THURSDAY, MARCH 20, 1913.

COLOUR VISION.

Researches in Colour Vision and the Trichromatic Theory. By Sir William de W. Abney, K.C.B., F.R.S. Pp. xi+418+5 plates. (London: Longmans, Green and Co., 1913.) Price 21*s.* net.

THERE is certainly no living authority on "colour-vision" more competent to throw light on that intricate and perplexing subject than the author of this work. Sir William Abney has attacked the various problems which present themselves by his own methods and with the utmost completeness of detail. In almost every conceivable way he has tried to correlate the more precise physical facts, elicited by carefully and ingeniously modified experiments, with the vaguer physiological conceptions arrived at from a study of normal and abnormal sensations of colour. The present work embodies and collects into a consecutive whole a record of the author's previously published researches. The book is consequently one which will be regarded as a standard work. It gives the most complete and clear exposition of the trichromatic theory of Young-Helmholtz. It will, we venture to think, be more readily understood than Helmholtz's own latest treatment of the subject as given in the last edition of his "Physiological Optics."

So far as Sir William Abney's researches go, it must be admitted that they afford strong evidence of the fitness of the trichromatic theory to explain how normal colour sensations may be evoked by the known physical causes. The difficulty comes in attempting to explain congenital and acquired defects in colour sensation in accordance with that theory. To do so by inferring that there is then a complete absence of stimulability, or a weakening in the stimulability, of one of the three end-organs supposed to correspond to a so-called "fundamental sensation," leads to hypothetical conclusions as to the way in which colours are perceived by the colour-blind. The many interesting experiments adduced by the author in support of the idea of altered stimulability of the end-organs in the colour-blind can scarcely be said to be convincing. It may indeed be asked: Why should abnormal colour "sensation" depend at all upon abnormal "stimulability"? There are different stages in the production of colour sensations in response to objective stimuli. These are: the effect of the physical cause on the percipient elements of the retina, the conduction by the optic nerve, and, lastly, the response in the brain-cells. Might not an abnormality in the last stage, the final "response," be consistent with colour confusion complete and incomplete, altogether independent of any abnormality in the colour end-organs of the retina? In cases of acquired colour-blindness there is, in fact, good reason to refer the defect both to altered conductivity in the optic nerve-fibres and to changes in the central cells.

From the way in which colours are matched by the "colour-blind" it is difficult, apart from theory, to believe that the colour-blind spectrum is such as would appear to the normal eye anything remotely comparable to that represented for a "red-blind" and a "green-blind" individual respectively in plate i. Even admitting that there is an appreciable difference between the two classes of cases, which are thus classified in accordance with theory, it is almost inconceivable that the spectrum can appear so different in the two cases.

Some colour-blind people, it is true, are unconscious or only vaguely suspicious of their condition. But there are others who are well aware of it. Some are even keenly interested in analysing their colour-impressions and in comparing them with those of normal individuals. The writer of this notice has met with several who have done so. Without exception and without regard as to whether they might be classified as "red colour-blind" or as "green colour-blind," they have arrived at the conclusion that their yellow and blue sensations are not materially different from the normal. Their absolutely dichromatic spectrum consists of a "warm" and a "cold" colour sensation, which, when saturated, as compared with other colours to them, are often described as "vivid" and "pleasurable."

In a letter received in 1879 from Dr. William Pole, who was "colour-blind" and well known for his own contributions to this subject, he states:—"I am more than ever convinced of the enormous difficulty normal-eyed persons find in understanding what we, the colour-blind, really see." Again, in 1890, referring to Clerk Maxwell, he says:—"He examined me carefully with spectral apparatus, but he spoilt all his results by insisting that my warm colour must be the Young-Helmholtz fundamental 'green,' and as I obstinately refused to adhere to what seemed to me a preposterous contradiction of all my experience, he never published his trials. . . . Now the general opinion seems to agree with my own impression that it is yellow, *i.e.* no Young-Helmholtz fundamental at all."

Again there is surely no proof that the colour-blind see white otherwise than the normal-eyed. No difference in a white object can be seen as it is passed from the periphery of the field of vision

to the centre. Yet there is a colour-blindness of the normal peripheral field which is analogous to, though possibly not identical with, congenital colour-blindness. One of the assumptions, however, which is made, in the endeavour to make the theory suit the case of colour-blindness, is that the colour-blind "white" is altogether different from the normal-eyed "white." According to Sir William Abney, the "white" of the "red-blind" is a sea-green, and that of the "green-blind" a brilliant purple. But it would appear from the nature of the actual experiments on which this assumption is based (pp. 273, 274) that there is here only a confusion between the sensations to which these colours give rise in normal eyes and the *neutral* sensations which they evoke in the colour-blind.

In every case of complete colour-blindness (which causes colour-confusion only and is distinguished, therefore, from total loss of any colour perception) there are two hues which, though most definite and vivid to the normal-eyed, appear altogether uncoloured or neutral. Only one of these neutrals is to be found in the spectrum, though both can be produced by combinations of spectral colours. This is obviously something different from a demonstration of the manner in which what to the normal eye is white is seen by the colour-blind. But it may be asked: Is there any reason for entirely giving up the trichromatic theory because it does not meet with general acceptance when "doctored" to suit the case of colour-blindness? A study of Sir William Abney's work must convince one how strongly it is supported by physical facts.

A quotation from the preface may fittingly conclude a necessarily too short notice of this valuable and comprehensive work. The author there makes the following suggestive remark:—

"A theory, to be one of perfection, must offer the truth, the whole truth, and nothing but the truth. The trichromatic theory offers the truth; but the physiologists must add their quota to make it the whole truth. There may be difficulties in welding together the physical and physiological aspects of colour vision to make a perfect theory, but it will be effected."

A MEDIEVAL PHYSICIAN.

John of Gaddesden and the Rosa Medicinae. By H. P. Cholmeley. Pp. 184. (Oxford: Clarendon Press, 1912.) Price 8*s.* 6*d.* net.

OLD books, at any rate old medical books, may, as regards their contents, be divided into three classes: those intrinsically valuable as sources of more or less original knowledge—of such are the Hippocratic writings, Galen, Alexander of Tralles, some of the Salernitan treatises, the greater medieval Italian and French surgeons, Sydenham, Morgagni—names taken at hazard; secondly, those which, although not original sources, yet enshrine more or less admirably the works of great men or of schools which had otherwise perished—of such are Celsus, our chief resource for the doctrines of Alexandrian medicine, or Cælius Aurelianus, which preserves for us some of the writings of Soranus, or Aretæus, or Oribasius—names again chosen at random, or smaller books which also, as rafts or broken pieces of the ship, may salve lesser fragments of ancient lore—books such as Aetius or Paul of Ægina; and, thirdly, old books which have no other value than the bibliophile may, in the fashion of the time, choose to confer upon them as antiques. These books, for their quaintness, may arouse some interest, and of such is the book before us.

John of Gaddesden's book may in its time have served as a handy "Practica" for his contemporaries, but in later centuries probably the best use it has served is as a nucleus around which Dr. Cholmeley has gathered much interesting historical matter, very aptly and pleasantly put together. The original John is poor stuff. His editor respectfully offers to him some tribute, asking us to recognise at least his clinical insight. John, who died in 1361, highly educated at Oxford and in later life a fashionable Court physician, enjoyed great advantages of experience, and no doubt brought these advantages to the construing of his Oxford "Theoretica" and "Practica"; but his own contributions were exiguous. Arderne, if no great author, was at any rate superior to John of Gaddesden, and we hope that the success of this edition may tempt Dr. Cholmeley to follow up Mr. D'Arcy Power's pioneer work with a like volume on Arderne.

In studying the writings of early physicians we must continually remember that literary ethics was not born until modern times—almost in our own day. It is scarcely fair to these old men, when they lifted pages upon pages from their forerunners, to accuse them of "shameful plagiary." They all did it, and not in medicine only; and not only the inferior authors, but the most reverend of them also. So John, with a pious obsequiousness, helped himself to what he could find elsewhere to serve his purpose. As a specimen of John's wonderfully vivid clinical pictures, Dr. Cholmeley quotes his description of obstructive jaundice with ascites. It is vivid, no doubt; but we may be sure that it is not John's. To track out the sources of all or many of his purple patches would be a long business, but in respect

of this passage, as Avicenna lay near me, I looked up this subject therein; I did not find there this paragraph as a whole, it is true, but I found every or almost every sentence of it in Avicenna (Lib. iii., Fen 14, Tr. 4), sentences condensed either by John himself or by someone whom John copied. And thus, with a little trouble, I suspect we might run to earth most or all of John of Gaddesden's clinical equipment. I turned to Avicenna remembering that Razes diagnosed ascites by fluctuation and percussion.

It is not quite easy to account for the sterility of Great Britain in medicine, as in much other knowledge, during the fourteenth and early fifteenth centuries. Gaddesden's book must have been written before the Black Death. Edward the Third was an accomplished sovereign, and England was not more harried by wars than France, yet we have nothing distinguished to show before the time when began the great procession of Gilbert, Clowes the elder, Harvey, Glisson, Wharton, Willis, Lower, Wiseman, Mayow, to prove that Englishmen were capable of carrying the banner of medicine as high as their neighbours. Before the revival it is true that England was somewhat isolated from the main streams of European learning. Anyhow, the history of medicine in England before the accession of the Tudors is a dreary study.

We know how well equipped in the fourteenth century Merton was, or ought to have been, in this field; and Gaddesden was of Merton. Perhaps no faculty has been so robbed of its endowments as medicine; witness also the Linacre trusts and the Gresham College; moreover, of the three "philosophies," the natural branch was gradually eliminated. It is interesting to learn, however, from Dr. Cholmeley that John was a graduate in medicine. I am not sure if Dr. Cholmeley has any higher authority for this title than Wood, to whom he refers. In Cambridge we have little record, if any, of actual M.D.'s before the sixteenth century; and the early statutes, which may be cited as evidence of study for the degree, are (as in Peacock) of uncertain date. Of course, it is probable that in both universities physicians then graduated as M.D.; but are the graduations on record? The "clerks" who studied medicine, at any rate if in orders, seem not to have taken the title of M.D. I ask this as Dr. Cholmeley has added to this book a very interesting narrative of medical education in Oxford. With a true intelligence he has done what was possible to trace the titles of books on medicine then in the University; for in the Middle Ages books were as much the cause of a university as teachers. The author says that Montpellier at that time outshone Oxford as a medical school; the reason, or one reason, is that the libraries of Montpellier were fed from Cordova. Thus also Frederick the Second wisely commended his foundation at Naples by purchasing books for large sums from the Grand Trunk.

Dr. Cholmeley has another interesting chapter on the medieval physician, and others on kindred subjects, for which we thank him cordially. We wish Dr. Cholmeley health and leisure to extend his gifts to us of like scholarly volumes on other chapters of the history of medicine.

CLIFFORD ALLBUTT.

THE STRUCTURE AND BIOLOGY OF THE BACTERIA.

(1) *Die Zelle der Bakterien.* Für Botaniker, Zoologen und Bakteriologen. By Prof. Arthur Meyer. Pp. vi+285+plates. (Jena: Gustav Fischer, 1912.) Price 12 marks.

(2) *Bau und Leben der Bakterien.* By Prof. W. Benecke. Pp. xii+650. (Leipzig and Berlin: B. G. Teubner, 1912.) Price 15 marks.

THESE two works are evidence, if any be needed, of the increasing interest which is being evinced in the study of the bacteria by biologists. The literature concerning them has now become so extensive that summaries such as are contained in these two volumes are very welcome.

(1) The first book treats almost exclusively of the structure and elements of the cells of the micro-organisms classed by Migula under the Eubacteria. The cells of most of these organisms are so minute that it is only by the employment of the most refined methods of research that their intimate structure and the nature of their cell-contents can be elucidated. The introductory portion deals with the classification of these organisms and with their affinities with other unicellular vegetable forms and with the Protozoa. The author considers that the Eubacteria are closely related to the Hemiascomycetes and Euascomycetes of the fungi. Successive sections deal with the structure and elements of bacterial cells—nucleus, plasmodia, cytoplasm, flagella, membrane, vacuoli, and reserve material. In each section the work of various investigators on the subject is summarised and criticised with commendable completeness. In a final section the question of the chromophyllous nature of the colouring matter of the "purple" bacteria is discussed.

For the specialist who requires a general summary of what is known respecting bacterial structure, no better book could be found. It is pro-

fusely illustrated in the text, and contains one coloured plate showing the elements and structures brought to light by the application of various methods, staining agents and other reagents. A full bibliography is appended, but an index is lacking, which is a great mistake.

(2) The second volume is one more adapted to the needs of the biologist or of the general reader, inasmuch as it gives a general survey of the structure and functions of the bacteria and of their activities. The first two chapters are devoted to a consideration of the size, form, development, and occurrence of the bacteria and to the methods employed in studying and cultivating them. Chapters iii.–vi. deal with their morphology and the structure of the bacterial cell. As regards classification (chapter vii.), the author divides bacterial organisms into two suborders, the Haplobacterinæ and the Desmobacterinæ, the former including the single-celled bacteria, the latter the thread-forming organisms such as Leptothrix, Crenothrix, Cladothrix, and Beggiatoa. As an appendage of the Haplobacterinæ he recognises the Mycobacteriaceæ ("Pilzbakterien"), in which he places such organisms as the tubercle bacillus and Actinomyces, and the Myxobacteriaceæ or "slime bacteria." Truly the classification of the bacteria is still in a very unsatisfactory condition!

Variation and mutability among the bacteria are discussed at some length, after which the conditions of life and general physiology of the bacteria are dealt with: assimilation and dissimilation, fermentation, nitrogen fixation, &c. Finally, the occurrence and distribution of bacteria on the earth's surface, in arable, grass, and wooded lands, in water and dwellings, are considered. The book is exceedingly well conceived, and contains a mass of trustworthy information with sufficient references to the literature. It is well printed and illustrated, and is supplied with adequate indexes to the matter it contains and to the authors mentioned.

R. T. HEWLETT.

OUR BOOKSHELF.

Guide Scientifique du Géographe-Explorateur. By P. Crépin de Beauregard. Pp. x+250+2 plates. (Paris: Gauthier-Villars, 1912.) Price 10 francs.

THIS work is not intended for the ordinary traveller who wishes to prepare a sketch-map of the country which he traverses, and to determine with moderate accuracy the position of his halting places. M. Crépin de Beauregard, who has had much experience of surveying both in France and in Indo-China, has prepared a handbook for the trained surveyor who has a certain knowledge of mathematics and has to undertake work of considerable accuracy in new countries in order to provide a control for subsequent topographical surveys. The treatment is consequently in a large degree theoretical, though actual examples from work in the field are given, but the simpler and less precise methods of topographical surveying are not included.

The first chapter deals mainly with the trigonometrical formulæ involved, while in the second the theodolite is discussed as being the instrument employed, and the errors introduced by dislevelment, &c., are investigated. Coming to the astronomical determinations which the surveyor requires to make in the field, the most suitable methods of determining the local time, the latitude of a station, and the azimuth of a mark are fully discussed theoretically, and an example of each is worked out. In these cases each observation made is worked out separately and a mean value of the results is obtained, though the probable error is not considered.

In that part which treats of triangulation the author deals with the computations which are necessary in first and second order triangulation where the surface is treated as that of a spheroid, and in third order work where spherical formulæ suffice. Map projections occupy a chapter, and these are not limited to those types which are likely to be employed by those who are surveying a new country, but include all the principal types. The book should be of much use to those trained surveyors who are steadily extending the network of triangulation in Algeria and Tunis, in Indo-China and Madagascar. H. G. L.

Introduction to the Rarer Elements. By Philip E. Browning. Pp. xii+232. Third edition. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1912.)

To this edition of Dr. Browning's book several additions have been introduced and numerous changes made. The chapter on qualitative analysis has been enlarged by the inclusion of new diagrams, new material has been added to the chapter on technical applications, and a table of spectroscopic lines and plates showing typical spectra have been introduced. The second edition was reviewed in NATURE of April 15, 1909 (vol. lxxx., p. 182).

A First Book of Electricity and Magnetism. By W. Perren Maycock. Fourth edition. Pp. xxii+351. (London: Whittaker and Co., 1913.) Price 2*s.* 6*d.* net.

THE first edition of Mr. Maycock's little book was reviewed in the issue of NATURE for January 14, 1892 (vol. xlv., p. 248). The present issue has been revised thoroughly and enlarged considerably, and the author has been successful in his desire to "carry the reader over the threshold of a subject whose theoretical and practical extents are very far-reaching."

LETTERS TO THE EDITOR.

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The Radio-Elements and the Periodic Law.

I AM grateful to Prof. Schuster for the opportunity he has afforded by his letter (NATURE, March 13) for the discussion of the wide generalisations that have been made with regard to the position of the radio-elements in the periodic table, consequent on the recent experimental work of A. Fleck and of the theoretical suggestions of A. S. Russell and K. Fajans. The whole question is one in which it is important that there should not be any doubt as to the real nature of the evidence adduced. Prof. Schuster's criticism of my views on the subject could scarcely be more sympathetic or helpful, and can only result in a maturer outlook on this important question.

Granting for the sake of argument the possibility of the existence of groups of elements not necessarily of identical atomic mass, with identical chemical properties and spectra, the only known direct manner in which the existence of the members of these groups could be separately recognised is radio-active evidence, in which one member is formed from another, not directly, but through the intermediary of other elements, possessing, necessarily as now appears, completely different chemical properties. Hence it is natural that at first direct evidence should be confined practically to the subject of radio-activity, and much depends upon whether that evidence is considered real evidence approaching experimental proof, or whether it is regarded as merely negative in character.

In the first place, I admit when I wrote the expression, "non-separable by any known process," I had in mind chemical processes. It is unusual and illustrative of the peculiarities of the problem that the relatively rough and partial means of physical analysis, to which Prof. Schuster refers, may be expected ultimately to succeed where the most refined and delicate methods of chemical analysis may be expected to fail. But so it is, and I agree with Prof. Schuster that it should ultimately be possible partially to separate by purely physical methods certain members of these chemically identical groups by virtue of the slight differences in their molecular masses. In fact, a year ago I commenced an experiment to try to effect a partial separation of the two uraniums by diffusion in solution. This case is an exceptionally favourable one as an alteration in the relative concentration of the two uraniums by only a few per cent. should be detectable without any uncertainty by radio-active methods.

Although the term "non-separable" I think connotes present inability, without implying, necessarily, anything as regards what may be possible in the future, I do, however, think that there are good grounds for believing that the *chemical* non-separability of elements occupying the same place in the periodic table is due to the general character of chemical methods rather than the state of refinement and delicacy attained at any particular time. The chemical analysis of matter has given us the periodic law, and there is no case known of two or more ordinary elements with claims to the same place in the periodic table. In this connection the case of the rare-earth group of elements is necessarily excluded, as these elements certainly do not obey the law without modification. In all other parts of the table the rule is that there is only one element for each place, and each place signifies a separate chemical type differentiated in a regular manner from its neighbours. But now the radio-active series have shown that different elements, not necessarily of identical atomic mass, do occupy the same place, and that when this occurs these elements possess identical chemical nature. It is therefore an inference supported by the known facts of chemical analysis that the single place in the periodic classification represents the limits of the analysis of matter by chemical methods, rather than the ultimate analysis into homogeneous types, such as is usually implied in the conventional view of elements.

Prof. Schuster admits that the chemical properties of these non-separable groups of radio-elements are probably more nearly equal than those of the longer-known elements, but claims that there is a vast interval between "very similar" and "identical." I do not like the term "very similar." It is ambiguous, and may mean nothing more than that the experimental examination has been neither skilled nor exhaustive enough to disclose the differences, if any exist. Unless this is the case, I feel that the proper term to use is "identical." Otherwise the word "identical" ought to be expunged from scientific language altogether. Unless there is some reason to foresee a qualification being required by the further progress of knowledge, a definite statement ought to be preferred in science to an ambiguous one, which on account of its vagueness must necessarily remain true for all time. Scientific statements can only express present knowledge, including in this term reasonable inferences from the whole field of such knowledge.

The term "chemically identical" has not been applied until after an examination, not, of course, in every case, but in every possible case, and in sufficient numbers of cases to reveal the general law, as skilled and exhaustive as the present art of chemical analysis allows, and, what is equally of importance, by the use of methods for detecting changes in relative concentration as delicate as any that exist. The example quoted of praseodymium and neodymium ought to be more closely examined. These elements proved to be separable as soon as optical methods of revealing their separate existence became known. In the case of the radio-elements the separate radio-active nature of each individual of the group is exactly known, the proportion of each in any mixture can be quantitatively evaluated. Yet they are non-separable. That some mixture to-day may still be classed as a homogeneous element because no means exist for the separate identification of its components does not affect the fact that some mixtures of elements capable of separate identification are chemically non-separable.

Difficulties of chemical analysis are often not connected with the methods of separation at all, but with the means of determining whether or not a separation has been effected, which, in the case of the difficult rare-earth group are relatively crude and sometimes misleading.

The suggestion, that in the disintegration process a mass equal to that of the α particle previously lost may be picked up, is not a probable one, but even if it is admitted, and it is supposed that parent and product have the same mass, it does not affect the view that they are two absolutely distinct types of matter, disintegrating at different speeds and in certain cases with expulsion of different kinds of rays. The attempt to meet this by supposing that the particular instability which determines their future may depend on their past is equivalent to admitting the

essential difference between the two types. Besides it can be stated definitely that for any one kind of instability, or for any one radio-active change, the past exercises absolutely no influence upon the events of the future. The period of average life of an atom depends neither upon how long it has already been in existence nor upon any other known condition. It is independent of concentration or the environment in which the atom disintegrates. These features of radio-active change are against the view that anything of the nature of atomic synthesis is going on concurrently with the disintegration, or that disintegration is conditioned by the drain of energy from the atom by radiation, as is so often affirmed.

The mass of evidence that has been accumulated that different elements have identical chemical nature is not accurately described as purely negative in character. The statement that A is non-separable from B is negative in form only. It contains explicitly an infinite number of definite positive statements that A is separable from C or D, or any other of the hundred or more known elements, or any conceivable mixture of them, by chemical methods, which are exactly indicated by the statement. It is not necessary that A and B should in every case coexist, though in certain cases—the two uraniums is a good example—they have never been obtained apart. Mesothorium-II. ordinarily occurs free from actinium, and the putting in of the latter substance is a voluntary experimental device to show that once mixed these two elements are chemically non-separable. The complete chemical nature of either, or of any other of the radio-elements, could be described in detail *ab initio*, but the negative form is brief and complete.

I do not think there are weaknesses in this part of the argument. It has been a slowly growing theoretical development, and I do claim for it something approaching experimental proof.

As regards the view that chemically identical groups of elements have the same spectrum, this admittedly I put forward on a single case, that of ionium and thorium. It rests entirely on the validity and generality of the α and β ray change rules, but, if these are true, ionium must be the direct product of uranium-II.; its period cannot be less than 100,000 years, and its proportion in the preparations spectroscopically examined less than 16 per cent. and 10 per cent. respectively. Any other view requires the assumption that one or more α ray and twice as many β ray changes remain to be discovered in the series, and it can be stated with some certainty that no such changes remain unknown.

Frankly, I do not expect Prof. Schuster or anyone else to accept a view of this kind, put forward on a single thread of evidence. The value of the view is merely that it suggests definite new lines of work, difficult and costly, but still experimentally feasible.

Prof. Schuster points out that the members of the thallium group, for example, ought to give the thallium spectrum in absence of thallium in the material. The latter condition is easy to ensure. But the case is not a very favourable one on the radio-active side, as thorium-D, the best example of the group to select, has a period of average life of only 4·5 minutes. The case, however, might be within the resources of some radium institute.

Since Prof. Schuster made this suggestion, I have gone into the experimental feasibility of getting evidence of this kind, and have decided to concentrate on the case of thorium-X, the spectrum of which should be identical with that of radium. It is a particularly crucial case. The spectrum reaction of radium is excessively delicate, and the amount of this element can be easily evaluated in quantities thousands of times less than can be spectroscopically detected. The chemical work is complicated, but really exceptionally favourable and elegant.

Mesothorium-I. is non-separable from radium, and radiothorium from ionium, the parent of radium, so that if radiothorium is grown from ionium-free mesothorium it can be purified from radium to any extent and left to produce thorium-X. Naturally, however, the work will require some years, but it should be within the resources of the individual investigator. At the same time, it will be possible to try during the course of the work a large number of similar cases, if a sufficient supply of the primary material, mesothorium-I. can be obtained. This inference as to the spectra is purely a personal view, and is to be taken merely as a suggestion until further evidence is forthcoming. But I would not have made it if I thought it inconsistent with any known evidence.

FREDERICK SODDY.
Physical Chemical Laboratory, Glasgow University, March 15.

An Unknown Assyrian Antelope.

MY attention has been directed by the Rev. A. Paterson to a plate in a portfolio of photographs from Assyrian bas-reliefs published at Haarlem, but now out of print. This plate represents a bas-relief in the great hall of Sinnacherib's palace at Nineveh, and consists of an upper and a lower portion. The latter depicts the monarch in his chariot, while the upper shows a reed swamp with wild animals. This swamp is believed to be part of a pleasure-ground made by Sinnacherib in the neighbourhood of the palace, into which wild animals were turned. It is divided in the bas-relief into an upper and a lower portion. In the left-hand corner of the lower half is shown a wild sow with a litter of young, as they might appear at the present day in the reed-brakes of the Euphrates. The other animals are three ruminants, about half as big again as the sow, but with longer legs. The two in the upper half of the scene — of which one is lying down—are hornless, and therefore females, but the third, in the right-hand corner of the lower half, carries spirally twisted horns, recalling those of the African kudu, nyala, and situtunga, although not corresponding exactly in curvature with any of them. The tail is relatively short, as in the nyala. The buck is represented with its head down, nibbling the stem of a reed; on its body, in addition to parallel lines representing the ribs, are certain patches, which may be intended for broken pieces of reeds. These animals have been regarded as deer, but the buck carries horns, and not antlers, and antlered deer are not inhabitants of reed-brakes. On the other hand, such situations are the resort of several African antelopes, notably the situtunga, and it therefore seems prac-

The male antelope in the bas-relief of Sinnacherib's Swamp at Nineveh.

tically certain that the ruminants represented in the sculpture are antelopes. They must, moreover, be antelopes of an African type, as there are no marsh-haunting species with spiral horns known from Syria, or Asia in general, and the presumption is that they represent an extinct member of the tragelaphine group allied to the nyala and situtunga, in which the females are hornless. The tragelaphine group is represented at the present day in India by the nilgai and chousingha, in which the horns of the bucks are small, but there is evidence that in the Pliocene India was the home of species akin to the kudu and bush-buck. And it is therefore quite reasonable to expect that in Assyrian times a member of the group may have inhabited the Euphrates Valley.

R. LYDEKKER.

Cavities in Stones.

IN the description of the Agglestone "on the old moor of Studland, near the north shore of the Island of Purbeck," given in Warne's "Ancient Dorset," allusion is made to superficial cavities or hollows in this stone, and in stones in Yorkshire and Lancashire. In some cases "the cavities consist of holes about an inch and a half broad and of the same depth drilled into the stone." Mitchell[1] gives illustrations of the stones with cup-shaped markings described by Sir James Simpson in his work on "Archaic Sculptures."

In all probability these examples of supposed archaic sculptures (and others) have long ago received the "more extended investigation by competent observers" that Warne thought they deserved. But it would be of interest to know if they have been examined by conchologists as well as archæologists. There is just a possibility that some may be burrows excavated by *Helix aspersa*, for the description and illustrations recall the helicidean cavities in Carboniferous Limestone that occur somewhat frequently in Ireland, but are uncommon in Britain. The rock-shelters of *Helix aspersa* at Great Orme's Head, Llandudno, and at Miller's Dale, Derbyshire, have been fully described and illustrated,[2] also others more recently observed by myself in the limestone on Brean Down, Weston-super-Mare.[3].

E. W. SWANTON.

Sir Jonathan Hutchinson's Educational Museum, Haslemere, March 10.

An Experiment for Showing Lines of Force in an Electrostatic Field.

A GILT cork ball, about 1 cm. in diameter, is attached by sulphur to a vertical straw about 28 cm. in length. The lower end of the straw is fastened by sulphur to the centre of a circular cardboard tray about 5 cm. in diameter, in which is a ring of lead. The tray is put on a watch glass which floats on the surface of mercury in a large flat dish. (A developing dish about 30 cm. by 26 cm. was used, but a shallow wooden trough made for the purpose would be better.) In this way the gilt ball is able to move fairly freely in a horizontal plane. This float arrangement is kept in a bell-jar desiccator when not in use.

Two conducting spheres, about 10 cm. in diameter, are mounted on vertical glass tubes (sealed off at each end), and coated for about 10 cm. with sulphur, which can be readily got into a good insulating condition when required by warming in a flame. The centres of these spheres and the gilt ball are at the same level. The spheres being arranged on opposite sides of the dish, and so that the ball can touch them.

The spheres are connected either to the same terminal or to the opposite terminals of a Wimshurst machine.

The gilt ball describes curves which, when it moves slowly, give the general directions of the lines of force between the spheres in the plane it is free to move in.

The experiment is effective for illustrating lines of force in an electrostatic field and for leading up to the mathematical definition of potential. It may be extended for different charges on the spheres.

R. F. D'ARCY.

Caius College, Cambridge.

Units of Pressure in Vacuum Work.

SURELY physicists do, or should, for convenience, always express wave-lengths in microns (μ) and molecular distances in millimicrons ($\mu\mu$). Why not follow the same practice in dealing with vacua? The millimetre is a convenient unit down to, say, 0·1 mm., but 1/1000 mm. and 1/10,000 mm. have frequently to be expressed. It is simpler to write and comprehend these in the form 1 μ or 0·1 μ. Again, in the pamphlet sent out by Dr. Gaede to describe his very successful pumps, we see unwieldy decimal expressions used. For instance, it is stated that it is possible to obtain a pressure of 0·000002 mm. of mercury after four minutes of pumping. Why not write this 2$\mu\mu$ of mercury?

There is a small unit sometimes found in researches, viz. one-millionth of an atmosphere, denoted by the letter M, but for this unit to have a definite numerical meaning it is necessary to quote the barometric reading at the time. If the barometric reading is normal 1 M = 0·76 μ. But, of course, 0·76 μ alone needs no qualifying as to the barometric pressure, and therefore is simpler and more direct.

P. E. SHAW.

University College, Nottingham, March 2.

NEW MICROSCOPE EYEPIECES.

Eyepiece Micrometer.

DR. METZ, one of the researchers employed in the Leitz optical factory at Wetzlar, has recently described[1] a micrometer for use with the microscope which, if we are not mistaken, will rapidly replace all others, including the expensive filar micrometer where a mechanical stage is available. The root idea is that the scale used is such that microns can at once be read off without greatly changing the tube-length, or considering the micrometer value of the objective employed, and therefore dispensing with the arithmetic for which this is a necessary datum.

To bring this about, the intervals of the new scale, instead of being 1/10 or 1/20 mm. wide, as is usually the case in eyepiece micrometers, have a definite value of 0·06 mm.

With an objective of 2 mm ($\frac{1}{12}$) focus when a stage micrometer with ten $\frac{1}{100}$ mm. divisions is viewed, each of these divisions falls on the larger

[1] "The Past in the Present," p. 86.
[2] John Taylor, "Monograph of the Land and Freshwater Mollusca of the British Isles," vol. i., p. 311, fig. 601, and vol. iii., pp. 244–246.
[3] E. W. Swanton, "The Mollusca of Somerset" (Somerset Arch. and Nat. Hist. Soc., 1912), pp. 26, 27, pl. iii.

[1] *Zeit. für wissenschaftliche Mikroskopie*, xxix., p. 72.

divisions of the eyepiece micrometer indicated by the steps (see Fig. 1). Each of the smaller divisions therefore represents a micron.

If exact coincidence between the eyepiece and stage scales does not occur with the proper tube-length, it should be varied—a slight variation is all that is necessary—and the new tube-length recorded for micrometer purposes.

It is obvious that as a 4 mm. ($\frac{1}{6}$) objective has half the magnification of one with a focus of 2 mm., such an objective treated the same way will give us the ten divisions of the stage micrometer covering five of the large divisions of the eyepiece micrometer; hence to obtain microns we must multiply by 2, and this is all the arithmetic needed.

It also follows that with an 8 mm. ($\frac{1}{3}$) we must multiply by 4, and with a 16 mm. ($\frac{2}{3}$) by 8, to obtain the number of microns subtended by each of the smallest divisions of the eyepiece micrometer.

It will be seen then that one of the results of the new departure is to obtain for each objective and for a given tube-length convenient, and in the majority of cases integral, micrometer values, which greatly facilitate the use of the instrument. The actual tube-length differs in most cases but little from the standard length.

Dr. Metz in his paper gives the value of the unit of the scale and the proper tube-length to be used with each of the twenty-four of the achromatic, fluorite and apochromatic objectives produced by the Leitz firm.

FIG. 1.—Micrometer scale showing steps.

But, of course, the new micrometer can be used with any objective, and for general purposes it will be employed with objectives having foci of 2, 4, 8, or 16 mm. focus. These we have already considered.

The following table gives the tube-length results obtained in a trial of the new micrometer with objectives of different makers; it will also show the wonderful simplicity brought about:—

Focal length mm.	in.	Maker	Tube length for best definition	Tube length for scale coincidences	Scale divisions equivalent to $\frac{1}{10}$ mm.	Multiplier to obtain microns (μ)	One division of the scale $=\mu$
2	$\frac{1}{12}$	Crouch	170	170	100	1	1
,,	,,	Reichert (dry)	170	190			
,,	,,	Watson	200	*172			
4	$\frac{1}{6}$	Bausch & Lomb	160	188	50	2	2
,,	,,	Watson	200	210			
8	$\frac{1}{3}$	Winkel	170	*192	25	4	4
16	$\frac{2}{3}$	Watson	200	193	12·5	8	8

* The variation from the normal tube length in these cases arises from the fact that the $\frac{1}{12}$th is really a $\frac{1}{14}$th, though listed as $\frac{1}{12}$th, and the focus of the 8 mm. examined is really 8·5.

To demonstrate the simplicity of the method and the degree of accuracy to which the step micrometer lends itself, the following examples may be given:—

The object selected was a valve of *Surirella gemma*; its length was measured first by an eyepiece micrometer of the usual type and then by the step micrometer.

(1) Leitz objective $\frac{1}{6}$ in., possessing micrometer value 0·00349 mm., length of valve 30·9 intervals of the scale; therefore $30{\cdot}9 \times 0{\cdot}00349 = 0{\cdot}1078$ mm. $= 107{\cdot}8$ μ.

With the step micrometer the value of the same objective is 2 μ at a mechanical tube-length of 178 mm., the valve covers 53·8 intervals of the scale; therefore $53{\cdot}8 \times 2 = 107{\cdot}6$ μ.

(2) Leitz objective $\frac{1}{12}$ in. oil immersion, micrometer value $= 0{\cdot}00164$, length of valve 65·5 intervals of the scale; therefore $65{\cdot}5 \times 0{\cdot}00164 = 0{\cdot}1074$ mm. $= 107{\cdot}4$ μ.

With the step micrometer the same objective possesses a micrometer value of 1 μ at a mechanical tube-length of 168 mm., the valve covers 107·5 intervals of the scale; therefore $107{\cdot}5 \times 1 = 107{\cdot}5$ μ.

In certain cases of frequent occurrence the use of the eyepiece micrometer involves difficulties. The usual eyepiece micrometer has very fine lines, and with some objects it is difficult to see them under unfavourable conditions of lighting. During prolonged observations with an eyepiece micrometer this is very fatiguing and apt to strain the eye.

This defect is particularly pronounced when an object and a micrometer scale are seen by dark-ground illumination, a method which is now largely employed. Indeed, in a dark-ground field the micrometer scale may refuse to come into view.

In the new micrometer the intervals are arranged in groups or steps of ten, each group being indicated in an unmistakable manner by a black echelon rising from the first to the tenth interval. This arrangement possesses the great advantage that the divisions can always be seen distinctly whether the objects be light or comparatively dark.

The micrometer is mounted on the diaphragm of the eyepiece, and can be sharply focussed with the eye-lens, which is mounted in a sliding sleeve. The device is made by E. Leitz, and its cost with eyepiece is fifteen shillings.

Double Demonstrating Eyepiece.

Next in importance to the new micrometer comes a form of eyepiece, introduced also by the firm of Leitz, which enables two observers to use the same objective, and therefore to view the same object. It is called a double demonstrating eyepiece, as no doubt its chief, though not its only, use will be to serve a demonstrator to instruct a student.

The new eyepiece slips into the draw-tube of the microscope like an ordinary eyepiece. The field of view is common to both eyepieces, and contains a pointer which either observer can direct

upon any feature to which he wishes to direct attention.

The arrangement of the device is shown in the subjoined figure :—

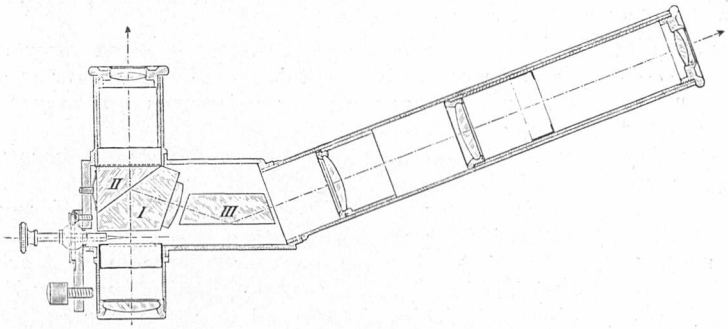


FIG. 2.—Demonstrating eyepiece.

I and *II* are two prisms in contact and mounted above the diaphragm between the field-lens and the eye-lens of the eyepiece. The prism *I* has an isosceles cross-section, and its angles are 35°, 35°, and 110° respectively. The prism *II* is rectangular, and its angles are 35°, 55°, and 90°. The prisms are placed with those faces in contact which subtend the angles of 90° and 110° in such a manner as to leave between them a very thin film of air. This film is inclined at an angle of 30° to the axis of the eyepiece and partially reflects the emerging pencil of rays; about two-thirds of the rays pass through the prisms, and one-third is reflected.

The image formed along the axis of the microscope is accordingly brighter than that produced by partial reflection. The centre line of the reflected pencil is inclined at an angle of 70° to the axis of the microscope. *III* is a prism the lower surface of which reflects the pencil upwards at a convenient angle for observation. In order that the two observers may not be in each other's way, the branch tube is fitted with a system of lenses which resembles a terrestrial eyepiece. The image as seen in the side tube is reversed with respect to that which appears in the axial eyepiece; but this scarcely affects the observer, since the oblique attachment of the side eyepiece changes the orientation of the field which is focussed through the principal eyepiece, as the image seen through it is brighter. The adjustment for one eyepiece furnishes a clearly defined image in the subsidiary eyepiece, provided the eyes of both observers can accommodate in a similar manner. The objective in conjunction with the field-lens below the double prism of the two eyepieces forms an image in the plane of the diaphragm below the double prism. This image and the pointer, being both in the plane of the diaphragm, are seen simultaneously in both eyepieces. The pointer can be moved backwards and forwards and turns on a pivot so that its extreme end can be set to any point in the field.

The new eyepiece is well adapted for the instantaneous photography of living bacteria and other moving organisms illuminated by means of a dark-ground condenser; it enables one to observe the object through the side eyepiece and to defer the exposure until a favourable moment presents itself.

This eyepiece makes the instrument to which it is attached into a binocular microscope in a new sense. Its use will certainly not be confined to laboratories; it will equally be a delightful acquisition to tyros discussing pond-life or other subjects in which amateurs take an interest. The 6-diameter power is to be preferred, and as the branch tube is not counterpoised, if the eyepiece tubes do not fit tight it is better to use the microscope in a vertical position.

STANDARDS AND TESTS FOR SEWAGE AND SEWAGE EFFLUENTS.

THE eighth report of the Royal Commission on Sewage Disposal deals with the important question of standards and tests for sewage and sewage effluents discharging into rivers and streams. In their fifth report the Commissioners indicated the desirability of fixing a legal standard for sewage effluents, and suggested that such a standard should be based on (i) suspended solids and (ii) absorption of dissolved oxygen. Their contention then was that the two tests should be taken separately, and they suggested three parts per 100,000 as the limit of suspended solids, and that the effluent after removal of its suspended solids should not absorb more than 0·5, 1, and 1·5 parts dissolved oxygen per 100,000 after one day's, two days', and five days' incubation at 65° F. respectively.

In their present report the Commissioners recognise the difficulty of the separation of the suspended solids, and finally recommend the following as the normal legal standard, viz.: 3 parts per 100,000 of suspended solids, and, including its suspended solids, the effluent shall not absorb more than 2 parts dissolved oxygen per 100,000 after five days' incubation at 65° F.

The importance of this report lies in the fact that not only is a definite legal standard recommended, but that in the opinion of the Commissioners this standard should be a variable one, dependent on the conditions at the outfall, *i.e.* condition of river or stream receiving the effluent and relation of volume of sewage effluent to river water.

The Commissioners state that their experience leads them to think that if the dilution while not falling below 150 volumes does not exceed 300 volumes, the dissolved oxygen test may be omitted and the standard for suspended solids fixed at 6 parts per 100,000, and if the dilution while not falling below 300 volumes does not exceed 500, the standard for suspended solids may be further relaxed to 15 parts per 100,000, and with a dilution of more than 500 volumes all

tests might be dispensed with and crude sewage discharged, subject to such conditions as to the provision of screens or detritus tanks as might appear necessary to the central authority.

In arriving at the proposed legal standard and modifications, the limit of the amount of dissolved oxygen absorbed by river water without creating a nuisance has been taken as a basis. The report contains data in regard to this point, and the method of determining the standard so far as regards the permissible amount of dissolved oxygen absorption is given. Tables are also given showing the amount of oxygen absorbed by typical sewage liquors and effluents, together with the theoretical amount of dilution necessary to prevent de-oxygenation beyond a certain limit.

E. A.

BIRTHMARKS AS A TEST OF RACE.

A SUGGESTION was recently made by Herr Bealz that blue patches in the sacral region furnished a valuable test of race. Such marks are found among the children of Chinese, Koreans, Japanese, and Malays. Mr. Gait, Census Commissioner for India, directed that during the 1911 census inquiries should be made into the question. Much information on the subject will be found in Mr. C. M. Webb's Census Report of Burma for 1911, recently issued (vol. i., pp. 281 *et seq.*). The results are not decisive, and there are at present no means of giving statistics showing the prevalence of these marks. But they are found extensively in Burma, and seem to indicate the existence of a Mongoloid strain in the population.

The question of Melanoglossia was also raised by Surgeon-Captain Maynard, I.M.S., and the prevalence of these black marks on the tongue was also investigated by Mr. Webb (*ibid.*, i. 286), They are very infrequent among Aryan immigrants to Burma, but are found to a large extent among Dravidians, and the pigmentation of the tongue seems to vary with the pigmentation of the skin.

It may be hoped that the question will receive further attention in India, and that inquiries will be made on a wider scale to determine the statistical incidence of these marks.

COLONEL J. S. BILLINGS, M.D.

THE world of letters, as well as that of science, has sustained a very great loss in the death of Col. J. S. Billings, M.D., who died in New York on March 11, at the age of seventy-six. Although born in Indiana, and not in New England, he was nevertheless a typical example of what Oliver Wendell Holmes in "Elsie Venner" calls "the Brahmin caste of New England." In person he was tall and powerfully built. He had a well-poised and shapely head, clear-cut features and a very quiet, unassuming and courtly manner.

In spite of his quiet appearance and manner, Dr. Billings was a man of extraordinary energy. He joined the army of the Northern States in 1861 as assistant surgeon, but he was medical inspector of the army of the Potomac when the war finished. During the war he designed most of the hospitals of the northern army. In 1883 he took charge of the Surgeon-General's Library at Washington, a small collection of about two hundred books. During the twenty-two years in which he held the office of director he raised this collection to be one of the finest medical libraries in the world. The catalogue of the library is a stupendous work, giving references not only to medical books, but to pamphlets and extracts, so that it is now indispensable to every worker in medical literature.

From 1891 to 1896 Dr. Billings was professor of hygiene in the University of Pennsylvania, and in 1896 he became director of the New York Public Library, Astor, Lenox and Tilden foundations. This he determined to make one of the seven or eight great libraries of the world, comparable with the British Museum and the Vatican Libraries. He had the satisfaction during his lifetime of seeing a new building provided for the library and the number and value of the books greatly increased. In addition, he arranged for branch libraries to which books could be sent out and consulted apart from the library itself.

Probably no other single man ever did so much for libraries as Dr. Billings. His work was recognised during his lifetime by various universities. He received the honorary degree of LL.D. from five universities—Edinburgh, Harvard, Buda-Pesth, Yale and Johns Hopkins—the D.C.L. from Oxford and the M.D. from Munich and Dublin. But his labours in founding a complete bibliography of medicine by the Surgeon-General's Catalogue and the "Index Medicus," in devising a new method of library cataloguing, and in extending and amplifying the work of the New York Public Library so as to make it a great national institution, will only be fully appreciated by posterity. His kindness of heart, his affectionate disposition and his charm of manner made him beloved by all who knew him, and it will be long indeed before we see his like again.

LAUDER BRUNTON.

NOTES.

THE Geological Society of France has awarded the Gaudry medal, the highest honour it can bestow, to Prof. Edward Suess, of the University of Vienna. The Fontannes prize for the best work in stratigraphical geology during the last five years has been awarded to M. Jean Boussac.

WE are asked to state that the Committee on Research Institute, Chicago, is collecting information about bibliographical material and indexes kept in manuscript by libraries or individuals. Those who have such material in their possession, or know of the whereabouts of any, are desired to communicate with Mr. A. G. S. Josephson, care of the John Crerar Library, Chicago.

IN accordance with the recommendation of the Royal Commission on Vivisection, the Home Secretary has appointed an Advisory Committee to assist him

in the administration of the Cruelty to Animals Act, 1876. The members of the committee, who have been selected from names submitted by the Royal Society and the Royal Colleges of Physicians and Surgeons, are :—Sir Anthony Bowlby, C.M.G., Sir J. Rose Bradford, K.C.M.G., F.R.S., Sir H. Bryan Donkin, Mr. G. H. Makins, C.B., the Lord Moulton of Bank, Dr. S. J. Sharkey, and Dr. C. J. Symonds.

WE learn from *Science* that the National Academy of Sciences will hold, on April 22–24, an adjourned meeting to celebrate the semi-centennial anniversary of its foundation. The academy held its first meeting in New York on April 22, 1863. In addition to the American speakers, there will be three speakers from Europe—Prof. J. C. Kapteyn, Holland, on the structure of the universe; Prof. A. Schuster, London, on international cooperation in research; and Prof. Theodor Boveri, Würzburg, on the material basis of heredity.

The Times of March 10 devotes an article to the recent attempts to introduce, as mosquito-destroyers, into various tropical countries, the tiny fresh-water Barbados fish, locally known as "milliones," and the unsatisfactory results by which such attempts have been attended. In India and Burma more promising results, as pointed out in a paper by Capt. Sewell and Mr. Chaundhuri, recently published in vol. vii. of the Records of the Indian Museum, are likely to attend the cultivation in pools and ponds infested with mosquito larvæ of native species of cyprinodonts, such as several of those of the genus Haplochilus.

THE founder's royal medal of the Royal Geographical Society is not awarded this year, but, with the approval of the King, a casket with a suitable inscription will be presented to Lady Scott, to contain the patron's medal and the special Antarctic medal awarded to her late husband, Capt. R. F. Scott, in 1904. The patron's medal has been awarded to the late Dr. E. A. Wilson, of the National Antarctic expedition, and a gold watch to Lieut. Campbell, who led the northern party of the same expedition. The Victoria medal is awarded to Col. S. G. Burrard, F.R.S.; the Gill memorial to Miss Lowthian Bell; the Murchison award to Major H. D. Pearson; the Cuthbert Peek grant to Dr. Felix Oswald; and the Back bequest to Mr. W. S. Barclay.

ACCORDING to a Reuter message from Hobart, the *Aurora*, the ship of the Mawson Antarctic expedition, returned there on March 14, without Dr. Mawson and the party of six who were left with him in Adelie Land. After leaving the six men behind, the *Aurora* left on February 8. Eight hours after her departure a wireless message was received stating that Dr. Mawson was safe, and the latter afterwards himself sent a message instructing the *Aurora* to return to Commonwealth Bay. A hurricane, however, prevented all communication with the land, and the captain left for Wilde's base. The *Aurora* reached Wilde's base on February 23. Mr. Wilde reported that he had taken possession for Great Britain of the whole area of land from Kaiser Wilhelm II. Land to longitude 101° 30′ east, and as far south as 67° 30′. The trend of the land is almost due east and west, and the coast-line almost on the Antarctic circle. The land is named King George V. Land.

AT the twenty-second annual meeting of the Royal Society for the Protection of Birds, held at the Westminster Palace Hotel, on March 6, Lord Curzon, as reported in *The Times* of March 7, strongly deprecated the continuance of the practice of wearing feathers (other than those of birds used as food) by ladies, and referred to the appalling slaughter of certain kinds of birds of brilliant plumage. In 1911 his lordship stated that in three sales in London no fewer than 41,000 skins of humming-birds, 20,700 of birds of paradise, and 129,000 egret plumes were sold. After adverting to the fact that the egrets are killed while in the breeding plumage, and that certain species or races of birds of paradise are reported to have been exterminated by the plumage-hunters, the speaker observed that although much had been done to stop the trade, yet there were weak links in the prohibitory chain, among these being the lack of prohibition of the import and sale of feathers and skins in this country.

THE International Congress of Historical Studies is to be held in London on April 3–9. The proceedings will consist of general meetings and sectional meetings. Already some 600 members and associates, coming from all parts of Europe, have signified their intention to take part in the proceedings, and delegates from a very large number of universities and learned societies will be present. Readers of NATURE will be interested most in the subsection of Section VII (History of Mediæval and Modern Civilisation), which deals with the exact sciences, natural history, and medicine. In this subsection the following papers have been promised :—"The Annals of the Royal College of Physicians in London," Dr. Norman Moore; "Origin and Development of the Compass Card," Prof. Silvanus Thompson; "Scientific Research in the Early Seventeenth Century exemplified by the Life of Peirese," Prof. L. C. Miall; "Aristarchus of Samos," Prof. H. H. Turner; "Newton's Principia" and "Magic," Mr. W. W. Rouse Ball; "The Mathematical Glories of Great Britain," Prof. G. Loria; "Palissy, Bacon, and the Revival of Natural Science," Sir Clifford Allbutt; and "Historical Method in Science," Mr. W. C. D. Whetham. Every person wishing to become a member of the congress is requested to send to the secretary of the congress, Prof. I. Gollancz, The British Academy, Burlington House, London, W., as soon as possible, name, title, office, and postal address; also, the section or sections with which he desires to be associated.

WE regret to see the announcement of the death of the distinguished cartographer, Dr. E. G. Ravenstein. For the following particulars of his career we are indebted to an obituary notice in yesterday's *Times* :—Dr. Ravenstein was born at Frankfurt-on-Main on December 30, 1834, and belonged to a family who for many years have been known as cartographers of high rank. He came to England when he was about twenty years of age, and his capacity as a carto-

grapher obtained for him a position in the Intelligence Department of the War Office, which he filled from 1855 to 1872. He had been a pupil of the famous Dr. Petermann, and did much to improve British cartographical methods. For the Royal Geographical Society he devoted several years to the compilation of a map, of many sheets, of eastern equatorial Africa, which was published in 1884; and even now, after all that has taken place in the last thirty years, it is a monument of fullness and accuracy, indispensable to the student of the evolution of African geography. He served on the council of the Royal Geographical Society for several years, and was president of the Geographical Section of the British Association in 1891. Among his publications were "Vasco da Gama's First Voyage," published in 1898; a "Systematic Atlas," 1894; and "Martin Behain, his Life and the Globe," 1908, a monumental work, the result of many years of research.

YESTERDAY was the hundredth anniversary of the birth of Dr. Livingstone, and the centenary has been celebrated by many eloquent tributes to the memory of the great explorer. At a meeting of the Royal Geographical Society on Monday an address on the subject of the life and achievements of Livingstone was delivered by Sir Harry Johnston, and the assembly included not only many distinguished geographers, but also relations and others, who were associated with the great explorer during his life. In the course of his remarks, Sir Harry said that a research into the life and work of Livingstone on which he had been engaged for thirty years past, beginning with his (the lecturer's) association with Stanley, with Sir John Kirk, and some of Livingstone's old Swahili followers on the Congo, left him unable to quote anything of importance which could be regarded as serious dispraise of that remarkable man. On the other hand, the repeated reading of Livingstone's works tended to increase his astonishment at Livingstone's achievements with the means in his possession, and to convince him more than ever that Livingstone was the greatest of African explorers, judged not only by his actual achievements but by his character, disposition, and mental capacity. He wrote things, he expressed ideas, in the 'forties, 'fifties, and 'sixties of the last century which seemed to-day singularly modern as conceptions, conclusions, and lines of profitable study. Indeed, it required very little accentuation of his opinions expressed in private letters in 1841 to formulate the phrase, since so potent, of "the Cape to Cairo." He never lost sight of this ideal, and during his last years speculated on its ultimate achievement through the work of Sir Samuel Baker on the Mountain Nile and the Albert Nyanza. The work done by Livingstone for geographical science and for humanity stands out among the greatest achievements of history; and we are glad to unite with all others who are bearing testimony this week to the noble career of the pioneer who passed away forty years ago, and whose work opened up a continent to civilisation.

THE Chingford reservoir of the Metropolitan Water Board, excellent accounts of which will be found in *The Engineer* and *Engineering* for March 14, was opened by his Majesty the King on Saturday last. The reservoir measures about two miles in length by more than one-third mile in width at its narrowest part, and covers an area of 416 acres; the length of embankment is about four and a half miles. The reservoir straddles the old course of the River Lea, and is divided into two parts by a bank near its centre, in order to reduce the fetch of waves. The embankments consist of a puddle trench reaching down to the London clay, and filled with earth, the outer slope being $2\frac{1}{2}$ to 1, and the inner slope 3 to 1 to 4 to 1. The slopes are faced with concrete slabs, the protection being most complete at the north-eastern corners where the highest waves with prevalent winds may be expected. The reservoir is capable of storing 3000 million gallons, to be pumped from the River Lea, and also from the River Lea Navigation, by means of five large Humphrey gas pumps, reference to which was made in NATURE for February 20 (p. 683). These pumps have been put to work with complete success. The large storage capacity required in the Lea Valley is necessitated by the enormous fluctuations in the volume of flow of the Lea. Much of the capacity will only be required at rare intervals, and in normal seasons will facilitate treatment by subsidence; it has been proved that storage alone affects a marked improvement in the quality of water, and thus reduces the work of the filters.

A LECTURE was delivered at the Galton Laboratory, University College, London, on March 11, by Mr. W. Palin Elderton, on the mortality of the phthisical under sanatorium and tuberculin treatments. Mr. Elderton showed that at present the best comparison is reached by studying the subsequent mortality of those who have undergone various kinds of treatment. The mortality of incipient cases under sanatorium treatment is, generally speaking, more than three times that of the general population, while advanced cases show a mortality of ten times, and far advanced cases a mortality of about forty times that of the general population. He discussed some interesting results from Dr. Lawrason Brown's statistics of the Adirondack Sanitarium, New York, but owing to the selection of patients and the increased proportion of early cases among the patients admitted more recently it is impossible to decide to what extent sanatorium treatment has improved. The statistics show, however, that at this particular sanatorium the authorities are now better able to say which cases will improve under treatment and which cases are cured. Mr. Elderton showed that the mortality of cases having tubercle bacilli in the sputum is two and a half times to four times as heavy as that of the cases which are without this symptom, and this result sometimes enables the extent to be estimated to which data are influenced by the admission of an undue proportion of early cases. There is no evidence to prove, he continued, that tuberculin, as compared with ordinary sanatorium treatment, appreciably lengthens the life of the consumptive. If the use of tuberculin had the marked results claimed by some definite evidence of its effect on mortality would have been anticipated.

MR. O. G. S. CRAWFORD, in the February issue of *Man*, discusses a remarkable funereal vase, now in the Isle of Wight Museum, which was found on Nunwell Down, Isle of Wight. The form and ornamentation of the vase, among those found in this country, are unique, and the nearest analogue to it appears in central Germany, whence it was probably imported. The remains associated with the vase are identified by Prof. A. Keith as belonging to a typical individual of the Bronze age type, a race which probably brought the vase with them from the Continent. This theory is strengthened by the fact that the Isle of Wight lies athwart the path of every invader of Wessex; the island has been, from the earliest times, in close touch with the opposite coast of France, and the Jutes followed the same route as their predecessors of the Bronze age.

To the *Anales del Museo Nacional*, Buenos Aires, vol. xxiii. (incorrectly lettered xx. on side of cover), Mr. F. Lahille describes a new species of malaria-producing mosquito from Tucuman under the name of *Anopheles tucumanus*, and likewise gives a new formula for indicating the wing-venation in this and other members of the group. He also states, in referring to the Argentine representative of *Stegomyia fasciata*, that the alleged sexual difference in the number of joints in the palpæ of that species is incorrect, and that the difference is really due to the extremely minute size of the terminal one in the female, which renders its recognition very difficult.

IN the same volume (*An. Mus. Buenos Aires*, xxiii., p. 269) Mr. Lahille describes, as *Phocaena dioptrica*, a new porpoise from the estuary of the La Plata River. It is described as having the upper part of the head and body, as well as the lips, deep lustrous black, but on the flanks this gives place suddenly to milk-white, which occupies the whole of the underparts, the flippers and a semicircle above each eye being also white. There are sixty-eight vertebræ, and $\frac{20-21}{19}$ teeth. On p. 391 of the volume Mr. A. Gallardo describes a specimen of Fitzroy's dolphin (*Lagenorhynchus fitzroyi*) stranded at Mar del Plata in December, 1912.

To Dr. N. V. Nasonov, director of the museum at St. Petersburg, we are indebted for a copy of a paper on *Ovis arcar* (or *arkar*) and its relatives, published in the *Bull. Ac. Imp. Sci. St. Pétersbourg*, 1912, pp. 1–32, plates i.–v.; the text being, unfortunately, wholly in Russian. Brandt, in 1852, gave the name *O. arkar* (from the Turki designation of all big wild sheep) to the wild sheep of the Ust-Urst plateau, Transcaspia; but in Blasius's "Säugethiere Deutschlands" the name was corrupted into *arkal*, by which title the animal has been almost universally known. Most naturalists regard the arkar as a race of the sha or urial (*O. vignei*), but Dr. Nasonov is of opinion that it should rank as a species, with three local races. One of these, from the Kopet-Dagh, dividing Persia from Turkestan, has been previously named *O. v. varentzowi* by Dr. Sátunin, but the third, which is based on two heads collected by Karelin, it is believed in the neighbourhood of Astrabad, is described as new, under the name of *O. a. dolgopolovi*.

PROF. OMORI, the well-known Japanese seismologist, directs attention in the Tokyo *Asahi* (January 29) to a remarkable coincidence between the frequency of earthquakes as recorded by the seismometer at Tokyo and the amount of rain- and snow-fall in north-western Japan. The relationship is borne out by statistics covering the whole of the Meiji era—forty-five years from 1867. The number of earthquakes recorded annually at Tokyo between 1876 and 1909 is found to be practically in direct ratio to the amount of rain- and snow-fall at Niigata and Akita, on the Japan sea coast. The curves for earthquake frequency in Japan show that these disturbances gradually increase in number over a period of years, and then undergo a corresponding decline, and in accordance with a recognised principle destructive earthquakes are most likely to occur in a period of minimum earthquake frequency. Such minima occurred in 1883, 1893, and 1903, and very violent earthquakes took place in 1884 and 1894. These periods, it is noted, corresponded with a conspicuous freedom from rain- and snow-storms in the north, while in the years of maximum earthquake frequency at Tokio—*i.e.* with no violent shocks—the amount of rain and snow falling in the north was much above the average. No reason for this apparent relationship can at present be assigned.

A NEW form of rain-gauge has been constructed by Messrs. Negretti and Zambra, of Holborn Viaduct, under the directions of Dr. H. R. Mill, of the British Rainfall Organisation, and the instrument has been named the "Seathwaite" rain-gauge. It is designed especially for use at out-of-the-way stations, where the gauge is visited at only long intervals. The registrations it affords will be of great value to science in those districts from which at present rainfall records are scarce, owing to the difficulty of frequent access, and it will probably be greatly appreciated by borough councils, waterworks, and various branches of engineering. The feature of especial interest in the construction is that it collects through a 5-in. funnel, the dimension approved by the British Rainfall Organisation, a large quantity of water, the receiver having a capacity of 30 in. of rain. The advantage over the older types of gauge is effected by enlarging the funnel from the 5-in. rim to a cistern of 8-in. diameter. As a protection against evaporation or frost, the gauge is lined with an insulating material. The measuring apparatus is quite apart from the gauge, and is carried in a small wooden case by the observer. A tentative measurement is first made by means of a graduated cedar rod, which gives approximately the depth of water in the gauge. For the ordinary measurement a dipper, made of copper, holding exactly 5 in. of rain, is used, and for the residue after the several 5 in. an ordinary glass measure is used, graduated up to 1 in. in subdivisions of 0·05 in. The total height of the gauge is 28 in.,

but only 13 in. remain above ground. The gauge is made of stout galvanised iron. Attention has been given to every detail in construction with the view of securing the greatest possible accuracy and with a minimum of trouble to the observer.

IN the Journal of the Meteorological Society of Japan for November, 1912, we find five articles. The first, by Mr. T. Hirata, is on wind in Korea, and other important meteorological phenomena. The second, by Mr. K. Asakura, is on the Red Stream, or Akashiwo, near Kanagawa. He remarks that in August it was very hot and many fish died, but not so many as in the previous year. Mr. K. Nakamura discourses on the climate in the Bonins, whilst Mr. N. Takenaka gives the results of twenty-seven years' observations in Kyūshū on the velocity and direction of the strongest winds. The only paper published in Roman characters is one by Mr. S. Fujiwhara. Its title is "Periodic Changes of Climatic Elements in Relation to the Oscillation of the Earth's Axis." The first climatic element to which he directs attention is the freezing of a small lake called Suwa, in Central Japan. In the sheet of ice two or three large fissures are usually developed, and there is a belief that this splitting is somehow or other connected with the weather and crops of the following year. For this reason a record has been kept since A.D. 1444 of the first date of the complete freezing up of this lake. These dates, in relation to years, have been plotted on squared paper. The resulting curves show, but not very clearly, a tendency for warm winters to recur every seven years. These curves of freezing are compared with temperature curves at several places in Japan, and curves showing the variation in latitude.

MESSRS. WRATTEN AND WAINWRIGHT, LTD. (Croydon), are issuing a second and revised edition of the descriptive list of their "light filters," which have gained for this firm a world-wide reputation. It includes nearly ninety varieties, each with a statement of its special use, whether in spectroscopy, photomicrography, or the getting of monochromatic light, &c., and its stability when exposed to light. It includes also the photographed absorption spectrum of each filter over a range of light intensities of from one to ten thousand, and the spectrum sensitiveness of the plates that the firm makes. There are filters designed for use with mercury-vapour lamps, passing respectively the yellow, green, and violet lines, and we are told of one filter that it transmits 72 per cent. of the light of the green line and ½ per cent. of the yellow, while by sacrificing 50 per cent. of the green light the yellow can be "completely absorbed." The list forms an excellent guide for those who use colour screens for any purpose.

AN address, delivered by Prof. Millikan at the recent meeting of the American Association for the Advancement of Science, is reproduced in *Science* for January 24. It deals with the atomic theories of energy, and shows that the only one which appears capable of explaining the whole of the facts of radiation, whether of light or of X-rays, is that advanced by Prof. Einstein, who, with Sir J. J. Thomson, supposes the radiation is concentrated in space along lines of force or Faraday lines, and not distributed uniformly over the wave surface, and further believes, with Prof. Planck, that along these lines the energy travels in atomic form and not as a continuous stream. The main objection to the general adoption of such a theory at the present time is its failure to explain the well-known facts of interference and diffraction of light.

THE third issue of the *Taschenbuch für Mathematiker und Physiker*, by Messrs. Teubner, contains a portrait of the late Prof. F. Kohlrausch, and a short account of his life. Five pages of the mathematical part are devoted to a report of the organisation and activities of the international commission on the teaching of mathematics. Other special articles deal with the theory of groups, with multiple valued functions and with analytical mechanics. The physical half has sections of the "quanten" theory, on physical chemistry and on crystallography. In both parts of the book vector methods are freely used, the quaternion being defined as the complex product of two vectors. The section on the "quanten" theory, by Prof. Sommerfeld, of Munich, gives a clear account of both the advantages and the difficulties of the theory. The pocket-book is well indexed, and contains a list of all the most important books on mathematics and physics which have appeared during the last two years.

IN the account, published in the issue of NATURE for April 11, 1912 (vol. lxxxix., p. 143), of the proceedings in connection with the one hundredth anniversary of the foundation of the Academy of Natural Sciences of Philadelphia, celebrated in March, 1912, it was stated that certain volumes would be published as a permanent record of the event. We have now received a copy of vol. xv. of the second series of the Journal of the academy, which has been published in a special form in commemoration of the hundredth anniversary celebration. It consists of two parts bound together, the first of which runs to 142 pages, and is concerned wholly with the proceedings of the centenary meeting. The second part contains twenty-two fully illustrated scientific memoirs, which together occupy 591 pages, and are illustrated by fifty-nine full-page plates, 11 in. by 14 in. Part i. consists chiefly of the addresses delivered by the mayor in welcoming the delegates, by the president, which took the form of a history of the academy, and by various speakers at the banquet, together with lists of delegates and selections from the congratulatory letters and cablegrams received from learned societies throughout the world. Some of the memoirs published in the second part of the volume were those read during the anniversary meetings. The frontispiece is a well-executed picture of the academy buildings, which, previous to the centenary meeting, were much enlarged and rendered fireproof with the assistance of the legislature of the State. The handsome volume forms a fitting memorial of an interesting series of meetings.

OUR ASTRONOMICAL COLUMN.

THE 100-IN. REFLECTOR AT MOUNT WILSON.—Some years ago the Mount Wilson Observatory ordered from France a 100-in. diameter mirror, the French foundry being the only one in the world which would undertake the casting of such a large mass of glass. The mirror, when delivered in California, was found not to be up to the standard of contract quality, and the French firm undertook to set about casting a new one. In the meantime, as an experiment, it was decided to figure the disc, and Prof. Ritchey worked away at it in the workshop at Pasadena. On the completion of his task, it appears from a note in *The Observatory* (March) that the tests have shown that the mirror is practically useless. It will be some time before the more perfect disc is procured, but it is hoped that the second attempt will be quite successful.

SOLAR RADIATION DURING THE ECLIPSE OF APRIL 17, 1912.—In the form of an extract from the *Comptes rendus de la Société Scientifique*, of Warsaw, we have received a paper in which Dr. W. Gorcynski describes the observations of the insolation made at Warsaw during the partial eclipse of the sun which occurred on April 17, 1912. The diminution of the solar radiation readings began about half an hour before the eclipse, and remained below the normal for the date for nearly the same time after. The maximum reduction of the solar radiation attained 89 per cent. at Warsaw, where 0·88 of the disc was covered at maximum phase, and the radiation curve agrees fairly well with the phase curve. Between noon and 4 p.m. each sq. cm. of surface received 110 great calories, at normal incidence, less than usual, and the drop in temperature, as recorded in the screen, was between 2° and 3° C.

BANTU STAR NAMES.—No. 12, vol. xii., of *Man* contains an interesting article by Miss A. Werner discussing the names by which the stars are described in Bantu by the tribes of Nyasaland. Miss Werner's general impression is that nearly, if not quite, all the peoples with whom she has come into contact have lost much star knowledge which they once possessed. The name for the Pleiades is always etymologically connected with agriculture, being derived from a root, *lima*, meaning "to cultivate," thus indicating that the Zulus, Swahilis, &c., have employed this asterism, as have so many other primitive races, as a substitute for the modern calendar. The "belt" stars of Orion seem always to be connected with hunting, and the name for Venus conveys generally the idea the planet is the moon's wife. The names applied to Jupiter also suggest a connection with hunting, a native explanation being that a hunting expedition should start on a night when Jupiter is overhead just before dawn. Several other of the names given are of special interest, and tend to show that the astronomical observations of primitive races are essentially utilitarian in character.

THE EXPLOSION OF WORLDS.—Some interesting speculations as to the possibility of such a world as the earth being shattered by the explosive energy of the now pent-up internal forces are published by Mr. Hudson Maxim in the February number of *The Fortnightly Review*. Among other things, he shows that the pressure of the earth's crust is so great that the most powerful explosive known, in any quantity, would fail to do more than shake it locally. Gravitational pressure is so enormous that were two solid steel balls, as large as the earth and as hard as the Harveyised surface of armour-plate, gently placed in contact they would flow together like water, and could have no variation from a true sphere greater than fifty miles high. By such arguments Mr. Maxim demonstrates the enormous strength and rigidity of the terrestrial sphere, and shows that it is immune from the effects of any shattering force less than the collision of the solar system with another celestial system.

THE DETROIT OBSERVATORY.—The first issue of the Publications of the Astronomical Observatory of the University of Michigan (vol. i., pp. 1–72) contains, *inter alia*, a most interesting account of the observatory and its work. The observatory also makes seismographic observations, and the records of the earthquakes recorded from August, 1909, to January, 1912, are given in the present publication.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE meetings of the Institution of Naval Architects opened on Wednesday, March 12, in the rooms of the Royal Society of Arts. During the three days over which the meetings extended, fourteen papers were presented for discussion. The gold medal of the institution for 1912 was presented to Admiral Sir Reginald Custance, and premiums were awarded to Prof. Gümbel and to Mr. A. Cannon. The Marquis of Bristol, in his presidential address, referred to the loss the institution had sustained in the death of Sir Wm. White, and hoped that some memorial of a permanent character would be instituted by the various societies with which he had been connected, and that such memorial might take a form of practical service to the profession.

Mr. D. B. Morison gave some interesting data regarding the influence of air pumps on the military efficiency of turbine-driven warships. According to the latest cruiser practice, a vacuum of 28·5 in. is required at full power in sea water at 55° F. If, under conditions of maximum and constant generation of steam in the boilers, the vacuum falls from 28·5 to 27·5 in., then the loss in power is about 6 per cent. The minimum capacity of an air pump is determined by the quantity of air in the feed water as it enters the boiler, without provision for insidious leakage. From his experience with high-vacuum plants of the highest class, Mr. Morison does not believe that ideal air-tightness can be maintained under the severe conditions of war; hence the necessity for the provision of an air margin in the capacity of the air pumps. Various types of air pumps are discussed in the paper.

Sir Charles A. Parsons states in his paper on mechanical gearing that such gearing for reducing the speed between the turbine and the propeller is now well advanced beyond the experimental stage. This type of gearing is now in service on vessels representing a total of 26,000 h.p., and there are others under construction aggregating 120,000 h.p., including two installations of more than 20,000 h.p. each. The Channel steamers *Normannia* and *Hantonia* continue to show an economy, as compared with other turbine steamers of somewhat different design on the same service, of about 40 per cent. The *Normannia's* gearing, inspected recently, shows no signs of wear. Comparative coal consumption trials have been carried out on a cargo steamer, built for the Cairn Line, and fitted with turbines and mechanical gearing, and on a sister ship, the *Cairngowan*, with exactly similar boilers and propeller, but with triple expansion engines. The coal was of the same quality, and measured in the same way on both ships, and the geared turbine ship has shown a saving of 15 per cent. in the coal consumption. So far, no limit in regard to the surface speed of the teeth in the gearing has been discerned, and there is no evidence of any limit to the power that can be transmitted by

mechanical gearing with gear-wheels suitably designed. Careful investigations have been made of the causes producing noise in the gearing, and show that the noise is due to slight inaccuracies in the teeth; it should be noted that the noise is an engine-room noise only, and is not perceptible elsewhere. This has led to a method of cutting the gear-wheels, which greatly reduces the errors involved in reproducing the parent gear. Two rotating tables are used in the new machine; the wheel to be cut is fixed to the upper one, and is given a creep in advance of 1 per cent. in relation to the motion of the lower table; the lower table is driven by worm-gearing at 1 per cent. less speed than would be the case if a single table were employed; hence the wheel on which the teeth are being cut has a motion compounded of the motion of both tables, and equal to that required for the given number of teeth to be cut. This device has the effect of causing the errors in the teeth to lie in very oblique spirals around the wheel, and also reduces the errors themselves. In the actual machine, the errors are reduced to about one-fifth of the original magnitude.

Mr. W. Reavell contributed a paper on the use of compressed air for working auxiliaries in ships propelled by internal-combustion engines. It is of interest to note, in the operation of deck winches in cargo steamers, that although steam at a pressure of 90 lb. per sq. in. may be supplied, the actual pressure demanded by the winches in working did not exceed 16 lb. per sq. in. Earlier attempts to deal with such cargo-hoisting problems with high-pressure compressed air have been wasteful; modern installations in which air at low pressure is used for operating the winches have been successful and economical.

Baron A. Roenne contrasted the advantages and disadvantages of airships and aëroplanes, and gave a suggested design for an airship 853 ft. in length and 72 ft. 3 in. in diameter, having a displacement of 104 tons at 0° C., and 760 mm. of mercury. A speed of fifty-two miles per hour could be obtained with 2000 h.p., and it should be possible to carry a regular passenger service and to master the air on almost every day of the year.

In a paper on the longitudinal stability of skimmers and hydro-aëroplanes, Mr. J. E. Steele states that the most notable machine in the aëroplane show at Paris this year from the point of view of inherent longitudinal stability was one designed by M. Drzewiecki. The principle embodied in this design is that of difference in pressure intensity on the forward and the after curved planes, due to the different cross sections. On the involuntary rising of the front part of the machine, the increase in the angle of attack has quite a different effect on the fore to what it has on the rear plane. The pressure per sq. ft. on the front plane is but very gradually increased for changes of the angle of attack between the limits of 5° and 18°, whereas that on the after plane increases very rapidly with the angle at which the wind meets it. The result is an excess of lift aft, which restores the machine to its original position. The converse holds if the front of the machine is involuntarily depressed. The reduction in the angle of attack leaves the pressure on the front plane but slightly altered, but reduces quickly that on the rear plane, resulting in a drop of that part to the normal position.

Mr. G. S. Baker gives the first published account of systematic research work carried out at the William Froude tank at the National Physical Laboratory. The experiments had for their object the testing of the effect upon the resistance of the ship of varying the relative lengths of the entrance to run (*i.e.* those portions of the bow and stern respectively which are clear of the perfectly parallel midship body), maintaining the same general form, water-line, and principal dimensions. Five parent models have been chosen, and with each of these, four or five proportions of entrance and run have been tried. Another set of experiments has been carried out with the view of testing the effect upon model resistance of various possible terminations to the lines, both in fore and after body. The alterations tried have affected both the area curve and the water-line, and, in addition, the effect of the presence of the rudder has been tested in one case.

Mr. C. E. Inglis contributed a mathematical paper dealing with the stresses in a plate due to the presence of cracks and sharp corners. Exact results are obtained for the distribution of the stresses around a hole in a plate, the hole being elliptic in form. If the axes of the ellipse are equal, a circular hole is obtained; by making one axis very small the stresses due to the existence of a fine straight crack can be investigated. One of the several results obtained may be quoted. A strip of plate of indefinitely great width is pulled in the direction of its length, the tensile stress intensity being R. There is an elliptic hole in the plate having major and minor axes, $2a$ and $2b$ respectively, and arranged so that the major axis is at right angles to the pulls. At the edge of the hole situated at the extremity of the major axis, a tensile stress occurs having an intensity $R(1+2a/b)$. This stress decreases rapidly as we proceed along the section of the plate made by producing the major axis, and, at a short distance from the edge of the hole, attains the normal value R. It will be seen that the maximum value becomes very large if b is made small; if $a/b=1000$, the maximum tensile stress has a value of 2001 times the intensity of the mean stress. In this case the ellipse would appear as a fine straight crack, and a very small pull applied to the plate across the crack would set up a tension at the ends sufficient to start a tear in the material. The increase in the length due to the tear exaggerates the stress yet further, and the crack continues to spread in the manner characteristic of cracks.

A paper on the distribution of stress due to a rivet in a plate, by Prof. E. G. Coker and W. A. Scoble, is also of considerable interest. In a former paper measurements have been described of the differences of principal stresses at points in plates having notches and holes of various kinds. In the majority of the former cases, the stress distributions were such that the minor principal stresses vanished or were of little importance. In many practical problems, both principal stresses are of considerable magnitude, and it is then important to obtain each stress separately. The present paper describes a general method for determining both the sum and the difference of the principal stresses at a point in a plate, considered as averages taken over the normal at the point, and bounded by the two faces of the plate. The stress difference may be measured directly by mechanical or optical means, advantage being taken in the latter method of the fact that plates of glass, celluloid, and like transparent bodies, become temporarily doubly refractive when stressed, and that in polarised light there is, in consequence, a relative retardation, R, between the ordinary and extraordinary rays, which is proportional to the stress difference, and to the thickness T of the plate. If p_r and p_t are the magnitudes of the principal stresses, the law is given very approximately by $R=c(p_r-p_t)T$, where c is an optical constant. The sum of the principal stresses may be determined by taking advantage of the fact that a plate, when subjected to stresses in its own plane, alters in thickness. Thus, if both stresses p_r and p_t are pulls, there is a lateral contraction of amount $(p_r+p_t)T/mE$, where m is Poisson's ratio

and E is Young's modulus. Hence by determining m and E and also by measuring the changes in thickness of a stressed plate, the sum of the principal stresses may be evaluated as an average throughout the thickness of the plate. Having obtained the sum and difference, it is a simple matter to state the values of p_r and p_t separately. A new form of instrument is described in the paper, specially devised for measuring small changes in thickness of a stressed plate. This instrument is partly optical, readings being obtained by means of a ray of light reflected from a mirror which is rotated partially by the strain to be measured. One millimetre on the scale is equivalent to two millionths of an inch change in the lateral dimensions of the specimen. A number of experimental determinations are given in the paper and show very concordant results.

COLLOIDS AND THEIR VISCOSITY.

SPECIAL interest attached to the meeting of the Faraday Society, held on Wednesday, March 12, in view of the distinguished foreign guests who took an active part in the proceedings. These included Prof. Pauli (Vienna), Dr. Wolfgang Ostwald (Leipzig), Prof. Victor Henri (Paris), Prof. Freundlich (Brunswick), and Prof. Nernst (Berlin).

The meeting took the form of a symposium upon colloids and their viscosity, and the afternoon session was opened by Dr. Wo. Ostwald, who, in an introductory address of a general character, showed the importance of viscosity measurements as a means of study of the colloidal state. In the course of his remarks, which were fully illustrated with examples, he laid special stress upon the need for kinetic, as opposed to static, methods for the investigation of heterogenous systems, and in this connection also emphasised the value of viscosity measurements. An illustration of this principle was immediately afforded by the communication of Profs. Freundlich and Ishizake on the rate of coagulation of $Al(OH)_3$-sols as measured by the viscosity change, the results of which were in complete accord with those of Paine upon copper oxide-solutions, using a totally different method. The following empirical formula proved to express the experimental results of coagulation by potassium salicylate with great exactness:—

$$dx/dz = 2Kz(1+bx)(1-x)^2,$$

where K is a constant depending on the concentration of the electrolyte, z represents time, and x the amount of precipitated particles, the latter taken as proportional to the increase in viscosity. From the equation in its more general form,

$$dx/dt = K_1 f(U)(1-x)^2,$$

Freundlich and Ishizake drew the following conclusions. The term $(1-x)^2$ suggests the coagulation process to be primarily a reaction of the "second order" in which the colloidal particles may be supposed to unite in pairs, the cause for which union is to be found in an asymmetry of their electric charges (expressed in the term $f(U)$) due to unequal degrees of electrolyte-adsorption. The degree of asymmetry was found to be proportional to the time z, to the number of precipitated particles, and to an exponent of c, the concentration of electrolyte thus:—$f(U) = \lambda c^q z(1+bx)$, where λ, q, and b are constants.

Prof. Pauli directed attention to the importance of viscosity measurements in the study of "emulsoid" colloids in a survey of the chief results obtained in his own school, showing what important generalisations as to the ionisation and degree of hydration of proteins in solution had been arrived at by this means. His experiments proved, for example, that at the iso-electric point, where, by definition, the ionisation of the protein is a minimum, a close correlation existed between that property and (1) osmotic pressure, optical rotation, viscosity, and imbibition of water, all of which reached their lowest value, and (2) precipitability by alcohol which was at its maximum. With increase in concentration of protein ions, caused by addition of either acid or alkali, a corresponding rise was found to occur in the value of the first set of properties and a fall in the precipitability.

The evening session was chiefly devoted to a discussion of the factors concerned in the viscosity of colloidal solutions and the interpretation to be placed upon the viscosity value. Mr. Emil Hatschek developed a mathematical theory of the viscosity of two-phase systems, showing that for "suspensoid" equally with "emulsoid" colloids, viscosity depended upon the volume-ratio of the two phases, and was independent of the size of the colloidal particles. In the case of the former, as shown also by Einstein and Bancelin, the viscosity increased in linear ratio with the volume of disperse phase, while in the case of "emulsoid" colloids the viscosity of the system was equal to $\frac{\sqrt[3]{A}}{\sqrt[3]{A}-1}$, where A = ratio: $\frac{\text{volume of system,}}{\text{volume of disperse phase}}$, the viscosity of the continuous phase being taken as unity. Experimental support was adduced in both instances, and interesting confirmation also obtained for the above formula in the case of paraffin soap-solution emulsions, where viscosity had been determined by means of Couette's apparatus, and direct measurement could be made of the volumes of both phases. Prof. Henri gave a critical survey of the various direct and indirect methods available for volume-measurement of colloidal particles. He showed that, among the indirect methods, that of Perrin (based on the distribution with depth of colloidal particles after settling), and that of Rayleigh (by measurement of the intensity of light after lateral diffusion through colloidal solutions) were among the most trustworthy, since in the formulæ used for calculation of r, the radius of the colloidal particles, the term r was raised to the third and sixth power respectively. As a result of work with $Fe(OH)_3$-sols Prof. Henri, expressed the view that apart from the question of phase-ratio, or size of colloidal particles, the *arrangement* of the latter might have a very important influence upon the viscosity of the system.

An interesting discussion followed, in which, among others, Dr. Ramsden, Dr. S. B. Schryner, Dr. McBain, and Dr. C. J. Martin took part. In the absence of the chairman, Dr. R. T. Glazebrook, the chair was taken by Mr. Emil Hatschek.

ATMOSPHERIC HUMIDITY AND TEMPERATURE.

TWO papers on the psychrometer formula, reprinted from recent Proc. Roy. Soc., Victoria (vols. xxiv. and xxv.), discuss a modification, proposed by Dr. Ekholm, of the Stockholm Meteorological Office, to be made in Regnault's formula for the wet- and dry-bulb hygrometer, which would have important consequences if confirmed. The formula so modified would be $x = \eta f - AB(t-t')$, where x and f are respectively the actual vapour-pressure and the saturation vapour-pressure at the temperature t' of the wet bulb. A is the ordinary psychrometric constant, and η the coefficient, less than unity, inserted by Ekholm to allow for a supposed diminution of vapour-pressure at the surface of the wet bulb due to hygroscopic action of the material covering it. The first paper, by Dr. E. F. J. Love

and Mr. G. Smeal (Government research scholar), dealt with temperatures near the freezing point, and the second, by Mr. Smeal, dealt with temperatures up to 31·4° C. The discussions appear to have proved that the suggested coefficient, being so nearly unity, is not wanted, especially if the covering be thin muslin and be kept clean. The factor, $A=0{\cdot}00072$, derived from the observations and careful computations, varies slightly according to wind force. In the event of any modification of the simple formula being accepted it might be in this sense, but we suggest that it would be more to the point if one formula were selected from among those which already exist, and be recommended for general adoption.

A useful paper on the wet-bulb thermometer and tropical colonisation, by Prof. J. W. Gregory, F.R.S., is published in the Journal of the Scottish Meteorological Society (vol. xvi., No. xxix.). The author points out that the view that the tropics are injurious to health is prevalent, but the explanations why this is so are very unsatisfactory. Heat is mostly regarded as one of the principal factors of tropical maladies, but it is now recognised that no locality with a *dry* climate has a temperature so high as to be injurious to health; in fact, the hottest districts in a country are often the healthiest. Healthiness of tropical localities does not depend upon diurnal or annual range of temperature, and moisture is not necessarily injurious; the latter is better for some constitutions, but heat and moisture combined may be very harmful. Experiments appear to indicate that "the industrial development of any locality where the wet-bulb temperature commonly exceeds 80° will be almost, and if it exceed 88°, quite impossible." But statistics supplied to the author by the Meteorological Office show that such high wet-bulb temperatures do occur in well-populated tropical localities. The author laments that the distribution of such temperatures is not well known, and refers to the collection of observations in Australia by Prof. W. A. Osborne, of Melbourne. The annual summary of the Australian Monthly Weather Report for 1910 (received by us in July, 1912) contains monthly wet-bulb isotherms from 9h. a.m. observations, with means of 80° in the north-west in December–February inclusive.

RECENT ADVANCES IN SCIENTIFIC STEEL METALLURGY.[1]

IT has already been pointed out that the year 1870 marked the commencement of the tungsten era, and 1880 that of the tungsten-chrome era. But the years 1899 to 1902 inaugurated what is destined to be the most remarkable epoch of the three, namely the vanadium era. During these years was carried out in the experimental steel works of Sheffield University a series of researches on the influence of the comparatively rare metal vanadium on plain carbon steel and on alloy steels. At that time (1899) vanadium was 60*s.* per lb. In 1912, owing to the large demand, the cost had fallen to 10*s.* per lb.

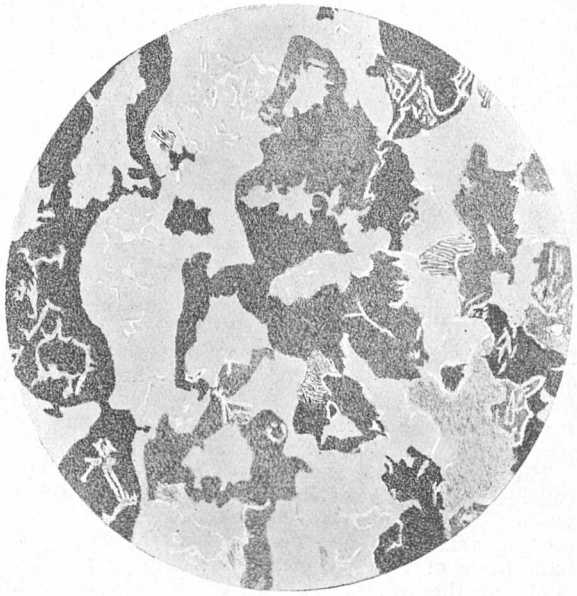
The first report, having reference mainly to cutting steels, was issued in June, 1900, and the second and third reports respectively in January and June, 1902. The results are briefly summarised in the two next paragraphs.

June 28, 1900.

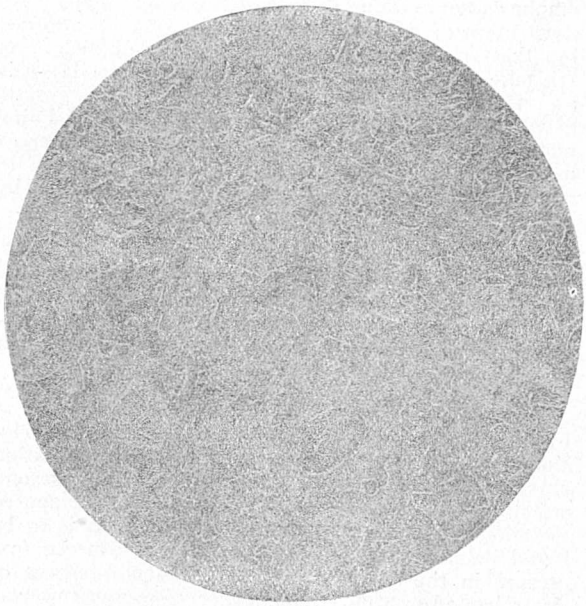
"The results of this preliminary investigation have profoundly impressed upon my mind the future before vanadium as a steel-making element, and even at this early stage of my knowledge of its effect, I venture to say that its action resembles that of tungsten, but that it is from ten to twenty times as powerful as the latter element."

January 14, 1902.

"It is already evident that as a steel-making element vanadium will place in the hands of metallurgists and engineers a very powerful weapon, because it is now demonstrated beyond doubt that the addition of a few tenths per cent. of vanadium raises the elastic limit of mild structural steel at least 50 per cent., without seriously impairing its ductility or presenting any difficulty in the hot or cold working of the steel."



(*a*) Carbon, 0·60 per cent. Vanadium, 0·71 per cent. Pale ground mass of slightly vanadiferous ferrite. Dark areas, troostitic vanadium pearlite. Less dark areas, sorbitic vanadium pearlite. White cell walls and masses, "B" iron cementite, resulting from thermal decomposition of laminated iron pearlite, a few areas of which still remain undecomposed.



(*b*) Carbon, 0·93 per cent. Vanadium 5·84 per cent. Ground mass of sorbitic vanadium pearlite, overlaid with a broken and irregular mesh-work of vanadiferous ferrite.

FIG. 6.—Magnified 450 diameters.

[1] Discourse delivered before the Royal Institution on Friday, January 24, by Prof. J. O. Arnold, F.R.S. Continued from p. 49.

Some of the results upon which these paragraphs were founded are tabulated below. Perhaps the most remarkable results in this series are :—

(1) A plain carbon steel containing about 1 per cent. of carbon has a yield point of 35 tons per square inch, a maximum stress of 60 tons per square inch, an elongation of 10 per cent. on 2 inches, and a reduction of area of 10 per cent. The addition to such steel of about 0·6 per cent. of vanadium raised the yield point from 35 to 65 tons, the maximum stress from 60 to 86 tons per square inch, still leaving an elongation of 7 and a reduction of area of 8 per cent.

(2) A steel containing 0·25 per cent. of carbon and 3·3 per cent. of nickel registered a yield point of 33 tons, a maximum stress of 42 tons per square inch, an elongation of 26 per cent. on 2 inches, and a reduction of area of 53 per cent.

A practically identical steel, but containing in addition about 0·25 per cent of vanadium, recorded a yield point of 50 against 33 tons, a maximum stress of 68 against 42 tons per square inch. The elongation was 17 per cent. on 2 inches, and the reduction of area 36 per cent.

(3) A steel containing 0·25 per cent. of carbon and about 1 per cent. of chromium registered a yield point of 27 tons, and a maximum stress of 41 tons per square inch, together with an elongation of 36 per cent. on 2 inches, and a reduction of area of 55 per cent.

The addition of 0·25 per cent. of vanadium raised the yield point from 27 to 40, and the maximum stress from 41 to 55 tons per square inch. The elongation was lowered from 36 to 26, and the reduction of area from 55 to 53 per cent.

Thus vanadium differs from tungsten in having an almost magically beneficial effect, not only on cutting, but also on structural steels. In connection with vanadium steels it is an interesting fact that the series of copyrighted and published reports issued from Sheffield University during the years 1900 to 1902 were unconscious plagiarisms of a series of American patents issued during the years 1904 to 1908. This seems to constitute a remarkable problem in psychology.

A study of what may be called the pure science of vanadium steels made by the lecturer and Prof. A. A. Read, of the University of Wales, has yielded results of profound theoretical and probably practical importance. It was shown that vanadium does not seem to form a double carbide with iron. It gradually wrests the carbon from the carbide of iron until when about 5 per cent. of vanadium is present Fe_3C cannot exist, and only a vanadium carbide, V_4C_3, containing 15 per cent. of carbon is present, and this constituent is constant, at any rate in tool steels containing up to 14 per cent. of vanadium. The micrographic analysis of these alloys, as shown in Fig. 6 (*a*) and (*b*), has resulted in the discovery of three new constituents, viz. vanadium pearlite, vanadium hardenite, and vanadium cementite. Vanadium hardenite seems to have a hardness of 8 (topaz) as compared with the hardness 7 (quartz) of iron hardenite.

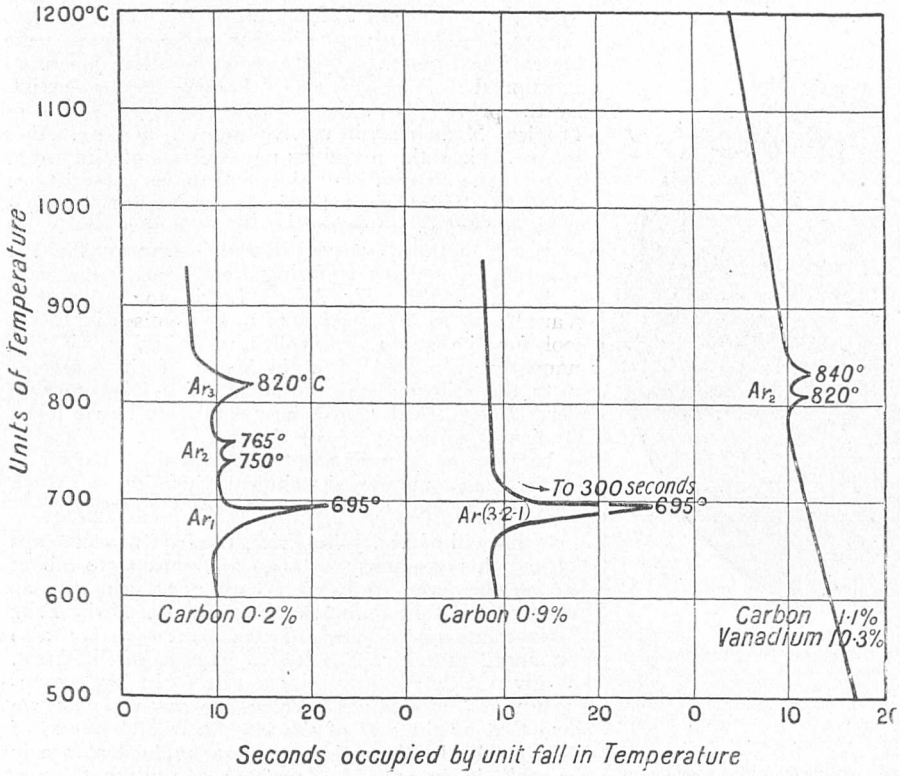


FIG. 7.

The recalescence results obtained are of great practical, as well as theoretical, interest. They strongly suggest the explanation of the curious thermo-mechanical behaviour of high-speed steels, and incidentally they appear provisionally to prove that the hardening is not due to allotropic change, but to the carbon change only. Fig. 7 shows (1) the inverse rate recalescence curve of a 0·2 per cent. plain carbon steel, which exhibits all Osmond's critical points, viz., Ar_3, Ar_2 (with a double peak) and Ar_1, the carbon change point; (2) the recalescence of a saturated steel containing 0·89 per cent. of carbon, in which all three points are merged into one very large evolution of heat at 695° C.; (3) the recalescence curve of a steel containing 1·1 per cent. of carbon, and 10·3 per cent. of vanadium. This curve was registered from 1210° to 505° C. It presents only the double-peaked point Ar_2. When the steel is quenched all along the above range it still remains quite soft to the file. To harden it it is necessary before quenching in water to heat the alloy above the A_1 or carbon change point, which takes place at a white heat, near 1400° C. The steel is then very hard.

Fig. 8 shows the transformation on heating up to a white heat (*a*) of annealed vanadium cementite into vanadium pearlite, (*b*) or sorbitic vanadium pearlite into amorphous and topaz-hard vanadium hardenite.

The advance in concrete cutting efficiency of turning tools from 1740 to 1912 was then dealt with. It

should be noted that the best steel of this kind made in Sheffield in 1740 would be absolutely incapable of cutting at all under conditions under which the best modern high-speed steel would remove 700 cubic inches of metal before breaking down.

The advantages of this enormous increase in cutting power are manifold, and an obvious example is the relative rapidity with which huge naval guns may now be turned out.

In January, 1909, I had the honour of suggesting to a Royal Institution audience the coming of a new British steel which would have a cutting power four times as great as the best steel then on the market. The skilful application of vanadium by Sheffield steelmakers has practically fulfilled that forecast, and the world-wide sensation and publicity created by the announcement has left Great Britain supreme in this very important branch of scientific steel metallurgy. An aspect of iron and steel metallurgy already demanding attention is the diminishing quantity of the

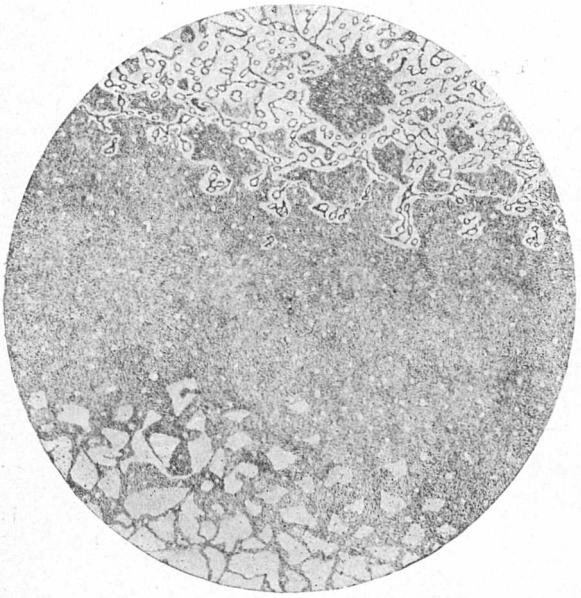


FIG. 8.—Carbon, 1·10 per cent. Vanadium, 13·45 per cent. Transformation stages of vanadium cementite and vanadiferous ferrite into vanadium hardenite. Upper area, mainly vanadiferous ferrite with vanadium cementite nodules, together with a little sorbitic vanadium pearlite. Middle area, ground mass of unsaturated vanadium pearlite, overlaid with undissolved nodules of vanadium cementite. Lower area, mainly structureless vanadium hardenite cells formed from a series of centres and surrounded by walls of the structure described for middle area Hardening temperature, near 1400° C. Magnified 450 diameters.

world's iron ore supply. To a great extent the latter could be strongly reinforced from the huge deposits of iron sands now lying useless if a simple, economical and direct process of reduction could be devised. That metallurgical science and art will do this eventually seems certain, and I hold an opinion, founded on practical data, that the solution of this hitherto baffling problem is nearer than most metallurgists suppose.

In conclusion, it may be pointed out that the skeleton history of early Sheffield steel metallurgy sketched in this discourse is in some important points in conflict with the somewhat disparaging historical outline written by Lord Macaulay, but in this particular connection there seems to be a modicum of truth in the answer of the schoolboy who, when asked to mention his favourite work of fiction, unhesitatingly replied, "Macaulay's History of England."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DURHAM—ARMSTONG COLLEGE.—The foundation-stone of the new building for the department of agriculture is to be laid on Saturday, April 5. Mr. C. Cochrane has promised the sum of 2,500*l.* towards the equipment of the department, and a Diesel engine has been offered to the college by Mr. G. E. Henderson. The appointment has been approved of Mr. G. D. H. Cole as deputy professor of philosophy, in the absence of Prof. Hoernlé, who is to deliver a course of lectures at Harvard University between October, 1913, and January, 1914.

THE Senate of the University of Dublin has approved the conferment of the honorary degree of doctor of science upon Prof. A. C. Seward, F.R.S., and Prof. the Hon. R. J. Strutt, F.R.S.

BY the will of Sir Alfred Jones, 227,100*l.* is left to charitable and educational institutions, and the scheme for carrying out the objects of the will has just been sanctioned by Vice-Chancellor Dudley Stewart-Smith. By the provisions of the will the Liverpool School of Tropical Medicine will receive 40,000*l.*, and a further 40,000*l.* when the annuities payable out of the estate cease. The 40,000*l.* now given is to form a fund to be called the "Sir Alfred Lewis Jones Bequest," and is to be devoted (*a*) to defraying the cost of a new wing or ward to the Liverpool Royal Infirmary for the reception of persons suffering from tropical diseases, to be called the "Sir Alfred Lewis Jones Tropical Ward"; (*b*) to the erection of new premises in Liverpool for the study of tropical medicine, to be permanently associated with the name of the testator; (*c*) to the erection and equipment of a laboratory in Sierra Leone, to be called the "Sir Alfred Lewis Jones Tropical Laboratory"; (*d*) the residue of the gift is to be used as a permanent endowment. 20,000*l.* is left for the promotion of technical education in British West Africa, and 1000*l.* to Liverpool University.

BY the will of Mr. John Fritz, the iron master, says *Science*, his residuary estate, amounting to about 30,000*l.*, is given to Lehigh University primarily as an endowment fund for the maintenance of the Fritz Engineering and Testing Laboratory. It is also announced that Mr. Charles L. Taylor, of Pittsburg, has given Lehigh University a gift for a large gymnasium and a stadium. From the same source we learn that by the will of the late Mr. C. C. Weld, of Newport, R. I., the residuary estate, valued at nearly 800,000*l.*, is, in case his daughter dies without issue, to be divided between the Massachusetts General Hospital and the Massachusetts Institute of Technology.

AT the opening of a new technical college and secondary school at Workington last week, Sir John Randles said he desired to commemorate the occasion by a gift of 1000*l.*, to provide a travel scholarship for a student of the college. The gift will yield some 50*l.* or 60*l.* each year to a student to assist him to become proficient in the metallurgy of iron and steel, which is associated with the local industry. The money is to be used by the student, within three years of its being awarded, in visiting some Colonial or foreign metallurgical centre, and may be recreative as well as useful. In this way Sir John Randles hopes some of the pleasure he has enjoyed in life by travel will be secured year by year to a Cumberland youth.

THE President of the Board of Education, Mr. J. A. Pease, spoke at a meeting of the National Union of Teachers at Sheffield on March 15, and referred to the

intentions of the Government with regard to education. He said the Government are not pledging themselves to carry an Education Bill this session; their proposals are to be placed before the House of Commons with a view to their discussion. In the next session of Parliament it is hoped to pass the proposals—with such alteration as may have been thought expedient—into law. It is proposed to add considerably to the powers that local authorities already possess in educational affairs. The Government wish to induce everybody to cooperate so as to make the boy and girl better fitted to render the best possible service to the State. They wish to bring the best brains to the top, and to provide for those not included in that category an education from which they will get most advantage in connection with the factories, or the workshops, or whatever vocation they adopt in after life. Account must be taken of the conditions of youth from the cradle up to the universities, and all the nation's educational energies must be marshalled on a strategic plan. The Government's scheme is not going to be limited to an attempt to solve what Mr. Pease believes to be an insoluble denominational problem. The general principle of the Government's scheme is to secure that the best brains of the whole community should get to the top, and to provide a general diffusion of knowledge, so that we shall possess an educated democracy.

LORD HALDANE is to speak on the educational proposals of the Government at a joint meeting of teachers in secondary and technical schools, to be held at the University of London, South Kensington, on Saturday, March 29. The meeting is organised by the Association of Assistant Masters in Secondary Schools. The headmaster of Eton will preside, supported by Mr. Arthur Acland, and the following resolutions will be submitted:—"That this meeting welcomes the announcement that the Government proposes to deal in the near future with the question of education; hopes that the State will leave to the schools all reasonable freedom in such matters as time-table, curriculum, and careful educational experiments; and, with the object of attracting into the schools a sufficient supply of able and efficient teachers, urges that the increase of salaries and the provision of an adequate pension scheme should be a first charge upon any further grants for secondary and technical education." "That this meeting is of opinion that no pension scheme for secondary and technical teachers in England and Wales can be considered adequate which does not provide benefits approximately equal to those now secured to Scottish teachers."

THE Institution of Mechanical Engineers has now established graduateship and associate membership examinations, and has published the rules which will govern the examinations. The institution has in this way decided to cooperate with other engineering societies in the endeavour to define and raise the status of the engineer. The examinations will be held in London twice annually, in April and October. The "graduate" is defined as a person, not under eighteen years of age, who has passed the graduateship examination or reached some exempting standard, and has satisfied the council that he has received or is receiving regular training as a mechanical engineer with the necessary practical and scientific experience. No person is to be elected a graduate after twenty-five years of age. The institution's examination for graduates covers English, elementary mathematics, and scientific knowledge, and matriculation and similar certificates exempt the candidate from the test. The associate membership examination is ordinarily for candidates of from twenty-five to thirty years of age, and covers general, scientific, and technical knowledge. General knowledge includes an essay on some subject in literature, science, technology, or economics and workshop organisation; scientific knowledge is tested by papers in applied mathematics, physics, and chemistry; and a choice of two technical subjects must be made from seven specified. Several recognised examinations exempt candidates from the institution's associate membership examination, and for candidates over thirty years of age special arrangements are made.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 13.—Sir Alfred Kempe, vice-president and treasurer, in the chair.—A. **Mallock**: A simple method of finding the approximate period of stable systems.—Prof. J. S. **Townsend** and H. T. **Tizard**: The motion of electrons in gases.—Prof. T. R. **Lyle**: The self-inductance of circular coils of rectangular section.—Dr. A. E. H. **Tutton**: Ammonium ferrous sulphate and its alkali-metal isomorphs. The author has added this salt to the thirty-six salts of the series

$$R_2M\left\{\begin{matrix}S\\SeO_4\\Cr\end{matrix}\right\}_2\cdot 6H_2O$$

which he has previously investigated in a detailed manner, both morphologically and optically.—H. **Thirkill**: The re-combination of the ions produced by Röntgen rays in gases and vapours. Measurements, under widely varying conditions, of the coefficient of re-combination of the ions produced by Röntgen rays in gases and vapours have yielded the following results:—(1) Re-combination seems to take place according to the simple law $dn_1/dt = dn_2/dt = -\alpha n_1 n_2$. (2) For a certain range of pressure, the coefficient of recombination is proportional to the pressure.—Dr. W. **Wahl**: Optical investigation of solidified gases. III., The crystal-properties of chlorine and bromine. Crystallised chlorine and crystallised bromine are rhombic. Bromine is strongly pleochroic; chlorine less so. The absorption diminishes strongly when the temperature is lowered. The existence of a complete analogy in the crystalline characters of chlorine, bromine, and iodine has been established.—F. B. **Pidduck**: The abnormal kinetic energy of an ion in a gas. The abnormal rate of diffusion of negative ions in dry air, investigated by Townsend, would be explained if the negative ions had a velocity of agitation in excess of that of an equal number of molecules of the gas. The present paper investigates this from the point of view of the kinetic theory of gases.

Geological Society, February 26.—Dr. Aubrey Strahan, F.R.S., president, in the chair.—Dr. C. A. **Matley**: The geology of Bardsey Island (Carnarvonshire), with an appendix on the petrography by Dr. J. S. **Flett**. Bardsey, an island a mile and three-quarters long, lies off the promontory of the Lleyn (western Carnavonshire), and forms the isolated extremity of the strip of pre-Cambrian rocks that borders the western coast of the Lleyn from Nevin south-westwards. The rocks are principally gritty schistose slates, with many thin and some thick bands of grit, quartzite, and limestone; and they contain an horizon of variolitic lava and tufaceous shale, which indicates that a volcanic episode took place during their formation. Sills of albite-diabase also occur, as well as one or more sills of a crushed granite.—E. B. **Bailey**: The Loch Awe syncline (Argyllshire). This syncline is a comparatively shallow trough, with well-marked fan-structure due to small-scale isoclinal folding, in which the limbs of the folds are vertical along the axial

belt of the syncline, and inclined outwards on either side.

Physical Society, February 28.—Prof. A. Schuster, F.R.S., president, in the chair.—Prof. C. G. **Barkla** and G. H. **Martyn**: The authors have made a preliminary investigation of the Röntgen radiation proceeding from a crystal of rock salt (which is of the simple cubical form) when a pencil of Röntgen radiation is incident in a direction nearly grazing one of the three sets of mutually perpendicular cleavage planes. Reflection of X-rays by the cleavage planes.—Using a very narrow pencil of radiation, it was seen that the principal secondary pencil was one obeying the laws of reflections from the cleavage planes. A pencil diverging in all directions from a point source produced a corresponding reflected pencil of radiation converging to a line focus after reflection from a set of parallel cleavage planes. The quality of the radiation forming the secondary pencils was shown both by the photographic and by the ionisation method to be, not the fluorescent X-radiation, but of the kind previously described as scattered X-radiation. It was approximately of the same penetrating power as the primary radiation, and was approximately homogeneous, having traversed 5 mm. of rock salt in the case investigated. Interference fringe systems.—A diverging pencil of radiation was directed on to a crystal so that various portions were incident on the cleavage planes at different angles. A photographic plate showed the relative intensity of the corresponding reflected radiations. It was seen that the intensity of the reflected pencil varied periodically with varying angle of incidence, the maximum being separated by intervals corresponding to approximately equal increments in the value of $\cos\theta$, where θ was the angle of incidence on the reflecting planes. Such a series of maxima may be explained by interference of the pencils reflected from equal spaced parallel planes, the maxima being spectra of various orders. The wave-length, calculated on the assumption that these are planes passing through corresponding portions of molecules in the planes of cleavage, and that a molecule is simply NaCl, is found to be $0{\cdot}6\times10^{-9}$ cm. If the molecule be more complex, the calculated wave-length would be greater. This value thus agrees remarkably well with the value (between 1 and 2×10^{-9} cm.) calculated from the velocity of ejection of electrons by this X-radiation, taking this to behave as ultra-violet light of short wave-length. There can be little doubt that the fringe systems are interference fringe systems. That the smaller system is a series of spectra of different orders and the other an interference band system seems probable; this theory certainly explains the results observed up to the time of writing.—Prof. E. **Wilson**: Alternating-current magnets. It follows from the well-known law of pull of an electromagnet that if the magnetic field alternates between positive and negative values the pull is undirectional and intermittent. Unless means are provided to reduce the consequent chattering and vibration, the magnet is rendered useless. In the present experiments a phase-splitting device has been adopted, and consists in surrounding a portion of the pole-piece of the magnet with a short-circuited coil. The portion of the pole-piece so surrounded is sometimes said to be "shaded," and the coil referred to as a "shading" coil. The effect of this coil is to alter, not only the relative amplitudes, but the phase of the magnetic fields passing through the shaded and unshaded portions of the pole-face.

Linnean Society, March 6.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Geoffrey **Smith**: The development and inheritance of sexual characters. (Discussion.)

Zoological Society, March 4.—Dr. A. Smith Woodward, F.R.S., vice-president, in the chair.—Dr. F. E. **Beddard**: The anatomy and systematic arrangement of the Cestoidea. A new genus of tapeworms, of the family Ichthyotæniidæ, from the crossed viper (*Lachesis alternans*) was described.—Dr. W. A. **Cunnington**: The Branchiura collected by the third Tanganyika expedition in 1904–5. The collection contained more than 300 specimens, and proved that in the case of this group of animals also, Lake Tanganyika exhibits a number of endemic forms. While two species of Argulidæ are known to be widely distributed in the lakes of Africa, they are associated in Nyasa with a single form peculiar to that lake, but in Tanganyika with no less than seven new types. Tanganyika is thus shown to possess not only a considerable number of characteristic species, but a much richer Branchiuran fauna than the other great African lakes. The paper was illustrated by lantern-slides made from photomicrographs of the new species.—W. **Schaus**: Descriptions of a large number of new species of Rhopalocera from Costa Rica. More than 100 species had been collected, and of these fifty-four were found to be new.—Dr. A. **Willey**: Notes on plankton collected across the mouth of the St. Croix River, New Brunswick, in July and August, 1912.

Mineralogical Society, March 11.—Prof. H. L. Bowman, vice-president, in the chair.—W. Campbell **Smith**: The mineral collection of Thomas Pennant (1726–98). The collection, which has recently been presented to the British Museum by the Earl of Denbigh, is accompanied by three volumes of manuscript catalogue written in 1757. The classification used in them is based, with some modifications, on Woodward's "Natural History of the Fossils of England," published in 1729. Special mention is made of specimens presented by Borlase, Pontoppidan, and da Costa, and the minerals from Flintshire were treated in some detail. Several specimens were described by Pennant in "A Tour in Wales."—Arthur **Russell**: The minerals and mineral localities of Montgomeryshire. Of the species described the more remarkable are aurichalcite, from Llanymynech Hill Mine, Llanymynech; harmotome in double twins, associated with barytes and witherite, from Cwm-orog Mine, Llangynog; hydrozincite, which forms a remarkable recent deposit on the sides of a level in the Van Mine, Llanidloes; pyromorphite from Aberdeunant Mine, Llanidloes, and Llanerch-yr-aur Mine, Llanbrynmair; witherite, from Cwm-orog Mine, Llangynog, Gorn Mine, Pen-y-gaer Mine, and Pen-y-clyn Mine, Llanidloes, the crystals from the last being noteworthy on account of the almost entire suppression of the alternate faces of the pseudo-hexagonal prisms and pyramids.—Dr. G. F. Herbert **Smith**: A new stereographic protractor. The novelty consists of a curved ruler, made up of a combination of springs, which sensibly retains a circular curvature within the limits for which it is required. At the centre of the arc it is clamped to an arm, movable in a groove and carrying a scale, from which the azimuth of the corresponding great circle may be read off. The other edge of the protractor carries the usual tangent scales, from which the position of the compass to draw any circle up to the one corresponding to the great circle making an azimuth of 50° with the equatorial plane may be determined. The scales are based upon a radius of 10 cm.—L. J. **Spencer**: A (sixth) list of new mineral names.

Royal Meteorological Society, March 12.—Mr. C. J. P. Cave, president, in the chair.—R. G. K. **Lempfert**: Weather forecasts: past and present. For the preparation of forecasts, information is now received at

the Meteorological Office each day by telegraph from thirty British stations, and from forty on the continent of Europe and the islands of the North Atlantic. Information from thirty stations is, however, quite inadequate for checking the accuracy of the forecasts. For this purpose results from more than 130 stations are used. The forecasts are checked separately for wind and weather, the term weather being considered in regard to (1) temperature; (2) precipitation; (3) cloudiness or the reverse; (4) fog. The extension of the period covered by the forecasts for "further outlook" was described, and the application of this to the notification of probable spells of fine weather which the Meteorological Office now issues to farmers during the summer.

Mathematical Society, March 13.—Prof. Love, president, in the chair.—H. M. **Macdonald**: The diffraction of light by an opaque prism.—S. **Lees**: The natural radiation from transparent media.—L. J. **Mordell**: Indeterminate equations of the third and fourth degrees.—A. **Cunningham**: Mersenne's numbers.—J. **Proudman**: (1) A two-dimensional potential problem with applications to hydrodynamics and elasticity; (2) tidal motion in rotating sheets of water.

Royal Astronomical Society, March 14.—Major E. H. Hills, C.M.G., F.R.S., president, in the chair.—H. F. **Newall** and F. J. M. **Stratton**: Enhanced lines in the early spectrum of Nova Geminorum No. 2. The elements most strongly represented by these lines are titanium and iron; a number of other elements were indicated with less certainty. Two well-known bands frequently ascribed to helium were considered by the authors to be enhanced lines of iron.—F. W. **Dyson**: The distribution in space of the stars of Carrington's circumpolar catalogue. This catalogue contains practically all the stars of the Bonn Durchmusterung within 9° of the north pole. The paper dealt at length with the proper motions of the stars, the proper motions being based on those determined in connection with the Greenwich astrographic work.—A. S. **Eddington**: The distribution in space of the bright stars. The stars considered were those brighter than 5·8 magnitude. Stars of the spectral types A and K were separately dealt with, and in each case results were obtained for two regions, one typical of high galactic latitudes and one of low.—Major **Hills** and F. C. H. **Carpenter**: Results of observations with the Durham almucantar during 1912. The results on the whole were not very encouraging, as there are two errors which are peculiar to all floating instruments—the temperature gradient and the unsteadiness of the telescope. These may be reduced, but it does not seem possible to eliminate them; the almucantar thus seems an inferior instrument to the transit circle.—R. S. **Capon**: Note on the possibility of refraction in the solar atmosphere (papers of the International Union for Solar Research, No. 8).

CAMBRIDGE.

Philosophical Society, February 10.—Dr. Shipley, president, in the chair.—G. R. **Mines**: Note on the respiratory movements of *Torpedo ocellata*. A method for recording the frequency and amplitude of rhythmic movements over prolonged periods of time is described. The respiratory movements of elasmobranch fishes are known to be of two kinds, the ordinary breathing movements interrupted by occasional "spouting movements." The spouting movements can be produced with ease by the slightest irritation of the inside of the pharynx, as by the introduction of foreign particles with the water. It has therefore been supposed that whenever the spouting movements are observed they indicate the entry of some foreign object with the inspired water. Experiments made with the apparatus referred to above show that the spouting movements have a tendency to recur at rhythmic intervals. The period of this rhythm is often as long as two to five minutes, but sometimes it is shorter. The modifications it undergoes in response to changes in the environment suggest that the nerve cells controlling the movements have themselves a tendency to discharge rhythmically.—F. A. **Potts**: The swarming of Odontosyllis. The appearance of great numbers of sexually mature individuals of *Odontosyllis phosphorea* was observed on the surface of the sea near Nanaimo, Vancouver Island, in the years 1911 and 1912, during four days in the latter part of August. The swarming begins before sunset, lasts nearly an hour, and is almost over before it is quite dark. A comparison was drawn with *O. enopla* from the Bermudas, described by Galloway and Welch, in which the time of swarming is a little later and phosphorescence is so greatly developed as to be used as a method of sexual recognition. Only in the case of the insects elsewhere has luminosity been proved to possess an adaptive significance.—S. R. **Price**: Observations on *Polyporus squamosus*. *Polyporus squamosus*, Huds., is a well-known timber-destroying fungus, frequent on many species of our trees. The artificial culture of the fungus on sterilised wood blocks was described for the first time.—R. H. **Rastall**: Note on the composition of some Pleistocene sands near Newmarket.

MANCHESTER.

Literary and Philosophical Society, February 18.—Prof. F. E. Weiss, president, in the chair.—Prof. G. Elliot **Smith**: The Sussex skull and its brain-cast. Plaster copies were shown of the fragments of the Sussex skull and the cast made from them to represent the formation of the brain. An account of our present knowledge of ancient man was given in order to illustrate the importance of the new information supplied by the Sussex remains.

March 4.—Prof. F. E. Weiss, president, in the chair.—A. D. **Hall**: The plant and the soil. The plant takes but a very small portion of its substance out of the soil, but that little is indispensable. Growth especially depends upon the supply of nitrogen, phosphoric acid, and potash, and the function of a manure is to supply the deficiencies of an ordinary soil in one or more of these substances. These substances having to be in solution before entering the plant, one had to conceive of the water which is always present in the soil in a thin film coating the soil particles as a nutrient solution containing more or less of the materials determining the plant's rate of growth. Compounds of phosphoric acid and potash present in the soil possess but a very slight solubility, and the soil solution would become saturated to its utmost capacity even though the soil contained much less phosphoric acid and potash than are ever found in cultivated land. The acceptance of this view prevents the difference between good and bad soil being attributed to any difference in the amount of phosphoric acid and potash in the soil; moreover, additions of these substances could not directly stimulate the nutrition of the plant. This hypothesis had then to face the well-known fact that the yield of crops on particular soils could be greatly increased by certain manures, namely phosphates. American investigators propounding this theory suggest that the manure acts by precipitating and putting out of action certain injurious substances excreted by the roots of the plants. The value of proper aeration of roots was demonstrated, and results of wheat- and barley-growing experiments given. The theory of the indifference of the plant to the amount of nutrients in the soil was found to be untenable.

EDINBURGH.

Royal Society, February 17.—Dr. Horne, F.R.S., vice-president, in the chair.—Helen **Pixell**: Polychæta of the families Serpulidæ and Sabellidæ, collected by the Scottish National Antarctic Expedition. Eight genera were represented in the collection, including four new species, one in Apomatus, two in Spirorbis, and one in Potamus.—Dr. J. R. **Milne** and H. **Levy**: The recording of fluctuating flow: its difficulties and errors. Owing to the inertia of its moving parts, any instrument employed to record either "instantaneous values" or the "time integral of a fluctuating quantity" is liable to err. The extent of this error is in many cases unknown, *e.g.* in the case of a Robinson cup anemometer; and the present paper describes some experiments made with an analogous instrument to elucidate the matter. From the results obtained it appears that fluctuation in the flow causes the instrument to read too high.

March 3.—Prof. Bower, F.R.S., vice-president, in the chair.—Dr. R. A. **Houstoun**, A. H. **Gray**, and C. **Cochrane**: The absorption of light by inorganic salts (three concluding papers of a series). No. IX. dealt with salts of copper, cobalt, and nickel dissolved on alcohol and acetone, and described a successful attempt to apply the mathematics of mass action to the change of colour in an alcoholic solution of cobalt bromide when water was added. No. X. was occupied more particularly with the bearing of new methods on the old controversy of the colour of the ions, and it was shown conclusively that the colour changes of the cobalt, nickel, and copper salts have nothing whatever to do with ionisation. In No. XI. Dr. Houstoun discussed the theoretical aspect of the results gained and the present state of research in the field.—Dr. G. A. **Carse**, G. **Shearer**, and H. **Jameson**: Note on a comparison of records of atmospheric potential at two stations in Edinburgh. The two stations were the Physical Laboratory of the University and the Royal Observatory, Blackford Hill. A large number of records were compared, and the curves for the two stations showed in general good agreement, the agreement being best in those which indicated a disturbed state of the atmosphere. This is interesting when it is considered that the University is in the centre of the town and the observatory in the clearer air of the outskirts, nearly two miles distant.

DUBLIN.

Royal Dublin Society, February 25.—Prof. J. Wilson in the chair.—Dr. G. H. **Pethybridge**: The rotting of potato tubers by a new species of Phytophthora having a method of sexual reproduction hitherto undescribed. A new form of rot in potato tubers is described, in which the cut surface of affected tubers when exposed to air turn at first pink and afterwards nearly black. The causative organism is a new species of Phytophthora, to which the name *P. erythroseptica* is given. Sexual organs are produced when the fungus is grown artificially as a saprophyte, and probably also in nature. At an early stage in its development the young oogonium penetrates the antheridium at or near the base of the latter, grows up through it, bursts out at the summit, where it swells to form the oogonium proper, in which the oosphere and oospore develop. Fertilisation, if it takes place at all, probably occurs while the oogonial incept is within the antheridium, and hence before the formation of the oosphere. The sexual organs of *P. Phaseoli, P. infestans,* and probably *P. omnivora,* var. *Arecae,* are developed in a similar manner, but those of *P. cactorum, P. fagi, P. Syringae,* and probably others, follow the usual course, where the antheridium penetrates the oogonium laterally. Species which follow this latter method are removed from the genus Phytophthora, and are placed in a new one, to which the name Nozemia is given.—Dr. G. H. **Pethybridge** and P. A. **Murphy**: Pure cultures of *P. infestans,* de Bary, and the development of oospores. An account is given of the cultivation of *P. infestans* as a saprophyte on various media, on some of which (Oat-Agar and Quaker Oat-Agar) sexual organs are developed. Clinton's discovery of undoubted oospores is confirmed, and the mode of their formation is explained by the process occurring in *P. erythroseptica.*—Prof. J. **Wilson**: Inter-alternative as opposed to coupled Mendelian factors: a solution of the agouti-black colour in rabbits. This is an alternative solution to that given by Prof. Punnett in the November (1912) number of *The Journal of Genetics* as to the agouti-black colour in rabbits. Prof. Punnett found three factors acting conspicuously. On the "presence and absence" theory each of these must have its "absence." Thus there were six in all, and to meet the case two of the three prominent factors had to be coupled. The author finds that there are five factors operating in the case, viz. three dominants and two recessives, but that two of the dominants, and one of the recessives are inter-alternatives—that is, any one of the three can alternate with either of the other two, just as happens with the black, white, and red colours of cattle, or with the colours of horses.—E. G. **Fenton**: Notes on recent pampa and other formations in Patagonia. The author, from his traverses of southern Patagonia, brings forward evidence of widespread glacial and ice-sheet conditions at the close of Pliocene times, followed by a long inter-glacial interval, during which extensive outpourings of lava and emission of exploded materials occurred. This interval, which may have lasted for some thousands of years, was followed by a more local glaciation, when the Andes sent glaciers into the lowlands. The author believes that elevation of the area is now in progress.

PARIS.

Academy of Sciences, March 3.—M. F. Guyon in the chair.—B. **Baillaud**: The publication of certain works of the Paris Observatory.—A. **Lacroix**: The mineralogical constitution of the Los Archipelago (Guinea).—Paul **Sabatier** and A. **Mailhe**: A catalytic method of isomerising the alkyl chlorides and bromides. Chloride of barium or chloride of thorium at 250° C. decompose the alkyl chlorides and bromides into acid and ethylenic hydrocarbon. If this mixture is passed over pumice in the same tube heated to 200° C. these gases re-combine, giving secondary and tertiary alkyl halides. Examples of the application of the method are given.—Charles **Depéret**: Observations on the Pliocene and Quaternary geological history of the Gulf and Isthmus of Corinth.—M. **Barbier** was elected a correspondant for the section of chemistry in the place of the late M. Ladenburg.—Charles **Nordmann**: The light yield of a black body at high temperatures and on that of the stars. First application to Arcturus and Vega. By the application of Planck's and Stefan's laws it is shown that the light yield of a radiating body increases with the temperature to a maximum and then decreases. As a first approximation this temperature is found to be 6430° C., very nearly that found by various methods for the sun. The effective temperature of Arcturus is deduced as 3400° C., and Vega is 2·2 times as great.—M. **Tzitzeica**: Derived reciprocal networks.— J. Le **Roux**: The determination of the harmonic functions. Application to the square.—Mlle. Th. **Tarnarider**: The best approximation of $|x|^{2s+1}$ by polynomials of indefinitely increasing degrees.—Jacques **Chapelon**: The numbers of classes of positive binary quadratic forms.

—Et. **Delassus**: The equilibrium and small movements of systems submitted to linkages of any order whatever.—André **Blondel**: The internal power and synchronising couple of synchronous alternators working on a network at constant potential or in parallel.—Casimir **Cépède**: A new method of mounting microscopic preparations permitting the study of both faces of the section under the strongest magnifications, and doing away with the necessity of special methods of packing. A hole is bored in the glass slide in such a manner that the object can be imbedded between two cover glasses. This allows either side to be examined, and the slides can be packed vertically in contact with each other without danger of damaging the section.—Pierre **Goby**: A new application of the X-rays: microradiography. The apparatus described and figured gives an enlarged radiogram of small objects. Illustrations are given of radiograms from twelve to seventeen times the diameter of the original objects.—G. **Reboul**: Capillary phenomena in gases. Extension of the Laplace formula to solid-gas contact.—Marcel **Boll**: The energy absorbed and mass formed in a photochemical reaction. A study of the conductivity of a very dilute solution of chloroplatinic acid under the influence of a monochromatic radiation.—André **Kling** and D. **Florentin**: The action of low temperatures on explosives. The handling and opening of explosive bombs has frequently to be undertaken in the Paris Municipal Laboratory, and experiments have been made to see if the force and velocity of detonation of various explosives can be reduced by cooling to the temperature of liquid nitrogen. It has been found that the sensibility of some explosives and detonators is reduced by cooling, but when explosion takes place the force of the explosion is not affected by the low temperature.—Victor **Henri** and Marc **Landau**: Study of the absorption of the ultra-violet rays by acetylene. Tables are given showing the positions of the bands produced by the gas and by its solutions.—Witold **Broniewski**: The critical points of iron. Heating curves are given for electrolytic iron and also the results of measurements of the thermo-electric power, electrical resistance, expansion, and thermal points.—L. **Guillet** and A. **Portevin**: Some properties of a commercial electrolytic iron. In this metal no carbon, manganese, silicon, or sulphur could be detected. It contained phosphorus 0·025 per cent., and arsenic 0·011 per cent. Determinations were made of its critical points, and two microphotographs are reproduced.—H. **Pélabon**: Study of the system antimony sulphide, lead sulphide. Definite compounds were shown by the existence of transition points and confirmed microscopically.—Daniel **Berthelot** and Henry **Gaudechon**: A levulose actinometer for ultra-violet light. The influence of the concentration on the velocity of the photochemical reaction. In weak solutions the absorption is slight and is proportional to the concentration; in concentrated solutions the absorption is total, and does not increase with the concentration.—MM. **Lespieau** and **Bresch**: The action of α-β-dichlorethyl ether on mixed magnesium derivatives.—Pierre **Jolibois**: Methyl-magnesium iodide. By the action of heat on methyl-magnesium iodide a substance is obtained of the composition MgI_2,Mg_2C. This is attacked by water, nearly pure methane being evolved.—André **Meyer**: "Halochromy" in the derivaties of phenylisoxazolone and in its indogenides.—Albert **Michel-Lévy**: The eruptive rocks of the Lyonnais.—M. **Mazé**: The relation which exists between the water evaporated and the weight of plant material elaborated by maize.—Eug. **Rousseaux** and Maurice **Sirot**: Soluble nitrogenous material as a factor in valuing flour. In a good flour the ratio between the total nitrogen and the soluble nitrogen should not fall below a certain figure. A low ratio corresponds with bad bread-making properties.—A. **Demolon**: Researches on the fertilising action of sulphur. The fertilising action of sulphur may be attributed to its action on the micro-organisms of the soil and also to its progressive oxidation to sulphuric acid.—L. C. **Soula**: The activity of the nervous centres and nitrogen catabolism of the nerve substance.—Raphael **Dubois**: The nature and development of the light organ of *Lampyris noctiluca*.—Gabriel **Bertrand** and H. **Agulhon**: The presence of boron in the animal kingdom. The authors conclude that boron exists normally in very small proportions in all animals. The amount is greatest in animals of madine origin.—Henri **Stassano**: Contribution to the knowledge of the plasma of propeptone.—H. **Maurice**: The results given by captive balloons north of the polar circle. Temperatures are given on the ground and at varying heights up to 20,000 metres.—E. A. **Martel**: Study of the temperatures of subterranean waters.

BOOKS RECEIVED.

Household Bacteriology for Students in Domestic Science. By E. D. Buchanan and Prof. R. E. Buchanan. Pp. xv+536. (London: Macmillan and Co., Ltd.) 10*s*. net.

Bücher der Naturwissenschaft. Band 15, Vom Keim zum Leben. By Prof. K. Lampert. Pp. 198+xii plates. (Leipzig: P. Reclam, jun.) 1 mark.

Government of India. Department of Revenue and Agriculture. Agricultural Statistics of India for the Years 1906–7 to 1910–11, in 2 vols. Vol. ii., Native States. Pp. 123. (Calcutta: Superintendent Government Printing, India.) 1*s*. 6*d*.

Garden Work: a Practical Manual of School Gardening. By W. Good. Pp. xvi+399+plates. (London: Blackie and Son, Ltd.) 3*s*. 6*d*. net.

Die Methoden der exakten, quantitativen Bestimmung der Alkaloide. By Prof. A. R. von Korczynski. Pp. iv+82. (Berlin: Gebrüder Borntraeger.) 3.50 marks.

Osmotic Pressure. By Prof. A. Findlay. Pp. vi+84. (London: Longmans and Co.) 2*s*. 6*d*. net.

Report of the Librarian of Congress and Report of the Superintendent of the Library Building and Grounds for the Fiscal Year Ending June 30, 1912. Pp. 235. (Washington: Government Printing Office.)

The Mosquitoes of North and Central America and the West Indies. By L. O. Howard, H. G. Dyar, and F. Knab. Vol. i., A General Consideration of Mosquitoes, their Habits, and their Relations to the Human Species. Pp. vii+520. Vol. ii., Plates. Pp. x+150 plates. (Washington: Carnegie Institution.)

Carnegie Institution of Washington. Year Book. No. 11, 1912. Pp. xvi+294. (Washington: Carnegie Institution.)

The Classics of International Law. Edited by J. B. Scott. De Jure Belli ac Pacis Libri Tres, in quibus Ius Naturæ and Gentium, item Juris Publici præcipua explicantur. By H. Grotius. Vol i., Reproduction of the Edition of 1646. Pp. 618. (Washington: Carnegie Institution.)

Researches of the Department of Terrestrial Magnetism. Land Magnetic Observations, 1905–1910. By L. A. Bauer. Pp. iv+185. (Washington: Carnegie Institution.)

The Vulgate Version of the Arthurian Romances. Edited from Manuscripts in the British Museum by H. O. Sommer. Vol. vi. Pp. 391. (Washington: Carnegie Institution.)

The Nummulosphere: an Account of the Organic Origin of so-called Igneous Rocks and of Abyssal

Red Clays. By R. Kirkpatrick. Pp. 104+2 plates. (London: Lamley and Co.) 2s. net.

V. v. Richter's Chemie der Kohlenstoffverbindungen oder Organische Chemie. Elfte Auflage. Zweiter Band. By Drs. R. Anschutz and H. Meerwein. Pp. xxii+1048. (Bonn: F. Cohen.) 26 marks.

A Guide for Laboratory Geography Teaching, for Use in connection with "A Laboratory Manual of Physical and Commercial Geography," by the late Prof. R. S. Tarr and Dr. O. D. von Engeln. By Dr. O. D. von Engeln. Pp. iii+20. (London: Macmillan and Co., Ltd.) 1s. net.

Elementary Principles of Electricity and Magnetism for Students in Engineering. By Drs. R. H. Hough and W. M. Boehm. Pp. vii+233. (London: Macmillan and Co., Ltd.) 6s.

Garden Flowers as They Grow, Photographed in Colour Direct from Nature. By H. S. Corke, with descriptive text by H. H. Thomas. Pp. iii+197. (London: Cassell and Co., Ltd.) 5s. net.

Heat: a Manual for Technical and Industrial Students. By J. A. Randall. Pp. xiv+331. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 6s. 6d. net.

Cambridge County Geographies:—Herefordshire. By A. G. Bradley. Pp. xi+149. (Cambridge University Press.) 1s. 6d.

University of Calcutta Readership Lectures. Matrices and Determinoids. By Prof. C. E. Cullis. Vol i. Pp. xii+430. (Cambridge University Press.) 21s. net.

Abhandlungen und Vorträge zur Geschichte der Naturwissenschaften. By Prof. E. O. von Lippmann. Zweiter Band. Pp. x+491. (Leipzig: Veit and Co.) 8 marks.

Brands Used by the Chief Camel-Owning Tribes of Kordofán. By H. A. MacMichael. Pp. vii+40+xvii plates. (Cambridge University Press.) 6s. net.

Die Mathematischen Wissenschaften. Erste Lief. Die Mathematik im Altertum und im Mittelater. By H. G. Zeuthen. Pp. iv+95. (Leipzig and Berlin: B. G. Teubner.) 3 marks.

The Fitness of the Environment. By Prof. L. J. Henderson. Pp. xv+317. (London: Macmillan and Co., Ltd.) 6s. 6d.

"Red Books" of the British Fire Prevention Committee. No. 174, Fire Tests with Roof Coverings of Asbestos Cement Corrugated Sheets. Pp. 31. (London: British Fire Prevention Committee.) 2s. 6d.

A Text-Book on Field Fortification. By Col. G. J. Fiebeger. Third edition. Pp. xii+155+xxvii plates. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd.) 8s. 6d. net.

A Text-Book of Experimental Metallurgy and Assaying. By A. R. Gower. Pp. xiv+163. (London: Chapman and Hall, Ltd.) 3s. 6d. net.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College for the Years 1905–1912.—Edited by R. M. Milne. (London: Macmillan and Co., Ltd.) 6s.

Catalogue of the Heads and Horns of Indian Big Game, bequeathed by A. O. Hume, C.B., to the British Museum (Natural History). By R. Lydekker. Pp. xvi+45. (London: British Museum (Natural History); Longmans and Co., and others.) 2s.

A Revision of the Ichneumonidæ, based on the Collection in the British Museum (Natural History), with Descriptions of New Genera and Species. Part ii. By C. Morley. Pp. x+140+plate. (London: British Museum (Natural History); Longmans and Co., and others.) 5s. 6d.

A Descriptive Catalogue of the Marine Reptiles of the Oxford Clay, based on the Leeds Collection in the British Museum (Natural History). Part ii. By Dr. C. W. Andrews. Pp. xxiv+206+xiii plates. (London: British Museum (Natural History); Longmans and Co., and others.) 25s.

Moderne Probleme der Biologie. By Prof. C. S. Minot. Pp. vi+111. (Jena: G. Fischer.) 3 marks.

Die Weltherrin und ihr Schatten. By F. Auerbach. Zweite Auflage. Pp. 74. (Jena: G. Fischer.) 2 marks.

Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India. (New Series.) No. 57, Studies on the Flagellates of the Genera Herpetomonas, Crithidia, and Rhynchoidomonas. No. 1. By Capt. W. S. Patton. Pp. 21+plate. No. 58, Studies on the Mouth Parts and Sucking Apparatus of the Blood-sucking Diptera. No. 2. By Capt. F. W. Cragg. Pp. 33+plate. No. 59, ditto. No. 3. By Capt. F. W. Cragg. Pp. 36+vi plates. (Calcutta: Superintendent Government Printing, India.) 1s. 2d., 1s., and 1s. 11d. respectively.

DIARY OF SOCIETIES.

WEDNESDAY, MARCH 26.

AERONAUTICAL SOCIETY, at 8.0.—Annual General Meeting, 8.30.—Hydro-Aëroplanes: Commander C. R. Samson, R.N.

THURSDAY, MARCH 27.

CONCRETE INSTITUTE, at 7.30.—Beams and Props for Mines: Prof. S. H. Dixon.

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