time. There were then no physical barriers to forbid the migration of Machairodus, Mastodon, *Elephas meridionalis*, and the rest, from central and southern France into Britain. Over this area, the animals migrated in the Upper Pliocene age. The discovery of a few of them in Derbyshire is to be looked upon as a monument of their former existence over the whole of this region.

EDINBURGH.

Mathematical Society, January 9.—On the decimalisation of English money and some simplifications in long division, by J. D. Hamilton **Dickson** and the late J. Hamblin **Smith**.—Note on the preceding paper, by J. W. **Butters**.—Notes on anti-reciprocal points, by A. G. **Burgess**.—On the singular points of plane curves, by Dr. **Sprague**.

PARIS.

Academy of Sciences, January 12.—M. Albert Gaudry in the chair.—On some new halogen derivatives of dextro-rotatory benzylidenecamphor and benzylcamphor, by MM. A. **Haller** and J. **Minguin**. By the addition of hydrobromic acid to benzylidenecamphor, a compound is obtained which can be clearly distinguished from the benzylbromocamphors by the different products obtained on opening up the camphor ring.—On the glycolysis of the blood *in vitro*, by MM. R. **Lépine** and **Boulud**.—The president announced to the Academy the loss by death of M. Sirodot, correspondent in the section of botany.—The variations in the activity of reduction of oxyhæmoglobin in the course of a balloon ascent, by M. **Tripet**. Observations were made at altitudes up to 5000 metres on three subjects, with the following results. At great altitudes, the duration of reduction of the oxyhæmoglobin diminishes to less than one-half of the normal time of reduction, this diminution in the balloon in the absence of all fatigue being nearly instantaneous. In all three subjects, the proportion of oxyhæmoglobin increased with the height. As the balloon approached the earth, the converse phenomena were noted, but the return to the normal was slow and was not completed on arriving at the surface of the earth. The results of observations on the arterial blood-pressure at varying heights are also given.—On a reciprocal transformation in mechanics, by M. Paul J. **Suchar**.—On the existence in certain differential systems of integrals responding to given initial conditions, by M. Ch. **Riquier**.—On the singular trajectories of the problem of three bodies, by M. T. **Levi-Civita**.—On graphical statics in space, by M. B. **Mayor**.—Resistivity and temperature, by M. **Ponsot**.—On two silicides of manganese, by M. P. **Lebeau**. The existence of a manganese silicide, MnSi, in steel has been indicated by MM. Carnot and Goutal, and of a silicide, $SiMn_2$, by M. Vigouroux, but neither of these has been isolated in a state of purity. It has been shown in a previous paper that copper silicide can be utilised in the preparation of the silicon compounds of iron and cobalt, and the same reaction applies equally wel to the study of the silicides of manganese.—On the expansion of tempered steels, by MM. Georges **Charpy** and Louis **Grenet**. The results of M. Svedelins on the contraction and variation in the coefficient of expansion of annealed and tempered steels are to a certain extent confirmed, but the differences found in the coefficients of expansion are not so great.—On the chloride of cinnamylidene, by MM. Ernest **Charon** and Edgar **Dugoujon**. This is produced by the interaction of cinnamic aldehyde and phosphorus pentachloride under certain conditions which are described. The compound is very unstable and is readily acted upon by water or moist air. The addition products with chlorine and bromine are described.—The action of sodium on iodophenoxypropane, by M. l'Abbe J. **Hamonet**.—On the use of nitrates for the characterisation of sweet wines, by M. **Curtel**. Advantage is taken of the presence of nitrates in sugar from the beet to detect the addition of sugar to wine.—On some cephalopods collected during recent voyages of the Prince of Monaco, by M. L. **Joubin**.—On two new types of parasitic Epicaridæ, by M. Jules **Bonnier**.—The fossil fishes of Belgium, by M. Maurice **Leriche**.—Preliminary note on the geology of the Isle of Eubée, by M. **Deprat**.—On glacial observations made in Upper Maurienne in the summer of 1902, by M. Paul **Girardin**. —The phenomenon of pyrenolysis in the cells of the hepato-pancreatic gland of *Europagurus Bernardus*, by M. L. **Launoy**. —Organic sexual dimorphism in the Gallinaceæ and its variation with feeding, by M. Frédéric **Houssay**.—On the presence of saccharose in almonds and on its function in the formation of oil, by M. C. **Vallée**.—On the formation of the purple of *Purpura lapillus*, by M. Raphaël **Dubois**. The author holds, contrary to the views expressed by M. Letellier, that the mechanism of formation of the colouring matter in Purpura is the same as in the genus Murex, and is the result of the activity of a zymase, to which the name of purpurase is given. —Researches on the influence of variations of altitude on the respiratory exchanges, by M. J. **Tissot**. A table of the experimental results obtained by two observers in a captive balloon is given, the discussion of the results being reserved for a future note.—A comparative study of the activity of production of glycose by striated muscle, by MM. **Cadéac** and **Maignon**. —On the calculation of the amount of water added and cream removed in milk analyses, by MM. **Louise** and Ch. **Riquier**. A criticism of a formula of M. Génin. It is necessary to take into account the change of volume produced by the removal of cream.—Remark on the origin of volcanic activity, by M. Stanislas **Meunier**. Remarking on the views recently put forward by M. Gautier, the author points out that they are identical with those put forward by him some time ago.

NEW SOUTH WALES.

Linnean Society, November 26, 1902.—Mr. J. H. Maiden, president, in the chair.—Studies on Australian Mollusca, part vii., by Mr. C. **Hedley**. An examination of the history of nomenclature shows that the current names of many well-known marine forms are defective. *Purpura amygdala* is shown to apply properly to a West Australian species; the Sydney shell usually so called is described as *P. pseudamygdala*. *Venus australis*, Sowerby, is replaced by *Chione lagopus*, Lamarck, and *Capulus danieli* of Angas (not Crosse) by *C. australis*, Lamarck. A new species of Cæcum, lately discovered by Miss Parker, is added to the fauna under the name of *C. lilianum*.

Some hitherto unfigured Victorian land shells are also illustrated. Finally, the species of Triforis dwelling on the coast of New South Wales are reviewed, the total being raised from four to fourteen, including nine new species.—Notes on Prosobranchiata, No. ii., Littorinacea, by Mr. H. Leighton **Kesteven.** While studying the affinities of Fossarina and Risellopsis, the writer found that Risella differed in important anatomical characters from Littorina, the type genus of the family to which, in the past, it had been assigned. As a result of studying Risella, Littorina and Tectarius and comparing their anatomy with that of other Tænioglossa, he has found it advisable to reclassify the littorine groups thereof.—Notes on Australian Rhopalocera: Lycænidæ, part ii., by Mr. G. A. **Waterhouse.** One species of Pseudonotis and two of Philiris are described as new.—Ngarrabul and other Australian tribes, part i., medical and surgical practice, by Mr. John **MacPherson.** Before the advent of the white settler, the Blacks affirm that there was but little sickness or disease of any kind. Tumours or neoplasms were unknown. The work of the doctors was mainly surgical, and consisted of the treatment of wounds or injuries—the result of accident or sustained in warfare. Sorcery and witchcraft, however, occupied a prominent place in the practice of medicine. Knocking out the incisor teeth, circumcision and subincision were not in vogue among the Ngarrabul Blacks, and no instances of perforation of the septum nasi were met with. Particulars relating to the materia medica are recorded.—On the occurrence of Monograptus in New South Wales, by Mr. T. S. **Hall.** The occurrence of Graptolites in the Silurian rocks of Bowning and Yass has already been recorded by Mr. John Mitchell in the Society's *Proceedings* (1886, p. 577; 1880, 150). A careful study of the specimens on which these records were based shows that they are undoubted examples of Monograptus. The imperfection of the specimens in the sicular region prevents absolute identification, but, so far as can be made out, they apparently belong to the group typified by *M. dubius*, which ranges through almost the whole of the Lower Ludlow and Wenlock in Britain.—On a new species of Symplocos from New South Wales, by Mr. R. T. **Baker.** This new Symplocos is a small, glabrous shrub of about 6 to 9 feet high, and differs considerably in general facies from the three species *S. spicata*, Roxb., *S. Stawelli*, F.v.M., *S. paucistaminea*, F.v.M., already described from Australia.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 22.

ROYAL SOCIETY, at 4.30.—Preliminary Note on the Relationships between Sun-spots and Terrestrial Magnetism: Dr. C. Chree, F.R.S.—Characteristics of Electric Earth-Current Disturbances, and their Origin: J. E. Taylor.—Solar Eclipse of 1900, May 28. General Discussion of Spectroscopic Results: J. Evershed.—Some Dielectric Properties of Solid Glycerine: Prof. E. Wilson.—On the Electrodynamic and Thermal Relations of Energy of Magnetisation: Dr. J. Larmor, Sec. R.S.

SOCIETY OF ARTS, at 4.30.—Indian Domestic Life: J. D. Rees.

ROYAL INSTITUTION, at 5.—Pre-Phœnician Writing in Crete and its Bearings on the History of the Alphabet: Dr. A. J. Evans, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Discussion on the Metric System. Opened by Mr. Alexander Siemens, in favour of the Metric System, and by Sir Frederick Bramwell, Bart., in favour of the British System.

FRIDAY, JANUARY 23.

ROYAL INSTITUTION, at 9.—Recent Volcanic Eruptions: Dr. Tempest Anderson.

PHYSICAL SOCIETY, at 5.—On the Oscillating Table for determining Moments of Inertia: W. H. Derriman.—Note on an Elementary Treatment of Conducting Network: Prof. L. R. Wilberforce.—On the Theory of the Quadrant Electrometer: G. W. Walker.

SATURDAY, JANUARY 24.

MATHEMATICAL ASSOCIATION, at 2.—On some Class Diagrams for Intuitional Geometry: E. M. Langley.—On the Representation of Imaginary Points on a Plane by Real Points: Prof. A. Lodge.—Incommensurables by Means of Continuous Decimals: Edwin Budden.

MONDAY, JANUARY 26.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Irrigation and Colonisation in British East Africa: R. B. Buckley.

INSTITUTE OF ACTUARIES, at 5.—Temporary Assurances: W. P. Elderton.

TUESDAY, JANUARY 27.

ROYAL INSTITUTION, at 5.—The Physiology of Digestion: Prof. Allan Macfadyen.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Nile Reservoir, Assuan: M. Fitzmaurice, C.M.G.—Sluices and Lock-Gates of the Nile Reservoir, Assuan: F. W. S. Stokes.

ANTHROPOLOGICAL INSTITUTE, at 8.—Presidential Address. The Position of Anthropology and its Needs: Dr. A. C. Haddon, F.R.S.

WEDNESDAY, JANUARY 28.

SOCIETY OF ARTS, at 8.—The Cost of Municipal Trading: Dixon H Davies.

THURSDAY, JANUARY 29.

ROYAL SOCIETY, at 4.30.—*Probable Papers:*—Relation between Solar Prominences and Terrestrial Magnetism: Sir Norman Lockyer, F.R.S., and Dr. W. J. S. Lockyer.—On the Bending of Electric Waves round a Conducting Obstacle: H. M. Macdonald, F.R.S.—On the Decline of the Injury Current in Mammalian Nerve, and its Modification by Changes of Temperature: Miss S. C. M. Sowton and J. S. Macdonald.

ROYAL INSTITUTION, at 5.—Pre-Phœnician Writing in Crete and its Bearings on the History of the Alphabet: Dr. A. J. Evans.

FRIDAY, JANUARY 30.

ROYAL INSTITUTION, at 9.—Vibration Problems in Engineering Science: Prof. W. E. Dalby.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Design of the Electrical Equipmen of a Light Railway: J. R. MacIntosh.

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