THURSDAY, JANUARY 16, 1902.

PSYCHOLOGY OF LANGUAGE.

Völkerpsychologie. By W. Wundt. Erster Band. Die Sprache. 2 Parts. Pp. xv+627 and x+644. (Leipzig: Engelmann, 1900.) Prices 14*s.* net and 15*s.* net.

PROF. WUNDT'S two bulky volumes form the first part of a long-expected treatise on race-psychology. The distinguished author has not the gift of concise utterance, and one almost shudders to think of the thousands of pages to which the work promises to extend by the time the second and third parts, dealing with myth and custom, have been completed. It is, perhaps, unfortunate that Prof. Wundt should have determined to treat his two remaining topics in the order just indicated; if there is anything at all in the results and methods of modern anthropology, it is from customs of the most practical kind, in fact from magic, that mythology on the whole derives its existence; hence one would think that custom rather than myth is entitled to the central position in a systematic "Völkerpsychologie." Can it be that Prof. Wundt's arrangement of his material has been unconsciously influenced by the now obsolete or obsolescent view of mythology as a "disease of language"? In any case, the intimate connection of the myths of one age with the magic of its predecessors seems to diminish the value of the author's psychological scheme by which custom is made to correspond to the volitional, myth to the emotional, aspect of racial life (vol. i. p. 27).

No one but a specialist in comparative philology is really competent to deal minutely with Prof. Wundt's elaborate investigations into the psychology of language. In the present notice, it is impossible to do more than supply a very brief summary of the topics treated of, and a briefer indication of a few of the author's leading results. He begins with a detailed and careful description of the general characteristics of emotion and its expression, which leads up to a study of the simplest and crudest form of language, the expression of emotion by a code of gestures. The account of gesture-language, which is based upon the artificial systems of signs in use among the dumb, as well as of the wide-spread gesture-language of the North-American Indians and of the Neapolitan populace, is full and interesting, especially in dealing with the question of the existence of grammatical form in gesture-speech. That gesture-language is not formless, as is often asserted, is well shown by reference to the fixed order in which the gesticulator expresses the constituent parts of a proposition. Prof. Wundt, by the way, appears not to be acquainted with the singularly full and excellent study of the gesture-language of Australian tribes contained in Mr. W. E. Roth's "Aborigines of North-West-Central Queensland." Proceeding in his third chapter to deal with articulate sounds, the author has much that is useful, if little that is new, to say about the differences between the song of birds and the song of men, and between the song and the speech of men. Incidentally he derives human song from vocal accompaniments of the rhythmical movements of work, and therefore regards its connection with religious cultus as secondary (i., p. 265). It might, perhaps, be objected that the beginnings of both rhythmical movement and its vocal accompaniments are to be found in the corroborees of the Australians, among whom systematic work hardly exists, and that here, at all events, the rhythmical movements appear to arise directly out of the magical representations of incipient cultus. Prof. Wundt is on surer ground when he goes on to deal with the origin of onomatopœia. It is impossible to resist the arguments by which he shows that direct and intentional imitation of natural sounds can have little to do with the origin of names, and that the real process is one of impulsive and unintentional imitation by the organs of articulation of striking forms of physical movement.

The fourth chapter deals with the psychological causes of sound-change. Prof. Wundt finds the principal source of regular and continuous changes affecting whole classes of sounds, apart from such incidental influences as those of climate or racial mixture, in the growing tendency of civilised men to speed of thought and utterance. To this psychical source he traces those changes in articulation which have often been ascribed to the imaginary desire for ease of utterance; a desire which, in the first place, is never consciously operative, and, in the second, could not exist unless advance in culture brought with it tendencies which make an originally easy articulation increasingly difficult. Such tendencies we have in the increasing speed of civilised speech, with its effects upon pitch and accent. Prof. Wundt uses his theory chiefly to explain the familiar changes formulated in "Grimm's law." On the value of the explanation no doubt the philologists will claim to be heard, but it has at any rate the merit of assigning a psychological *causa vera* for facts which have often been either left entirely unaccounted for or put down to a purely imaginary "desire for ease." In the case of the sound-changes produced by assimilation, a second psychological principle is invoked, viz. the tendency of thought to outrun speech. The assimilation takes place because the second sound is already "in consciousness" before the first has been duly articulated. The same principle in combination with the laws of association is in the succeeding chapter employed to explain the various forms of paralalia. Curiously enough, the author does not treat of the important vowel-changes which occur in the life of a language, such as those by which diphthongs have been substituted in modern spoken English for so many of the original vowels. In the chapter on word-formation the sections dealing directly with the nominal subject are rather of grammatical and philological than of strictly psychological interest. The earlier parts of the chapter, on the other hand, which treats of the cerebral speech-centres, the phenomena of aphasia and the perception of short words, are of great psychological interest, but so loosely connected with the ostensible subject of the chapter that they would be more in place in a separate work on experimental and physiological psychology.

Prof. Wundt's second volume is at once far the more important half of his book and the more difficult to describe with justice in a brief notice. He has set himself the gigantic task of digesting the facts contained in such works as F. Müller's monumental "Grundriss der Sprachwissenschaft" into a systematic form, and eliciting

from them a psychological theory of the successive evolution of grammatical form and syntactical construction. This task is performed in the two chapters which deal with "word-forms" and "sentence-construction." These are followed by a chapter on the psychical causes of change of signification, and the whole work concludes with a final chapter devoted to a brief *résumé* and criticism of the various theories of the "origin of language." It is significant of the influence exerted upon modern psychological thought by the concept of evolution that this last chapter is by far the shortest in the book and that its result is in the main the purely negative one that speech, like the other human faculties, has no definite beginning or origin, but is connected by a continuous development with a pre-articulate and pre-human past, while the earliest stages of language known to us themselves presuppose a long development within human speech itself. Of the elaborate investigations which fill Prof. Wundt's chapters vi.–viii. it is impossible, for reasons of space, to say much except that they are of the highest psychological interest and importance. Specially important are the distinction between a preeminently nominal and objective type of language, like those, *e.g.*, of the American or of the Ural-Altaic family, and a pre-eminently verbal and subjective type, like that to which we are accustomed in the familiar Indo-Germanic group, and the very similar distinction, in the realm of syntax, between the attributive and predicative types of proposition as corresponding to the "nominal" or objective and the "verbal" type of thought respectively. These and similar differences, obviously pointing to marked divergence of psychological endowment, are minutely and learnedly discussed by Prof. Wundt in a way which only makes one regret that his weakness for diffuse expression makes it so difficult to get a clear and systematic grasp of his argument as a whole.

A. E. T.

ELECTRICAL ENGINEERING TESTING.

Electrical Engineering Testing. By G. D. Aspinall Parr. Pp. viii+474; 218 diagrams, 31 tables. (London: Chapman and Hall, Ltd., 1902.) Price 9*s.* net.

DURING the last few years the rapidly spreading use of electrical methods of dealing with engineering problems has been naturally accompanied by the publication of a great mass of isolated work on the testing of electrical materials and machinery. Successful design requires not merely a knowledge of principles, but an intimate acquaintance with the properties of materials to be used; that these may be used economically and without needlessly high "factors of safety." And an electrical engineer is required to understand how to test for magnetic and electrical excellence the material he may have to use, as well as how to test his machinery for efficiency and staying power and his instruments for accuracy. It is probable that electrical engineering testing presents not only a possibility of, but a necessity for, greater refinement of measurement than occurs in other branches of engineering testing; the success of much of our electrical machinery and apparatus being more immediately dependent on exact design.

When a subject is developing so rapidly as that which Mr. Parr has chosen, it is not easy to maintain an exact knowledge even of what should be regarded as the simpler matters, and it is still less easy to keep this knowledge in due proportion. For that which was but lately abstruse or useless may rapidly become clear and even elementary information.

The volume before us will prove useful to many, containing, as it does, much information relating to electrical testing which, in spite of a rather unsatisfactory arrangement, is in a fairly accessible form. Its main portion consists of accounts of about 130 different tests, each arranged as follows:—A descriptive introduction; a list of apparatus wanted; what observations to take and how to take them; and concluding with "inferences" to be drawn from the results of the test. The book is styled "a practical work," meaning, we presume, not so much a text-book in which difficulties are explained as a hand-book containing useful information about tests. It is primarily written for students, and we do not doubt it will prove very useful alike to student and demonstrator.

The "descriptive introductions" are probably as satisfactory as the nature of the book will allow. The list of apparatus, while usually complete, will strike the reader as relating in particular to the apparatus of Mr. Parr's laboratory in the Yorkshire College. The next section of each test on taking and tabulating observations is very well given. It will save the student much thought and keep him from much bungling, and will raise the quality of his work—all but the first no doubt desirable when the course must be hurried over. The "inferences" are added at the end "to make the experimenter think and reason for himself." If the test had not been so well arranged for him beforehand, or the instructions so fully given, perhaps he would have had to think for himself before the test could have been carried out. This is a matter of opinion; but we think that the book will prove more useful in evening classes than with day students.

An appendix gives in a few pages the derivation of some formulæ employed, and the book concludes with some 100 interesting pages descriptive of apparatus used. The author shows much of his own apparatus and methods, which are interesting even when they do not strike one as the best.

The book is nicely printed, but bears signs of haste in preparation. Thus most readers, when they have grasped the peculiar use of the word "inference," will be surprised, if not amused, at the following: "Inference: Does the accuracy of the above test depend upon anything in particular?" p. 17; and on p. 22, under a similar heading, "Can anything in particular be deduced from the above results?" The author spells converter with an *o* in the final syllable, and writes anti-inductive where non-inductive is meant; and slips such as series for serious, p. 154, sale for scale, p. 378, Jolly for Joly, p. 390, &c., which are not infrequent, should have disappeared in the proof.

The figures are on the whole good, and the tables at the end welcome.

The author's style is often by no means lucid, and even when the meaning is clear it does not make agreeable

reading. The book is a great contrast to the other recent English work on the same subject, by Dr. Fleming, which is both readable and interesting. But we feel that there is a place also for a book such as Mr. Parr's, in which short accounts of many specific experiments are given, and the book will be of value to engineers as well as in a teaching laboratory.

D. K. M.

BURMA.

Burma under British Rule—and Before. By John Nisbet, D.Œ.C. Two volumes. Pp. xvii + 912. (Westminster: Archibald Constable and Co., Ltd., 1901.) Price 32*s.* net.

LITTLE more than a year ago a most beautifully illustrated, interesting volume on "Burma," by Max and Bertha Ferrars, appeared, which has been most favourably received. And now we have a second work on Burma. This comparatively recent part of the empire, then, receives a full share of attention, and not the least interesting part of the business is that both Mr. Ferrars and Dr. Nisbet are retired Burma forest officers. Even a cursory glance at the books will show that these two gentlemen have become most intimately acquainted with the customs and character of the Burmese. As a matter of fact, though this has not always been admitted, there is no branch of the Indian services the members of which come into closer contact with the inhabitants away from towns, than Indian forest officers. If it is remembered that in many cases the peoples in question live in out of the way places and that many of them never see a magistrate or a judge, it will readily be acceded that the selection and training of the members of the Indian forest service should be done with special care, since the happiness of millions of ignorant people depends to a considerable extent on the tact and sympathy of these officers.

Mr. Nisbet's work is divided into two volumes. In the opening chapter of vol. i. he deals with the history of Burma from the year 2266 B.C. to 1852 A.D. It will readily be understood that this sketch, occupying twenty-five pages, can only touch lightly on the history of this interesting country, and, unfortunately, the notes appear to us by no means as well arranged as they might be. Chapter ii. describes the political and commercial relations between British India and Upper Burma during the years 1853–80, relations which were anything but cordial. Here we find the great shoe question recorded, that is to say, that the British envoy had to take off his shoes and kneel down if he wished to address the King of Burma, until we come to the massacres of some fifty members of the Royal house by King Thibaw. The existing and increasing differences are further described in Chapter iii., explaining the causes of the third Burmese war. It broke out in November 1885, resulting in the annexation of Upper Burma. Apart from the utter unreasonableness of the last two kings of Burma and the cruelty of Thibaw, French intrigues contributed most powerfully to hurry on the crisis. The last straw, however, was the difference between King Thibaw and the Bombay-Burma Trading Corporation, the latter having been fined 153,000*l.* by the former. For ourselves, we cannot conceal that we should have been better pleased if the crisis had come without this last incident.

Chapter iv. deals with the third Burmese war, which practically lasted only from November 13, 1885, till January 1, 1886; but it was followed by five years during which the pacification of the country was ultimately effected.

Chapters vi.–viii. deal with civil and military administration, law and justice under Burmese rule, and the Royal Golden City. They contain much interesting information, of which the marriage law is perhaps the most curious. There were seven kinds of wives, of which four could not be divorced, but there was no difficulty in getting separated from any of the other three kinds.

Chapter ix. gives a rapid survey of "The British System of Administration in Burma." It shows how an orderly administration has been established in a comparatively short time as regards the organisation of the civil authorities, law, military and police, public works, forests, education and revenue. Of special interest is the development of the latter, it having risen from 2,415,000*l.* in 1886–87 to 5,242,000*l.* in 1899–1900, while the surplus has, during the same period, risen from 637,000*l.* to 1,821,000*l.* It is shown that Burma has already more than repaid all the outlay upon it during and since the third Burmese war. The net revenue includes a sum of 400,000*l.* derived from the teak and other forests, and this sum is capable of a further great increase.

Chapters x. to xiv. give a detailed account of the various branches of administration, such as the land tenure, settlements, agricultural and rural customs, minor rural industries (such as sifting for gold dust, silk weaving, dyes and dye-stuffs, pottery, fisheries, collection of wood-oil, preparing and transport of timber, cutch boiling, manufacture of cheroots, &c.); the mineral resources (coal, petroleum, tin, silver, lead, gold, jade, rubies); trade and commerce (the sea-borne trade of Burma in 1888–89 amounted to a value of 11,717,000*l.*; in 1899–1900 it had risen to 20,820,000*l.*)

The second volume opens with a chapter on Britain and France in further India and south-western China, and is followed by others on railway extensions; Burma's forest wealth and the importance of maintaining and increasing the production of teak timber; Burmese Buddhism; beliefs and superstitions; national habits and customs; the social system; national festivals and amusements; science and art among the Burmese; language and literature; folklore; archæology and the hill tribes.

It would be beyond the scope of this notice to go into the details of all these matters, but attention may be drawn to two points: As regards railways, Dr. Nisbet points out that the most pressing need is to develop internal communication before connections with the outside are established. When the time and money for the latter have become available it will be well, in the first instance, to connect Burma with India *via* Assam (or Arakan and Chittagong), then with Siam, leaving any possible connection with China, by way of Yunnan, for discussion in the future. Although we agree with this

view, it may happen that events in China will upset it, and that a connecting link between Burma and Yunnan by means of a railway may become a necessity.

The second point to which we desire to draw attention is the chapter on Burma's forest wealth. It is but natural that this is treated in a very full way, and we recommend its perusal to those who have up to date been hostile to forest conservancy in India and Burma. More especially Dr. Nisbet describes in full detail the great pains which are taken in ascertaining the full extent of existing rights and privileges, and the minuteness with which the requirements of the local population are provided, before any forest tract is declared a permanent State forest.

On the whole Dr. Nisbet's work may be called a very storehouse of information on Burma, to collect which must have taken him many years. If we were to find any faults with the work they would be that the author's facile pen has led him into too great a length, and that there are numerous repetitions in it. Still, those who have leisure to read the two handsome volumes will be richly rewarded for their trouble. They will find in it, not only a minute description of an interesting people, but also a record of the admirable manner in which civilised methods of administration have been successfully introduced in this far-away country in a remarkably short space of time.

OUR BOOK SHELF.

The Birds of South Africa. By A. C. Stark, completed by W. L. Sclater. Vol. ii. Illustrated. Pp. xiv+324. (London: Porter, 1901.) Price 21*s.* net.

IN a review of the first volume of this work (part of the "Fauna of South Africa"), published in our columns soon after its appearance, reference was made to the tragic death of its author, Dr. Stark, in Ladysmith, at the commencement of the siege. The first volume was practically completed by the author before his death; but of its successor the manuscript was left (partly stored at Durban and partly at Ladysmith) in a state which rendered necessary a considerable amount of revision and addition on the part of whoever undertook the task of editing and preparing it for press. By desire of Dr. Stark's executors this labour was entrusted to Mr. W. L. Sclater, the editor of the series to which the volume belongs, who is to be congratulated on having carried out so successfully an undertaking of no ordinary difficulty. For, as all those who have tried it are well aware, the completion of another man's unfinished work is often a more difficult task than to write a volume *de novo*. As this volume may be regarded as in some respects a memorial of the lamented author, his portrait is very appropriately introduced as a frontispiece.

Since the general plan of the work was somewhat fully referred to in our previous notice, and as in this respect the present volume agrees in all essential points with its predecessor, nothing need be added on the present occasion. This volume continues the description of the perching-birds, taking up the thread at the shrikes, and ending with the swallows and pittas, so that the African representatives of five families are discussed. The editor has been fortunate in again securing the services of Mr. H. Grönvold as artist; and, needless to say, the illustrations are exquisitely drawn, and at the same time true to nature. Attention may be especially directed to the figure of puff-birds and their nest, which is based on a photograph taken near Grahamstown, and forms a charming bit of bird-life. One illustration alone—that of rock-thrushes and their nest, on p. 182—has been reproduced direct from a photograph. A comparison of this with the above-mentioned picture by Mr. Grönvold leaves little doubt where the superiority lies. In addition to the text-figures this volume contains a map which should prove of much value to the students of the South African fauna.

While congratulating Mr. Sclater on the completion of this much of his arduous task, we may take the opportunity of mentioning that, with the help of Dr. Stark's note-books and papers he hopes ere long to bring out the two remaining volumes of the "Birds of South Africa." R. L.

Elementary Telephotography. By Ernest Marriage. Pp. xxix + 117. (London: Iliffe and Sons, Ltd., 1901.)

THE telephotographic lens is becoming more generally used every day, so that the publication of a good elementary treatise on the chief advantages of its employment and on its successful manipulation will be received with favour. The opening chapters describe, in simple and clear language, backed up with excellent illustrations, the optical arrangements of telephotographic lenses, the different types of such lenses, the work for which they are specially adapted, and the form of camera and accessories that experience has shown to be the most satisfactory. The author lays great stress on the importance of rigidity in both the camera and support, so the beginner should take special note of this fundamental consideration.

After a chapter on the general applications of telephotography, the author gives the beginner some excellent advice in separate chapters on the special branches of the subject, namely, architecture, portraiture and the telephotography of animals, illustrating the chief points with reproductions from photographs.

Last, but by no means least in importance, are two chapters on exposure and development and useful tables. In the former it is shown, among other things, that with a little trouble the most difficult part of the whole manipulation, namely, "correct exposure of the negative," may be successfully overcome by a simple calculation, this method being rendered more practicable and easy by the use of the tables given in the latter chapter.

It may be mentioned in conclusion that the book is neatly printed on good stout paper and the illustrations are well reproduced, so that with these extra points in its favour it will form a useful addition to photographic literature.

The British Journal Photographic Almanac, 1902. Edited by Thomas Bedding. Pp. 1560. (London: Henry Greenwood and Co., 1901.) Price 1*s.*

THE forty-first yearly issue of this almanac is well up to the standard of former years, and contains a mine of useful information for both the amateur and the professional photographer.

Among the principal contents we notice an interesting, and what should prove a useful, article on "Introductory Notes on Tele-photography," by the editor, which brings together the more important facts on the subject. This is followed by a series of short contributions on practical subjects by prominent photographers, by numerous notes and suggestions of the year, and by an epitome of the advances made in 1901. The almanac portion of the volume and tables will be found as useful as ever, and the reader will find the collection of photographic formulæ and recipes, list of photographic societies, and other miscellaneous tables and information very complete.

In addition to the 600 pages of text, those devoted

to advertisements have also their interesting features, and the numerous illustrations and process plates scattered here and there add an additional attraction to the volume. The success of this present edition will be gathered from the fact that it has already been sold right out, as is stated by the *British Journal of Photography*.

Encyclopédie Scientifique des Aide-Mémoire. Le Vin. Par Henri Astruc. Pp. 208. (Paris : Gauthier-Villars, 1901.) Price 3·0 F.

THIS little treatise on wine-making is essentially encyclopedic in character, and as such calls for only a brief notice. The author is evidently familiar with his subject, and in the limited space at his disposal has been very successful in reviewing both the scientific and economic position of the French wine industry. There is nothing novel in the scientific questions discussed in this book, but some of the economic questions brought forward are not generally recognised in this country. For instance, here we have been inclined to regard wine growing in France as only in process of recovery from the devastation wrought by phylloxera, and it comes as a surprise to be told by the author that the wine-growers of his country are at present suffering from the effects of over-production.

This little book will be useful to anyone who desires to make a rapid survey of the present position of the French wine industry. A. J. B.

A Commercial Geography of Foreign Nations. By F. C. Boon, B.A. Pp. viii + 174. (London : Methuen & Co). Price 2*s*.

THIS book will not assist to make commercial geography a scientific study. Like the geographical books of old time, the volume consists largely of disconnected details which no pupil ought to be asked to remember, and which produce weariness of the flesh in the unfortunate reader. If commercial geography means what Mr. Bovn makes it, then it is the duty of all who are anxious for the introduction of reasonable methods of instruction in schools to condemn it at every opportunity. Here are a few examples of unqualified or loose statements which occur in the early pages of the book. "The greatest heat for the greatest number of days is on the Equator" (p. 1). "As the Equator is neared [from the Tropics] two days have vertical sunshine at each point within the Tropics, approaching gradually to the autumn and vernal equinoxes at the Equator" (p. 1). "Added to the effects of the neighbouring land or water are the similar effects of the winds that blow over them" (p. 2). "The Gulf Stream washes the coast of Norway" (p. 11). But we do not object so much to statements of this kind as to the principle of cramming pupils with information which has to be accepted without inquiry and cannot be assimilated. The less we have of commercial geography of this kind the more likely are we to create an interest in the study of the subject.

Mining Calculations. By T. A. O'Donahue. Pp. viii +211. (London : Crosby Lockwood and Son, 1901.) Price 3*s*. 6*d*.

THE primary object of this little book is to enable candidates for certificates as colliery managers to obtain with a minimum of trouble a sufficient knowledge of arithmetic and mensuration to pass their statutory examinations. If the student will steadily work out the numerous useful examples given by the author, his chances of success will certainly be increased. Some of the absurdly easy arithmetical questions, quoted from the official examination papers, do not tend to enhance one's respect for the statutory certificate ; however, this is no fault of the author, who has simply written a book to supply a want created by the examiners appointed under the Coal Mines Regulation Act.

LETTERS TO THE EDITOR.

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

The Inheritance of Mental Characters.

ALL biologists must be grateful to Prof. Karl Pearson for his extremely valuable and interesting paper reported in your issue of December 5, 1901 (p. 118). Inasmuch, however, as his conclusions are likely to be taken as the settled results of scientific research, it may be appropriate at this time to express certain doubts which naturally arise on reading the abstract. A man at the age of thirty, for example, possesses certain physical, intellectual and moral qualities. These must be due to more than one class of factors, and may possibly be due to three :—

(1) Heredity ; characters derived from ancestors, including for present purposes the results of normal variation.

(2) Environment.

(3) Soul ; supposing that the man is something more than an intelligent mechanism, and considering the possibility that his soul may have preexisted his advent here as an individual of *Homo sapiens*.

The third factor will be ridiculed by many, but if it has any reality it may eventually be capable of demonstration by just such methods as Prof. Pearson employs. The first and second factors are universally recognised.

Now it is apparent at once that the influence of the several factors is not the same on all the qualities of the man. Stature will depend almost wholly on the first set of factors, eye-colour wholly so. On the other hand, health will certainly depend largely on the second, so will shyness, intelligence, &c.

If, therefore, it is found that stature and eye-colour exhibit exactly (or almost exactly) the same degree of divergence from parental or fraternal standards as do health, shyness, &c., may it not be that this disproves just what it seems to prove, because A does not equal B, but equals $B+x$?

It may be said that the statistics given are based on pairs of brothers, whose environment must have been almost identical, and hence the second factor would not affect the divergence between them. But this appears a doubtful argument, because (1) the treatment of successive children is very commonly not the same, and the fact of being an elder child is itself influential ; (2) germinal selection must be supposed to be going on from the earliest moment of existence, and very slight environmental factors may make great ultimate differences.

There is another consideration, that of the stability of the different qualities in the race. Characters which were highly variable would not appear to be inherited to the same degree as those which were very stable. This might also appear in cases of atavism, where the pendulum of variability took an exceptionally long swing, going back to ancestral features of which we possessed no record. Thus let the inheritance be expressed by A B C D E A B C D E A B, &c., instead of A B A B A B, &c. In the former case our data might only cover A B C D, in the latter A B A B. We should say that the individuals of the latter series came very "true," those of the former not at all, though the result in the long run might be about the same in either case. Lest it be said that the former series is wholly imaginary, I will cite the case of the domestic dog. The ordinary mongrel street-dogs in a single town would afford material for several genera and very numerous species, judging them by the physical standards we employ for wild animals. Yet the domestic dog, taken as a whole, has not changed very much in long periods. That is to say, the extraordinary variability presented is not progressive under existing conditions, and we return sooner or later to about the starting point. T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., December 20, 1901.

I AM not unmindful of the possible influence of environment in increasing the correlation of brothers. I strongly suspect that home influences have a good deal to do with the rather exaggerated value for the fraternal correlation in the category of *conscientiousness*. But certain characters, *e.g.* the cephalic index after three years of age, the eye-colour between twenty and thirty

and the hair-colour from seven to fourteen are but little, in England at any rate, subject to environmental influence. The cephalic index remains almost constant throughout life. Now the mean value for the fraternal correlation for these three characters is 0·5161, and for stature, span, forearm and health, which might be supposed to be largely influenced by environment, it is 0·5179. It thus seemed to me that environment was not an important factor in modifying the correlation of the *physical* characters between brothers. In other words, *environment does not influence the constant uniformly in one direction.* This view was apparently appreciated by Prof. Cockerell when he wrote "the treatment of successive children is not the same." Any influence of environment, strange as it may seem, was thus found to be negligible. Turning to the intellectual characters, my own *a priori* conception was that I should for the first time be able to distinguish between nurture and heredity. I expected much higher correlations in the case of temperament and probity than in that of physique. I was therefore somewhat surprised when the values came out much the same as in the case of the physical characters, say an average of 0·5. Of course it is open to Prof. Cockerell to say that 0·3 of this only is due to heredity and 0·2 to environment, or whatever other division appears to him probable, but he will then have to explain why the sum of the two makes 0·5, and why the influence of heredity is less in the intellectual than it appears to be for the physical characters. There is the obvious direct scientific interpretation which seems to me the true one, environment does not act in one direction in *either* case, and the mental and physical characters are inherited precisely at the same rate. To those who have taken the trouble, as I have done, to examine carefully the mental characteristics of a family at intervals of a century apart, so that we are not troubled by the co-environment peculiar to brothers, it is needless, perhaps, to urge the very strong inheritance of mental qualities. If Prof. Cockerell attributes it to his third factor, "pre-existing soul," I should, indeed, be proud to have aided in the demonstration of its reality, although I fail entirely to see how it is to be done "by just such methods as Prof. Pearson employs." Meanwhile most people will, I think, prefer to stick to heredity.

Of the last paragraph of Prof. Cockerell's letter I understand not a word. Correlation is quite independent of variation, and although skull capacity is highly variable as compared with length of femur, I see no reason for supposing the former is therefore less strongly inherited than the latter.

I have not touched on the influence of "local races" on my data, because that appears to be a factor which has escaped Prof. Cockerell, and so I am not bound to state a doubt which I have well considered in order to reject it.

KARL PEARSON.

Magnetostriction of some Ferromagnetic Substances.

WE avail ourselves of your valuable Journal to give a short notice of some new results, obtained in our researches on magnetostriction, being a continuation of our investigation on the same subject, given in the "Rapports présentés au Congrès international de Physique," t. ii., by one of us.

It was generally believed that ferromagnetic bodies show change of length by magnetisation, but not of volume. Minute as the effect generally is, it is now placed beyond dispute that iron, nickel, cobalt and especially steel differ also in bulk in the magnetised state from that in the unmagnetised. In the course of our researches on the magnetostriction of different ferromagnetic bodies in the form of ovoids we came across a substance which shows a remarkably large increase of volume.

Examining the magnetostriction of reversible nickel-steels of different composition, which were kindly placed at our disposal by Dr. Guillaume and M. Dumas, we find that alloys containing 46 per cent., 36 per cent. and 29 per cent. of nickel all show increase of length several times greater than that observed in ordinary iron. But far more striking is the change of volume; of the three above-mentioned alloys, the effect increases as the percentage of nickel becomes less; with 29 per cent. alloy we observed a motion of 5 mm. of the liquid in the capillary tube (diam. 0·4 mm.) attached to the volumenometer containing the specimen (volume $v = 10$ c.cm.) under examination. Thus the greatest change of volume by magnetisation amounts to $\delta v/v = 51{\cdot}1 \times 10^{-6}$ in H = 1690 C.G.S. With ordinary iron, the same change $\delta v/v = 1{\cdot}2 \times 10^{-6}$ in the same field, being only about 1/40th of that observed in nickel-steel. The magnetisation of 25 per cent. nickel alloy is so feeble that it is impossible for it to be magnetometrically measured, and the change of length is inappreciably small, but the volume change is measurable and amounts to $0{\cdot}2 \times 10^{-6}$ in H = 1790. It is thus quite probable that there is an alloy containing somewhat more or less than 29 per cent. of nickel that indicates largest increase of volume by magnetisation.

We at first thought it would be possible to trace some connection between the thermal expansion and the change of length by magnetisation. No such relation seems to exist; the 36 per cent. alloy, which is the least expansible by heat, indicates tolerably large elongation by magnetisation.

As regards the Wiedemann effect, nickel-steels behave very much like iron, showing the maximum amount of torsion in moderate fields.

As is well known, the behaviour of cast cobalt, as regards the change of length by magnetisation, is opposite to that of iron, but the volume change in the same metal is much smaller. By annealing cobalt in a charcoal fire it assumes a pale ashy colour, and the magnetic character is greatly changed. The metal becomes less magnetisable, and shows constant decrease of length accompanied by increase of volume.

We have also found, by actual experiment, that the effect of stress on magnetisation and the magnetostriction in cobalt and in nickel-steel are reciprocally related to one another, as was already established for iron and nickel.

H. NAGASKA,
K. HONDA.

Physical Laboratory, Imperial University,
Tokyo, December 3, 1901.

Results of International Magnetic Observations made during the Total Solar Eclipse of May 17–18, 1901.[1]

To test further the results obtained by the United States Coast and Geodetic Survey magnetic parties during the total solar eclipse of May 28, 1900, regarding a slight magnetic effect that may be attributable directly to some change produced in the electrification of the upper atmospheric strata by the abstraction of the sun's rays due to the interposition of the moon between the sun and the earth, an appeal was made for international cooperation in magnetic and allied observations during the recent total solar eclipse.

The repetition of the observations was doubly interesting owing to the fact that the present eclipse occurred in the opposite magnetic hemisphere to that of the year 1900, and hence the opportunity was afforded for ascertaining whether the magnetic effect was reversed in its general character to that of 1900, as is, for example, the case with the diurnal variation in passing from one magnetic hemisphere to the other. The conditions, however, for obtaining observations at a number of stations distributed along the belt of totality, as was done in 1900, and thus testing whether the magnetic effect again followed directly in the wake of the shadow cone, were not favourable owing to the present location of the belt of totality.

In response to the appeal, simultaneous magnetic observations were made on May 17 from 14 to 21 o'clock Greenwich mean astronomical time—an interval amply covering the time of the eclipse—at a number of stations encircling the entire globe, three of which were in the belt of totality. The prime purpose of making the observations so as to cover the entire globe was to furnish the possibility of separating a possible eclipse magnetic effect from a contemporaneous magnetic storm of the usual type. The eclipse effect, for instance, doubtless would be confined to a very small belt, whereas a customary magnetic storm, in conformity with the usual experience, would manifest itself at practically the same moment of time over a very large area and thus be felt at stations far from the totality belt.

At none of the outside stations has a disturbance of any appreciable size been thus far reported to me, the general consensus of opinion of observers at these stations being that "nothing unusual occurred."

At the three stations within the belt of totality the majority of opinion is that something unusual did occur during the time of the eclipse.

[1] Presented before the meeting of the Astronomical and Astrophysical Society at Washington, December 30, 1901.

Thus at Karang Sago, where was situated the Dutch eclipse party, Dr. W. van Bemmelen, assistant director of the Batavia Magnetic Observatory, observed the changes in the magnetic declination and in horizontal intensity, and he reports the occurrence of "an extremely interesting magnetic effect." He has courteously sent me an extract of his observations, made during several days before and on the day of the eclipse, and there certainly appears evidence of a magnetic effect in both elements different from that observed on the days prior to the eclipse.

At Sawah Loento, the site of the Massachusetts Institute of Technology party of Boston, the variations in magnetic declination were observed by Mr. G. L. Hosmer on May 17 and 18. Comparing the two days' results for the interval of the eclipse, there is indisputable proof that something different occurred on the day of the eclipse than on the day before. Namely, at this station, situated so close to the magnetic equator, the range of the diurnal variation of the magnetic declination is about one minute of arc. The magnetic effect during the time of the eclipse was of about the same amount, so that a steady *decrease* of east declination resulted during the time of day when, normally, there is a steady *increase*.

There was but one magnetic observatory directly within the belt, viz. the one at Mauritius, and this was situated not far from the place of beginning of the eclipse. No special magnetic observations were made at this place, however, but regular photographic curves giving the variations in the magnetic elements were obtained. The declination and the vertical intensity curves apparently do not show any disturbance that could easily be picked out and referred to the eclipse. Regarding the horizontal intensity curve—the more sensitive one—Mr. Claxton states "that the original curve shows slight tremors between 7.15 and 7.50, and occasionally between 8.5 and 9.0 a.m." I have plotted this intensity curve on a larger scale, and find that the curve shows no very marked disturbance that might be readily referred to the eclipse, with the exception of one producing an easily perceptible bulge in the curve amounting to about 3–4 units in the fifth decimal C.G.S. units and lasting about 30 minutes. Anyway the effect, if there be one, is very minute, and will not be so readily separated from the usual diurnal variation as in the case of the two previous stations. Whether this is due to the fact that owing to the vicinity of Mauritius to the beginning of the eclipse the minute eclipse magnetic storm did not have time to develop itself or was just in the embryonic state cannot be said.

The magnetic effect observed at Karang Sago and at Sawah Loento does not appear to have extended very far outside the belt of totality, it being scarcely appreciable at the Batavia magnetic observatory.

My grateful and appreciative acknowledgments are due to all who have participated in this interesting investigation—one, to my mind, of fundamental importance to the theory of the diurnal variation of the earth's magnetism as elaborated by Schuster and von Bezold.

L. A. BAUER.

U.S. Coast and Geodetic Survey, Washington, D.C.
December 30, 1901.

The Roots of the Equation $u = \tan u$.

IN many treatises on optics it is stated that the roots of the equation, $u = \tan u$, were calculated by Schwerd. Verdet ("Oeuvres," t. v. p. 266), says:—"These roots have been calculated by Schwerd, who arrived at the following values: $u_1/\pi = 1{\cdot}4303$, $u_2/\pi = 2{\cdot}4590$, . . . " up to u_7/π. Preston ("Light," p. 255, second edition) says:—"The values of u corresponding to the maximum values of the illumination have been given by Schwerd as follows:—" The values given are precisely the same as Verdet's. Rayleigh ("Encyc. Brit.," vol. xxiv. p. 430, art., Wave Theory) gives a method for calculating the roots of the equation, and remarks that they were obtained in another manner by Schwerd. (There is a misprint in Rayleigh's value for u_4). Other references might be added.

Will someone kindly indicate where Schwerd gives the results referred to?

In his "Beugungserscheinungen" he shows that the roots of the equation are approximately the values of $(2n+1)\pi/2$, obtained by giving integral values to n; and he remarks (in § 63, p. 28) that for values $n=1$, and $n=2$, the true values of u differ by 12°·5 and 7°·5 from $3\pi/2$ and $5\pi/2$, respectively. In table i., at the end of the book, he gives values of the expression for the intensity, $\sin^2 u/u^2$, for values of u increasing by 15°; and at the foot of the table he states that the first and second maxima are at 257°·5 (*i.e.* 270° − 12°·5) and 442°·5 (*i.e.* 450° − 7°·5). Further details I have not found.

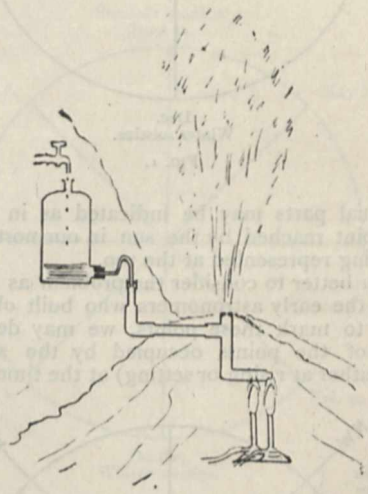
It may be remarked that the roots of the equation under consideration were given long before Schwerd's time. In Euler's "Introductio in Analysin Infinitorum" (Lausanne 1748) the question is fully discussed. See t. ii., cap. xx., prob. ix.

C. A. CHANT.

University of Toronto, December 27, 1901.

A Model Geyser.

IF the following working model, which was the outcome of a good many trials, is in any way original it may prove of interest, as it works automatically and with excellent effect as a geyser of regular period, suitable for a lecture table. The figure needs but little description. A small aspirator with a bent glass tube exit acts as an intermittent syphon. The water is discharged into a half-inch iron pipe, the long horizontal limb of which measures some 13 centimetres. The glass syphon tube slips through a rubber ring at the top of the pipe (gauge fitting), or a cork would doubtless answer the purpose. The lower closed end of the tube is heated by the equivalent of about four ordinary Bunsen burners, and should be placed as shown, as if placed



under the exit, steam is generated too fast and the water may be blown back into the aspirator. Water drips into the aspirator at such a rate that the syphon discharges about 300 c.c. of water once in every ten minutes. A jet of steam some six feet high and water some two feet high results, with many appropriate gurglings. The diameter of the exit is about 6 millimetres. Of course the apparatus is concealed; a large circular tin canister to which the iron pipe is screwed forms a good foundation and serves to keep the water off the burners. Furnace clinker, which is not wholly unsuitable, forms a readily obtainable material for completing the external features of the geyser.

Felsted, January. A. E. MUNBY.

Birds Capturing Butterflies in Flight.

WITH reference to Mr. Latter's letter in NATURE of November 16, 1899 (vol. lxi. p. 55), which has been brought to my notice, I would say that the supposition that birds do not attack butterflies in flight is not strictly correct.

The common King Crow (*Dicrurus ater*, I believe) invariably captures butterflies on the wing; I have seen these birds scores of times do this. Their usual prey seems to be a small deep yellow butterfly with black on the tip of the wings, but I have occasionally seen other butterflies so captured by them.

India, December 18, 1901. A. E. MCKAY.

THE FARMERS' YEARS.

I.

SOME years ago in the "Dawn of Astronomy" I showed how carefully the sun had been observed by the ancient Egyptians, not only when it rose or set at points most to the north or south, as at the solstices, but also when it rose exactly half-way between these points, that is, east and west at the equinoxes.

This fundamental division of the sun's apparent revolution and course which define our year into four

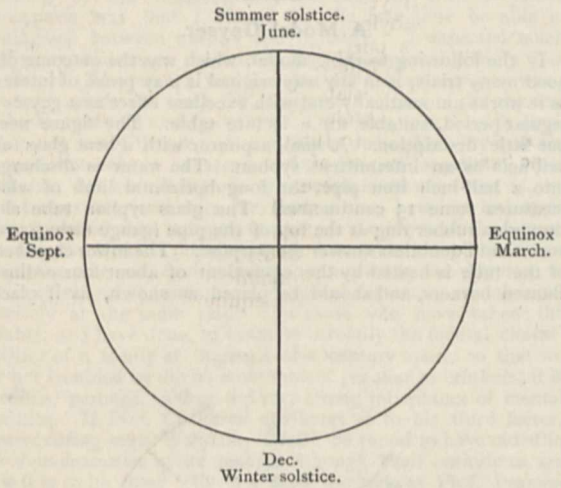


FIG. 1.

nearly equal parts may be indicated as in Fig. 1, the highest point reached by the sun in our northern hemisphere being represented at the top.

In order better to consider the problem as it was presented to the early astronomers who built observatories (temples) to mark these points, we may deal with the bearings of the points occupied by the sun on the horizon (either at rising or setting) at the times indicated.

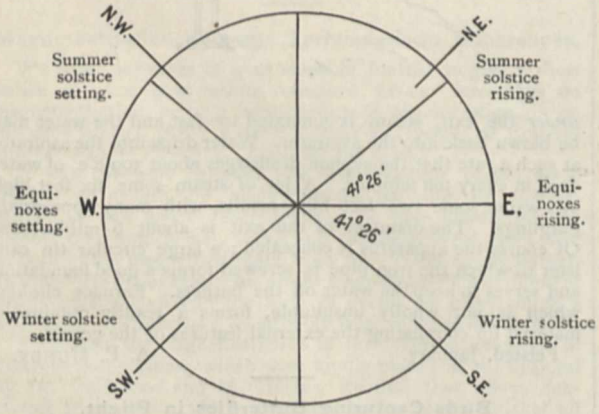


FIG. 2.—The various bearings of the sun risings and settings in a place with a N. latitude of 51°.

These points are conveniently defined by their "amplitude" or their distance in degrees from the E. or W. points of the horizon. In the diagram (Fig. 2) I represent the conditions of our chief British sun-temple, Stonehenge, in latitude 51° N. approximately.

Taking the astronomical facts regarding the solstices and equinoxes for the first year (1901) of the present century, we find :—

Sun enters Aries,	Spring equinox,	March 21.
,, ,, Gemini,	Summer solstice,	June 21.
,, ,, Libra,	Autumn equinox,	September 23.
,, ,, Sagittarius,	Winter solstice,	December 23.

These points, then, are approximately ninety-one days apart ($91 \times 4 = 364$).

In Fig. 2 I deal with the "amplitudes" at Stonehenge, that is, the angular distance along the horizon from the E. and W. points, at which the sunrise and sunset at the solstices are seen, the equinoxes being seen at the E. and W. points themselves. But as these amplitudes vary with the latitude and therefore depend upon the place of observation, a more general treatment is possible if we deal with the declination of the sun itself, that is, its angular distance from the equator.

The maximum declination depends upon the obliquity of the ecliptic, that is, the angle between the plane of the ecliptic and that of the equator at the time of observation. When the Stonehenge Sarsen Stones were erected this angle was 23° 54′ 30″. Its mean value for the present year is 23° 27′ 7″ ; it is decreasing very slowly.

It will be obvious from Fig. 2 that in temples built to observe the solstices or equinoxes, if they were open at both ends, looking in one direction we should see the sun rising at a solstice or equinox, and looking in the other we should see the sun setting at the opposite one. This, however, interfered with the ceremonial, which required that the light should illuminate a naos generally dark, so, usually, two temples were built back to back, with a common axis, as at Karnak.

In the beginning of astronomical observation it was more easy to align accurately a solstitial temple than an equinoctial one.

So much, then, for the chief points in what we may term the astronomical year, those at which the sun's declination is greatest and least. We see that they are approximately ninety-one days apart—say three months.

Now the priest-astronomers in these temples could only have won and kept the respect of the agricultural population with which alone they were surrounded in early times, and by whom they were supported, by being useful to them in some way or another. This could only have been in connection with what we may term generally the *farming* operations necessary at different times of the year, whether in the shape of preparing the ground or gathering the produce.

A very large part of mythology has sprung out of the temple cults, prayer, sacrifice and thanksgiving connected with these farming operations, in different lands and ages, but it is not my purpose to touch upon this side of the question now at length.

I wish to show, however, that by studying the orientation of ancient temples erected to watch the sunrise and sunset at times other than the solstices or equinoxes an immense amount of information may be gained if we endeavour to find the way in which the problem must have been attacked before the year was thoroughly established, and when it was still a question of grass- or corn-kings or gods who had to be propitiated.

In a solstitial temple the sun only makes its appearance once a year, when it reaches its greatest "north or south" declination: but in the temples dealing with lower declinations the sun appears twice, once on its journey from the summer to the winter solstice, and again on its return.

The first difficulty of the inquiry in the direction I have indicated arises from the fact that the products of different countries vary, and that identical farming operations have to be carried on at different times in these countries. We must, then, begin with some one country, and as the record is fullest for Greece I will begin with it.

The first thing we find is that the chief points in the farmer's year in Greece are about as far from the fixed points in the astronomical year as they well can be.

In the Greek information so admirably collated by M. Ruelle in the article on the calendar in Daremberg and Saglio's monumental "Dictionnaire des Antiquités Grecs et Romains," the earlier Gregorian dates on which the seasons were reckoned to commence in ancient Greece were as follows:—

Summer	May 6
φθινόπωρον	August 11
Winter	November 10
Spring	February 7

I may also add from the same source that in the calendars of the Latins the dates become:—

Summer	May 9
Autumn	August 8
Winter	November 9
Spring	February 7

Now we see at once that these dates are, roughly, halfway between the solstices and equinoxes.

This, then, at once brings us back to the orientation problem, which was to fix by means of a temple in the ordinary way dates nearer to these turning points in the local farmer's years than those fixed by the solstitial and equinoctial temples.

It must be borne in mind that it is not merely a question of stately piles such as Karnak and the Parthenon in populous centres, but of the humblest dolmen or stone circle in scattered agricultural communities, which were as certainly used for orientation purposes, that is, for recording the return of some season of the year important to the tiller of the soil, the advent of which season could be announced to outlying districts by fire signals at night.

I have already pointed out that any temple, dolmen or cromlech pointed to a sunrise or sunset at any dates between the solstices will receive the sunlight twice a year.

If the temple is pointed nearly solstitially the two dates at which the sun appears in it will be near the solstice; similarly, for a temple pointed nearly equinoctially the dates will be near the equinox; but if the ancients wished to divide the ninety-one days' interval between the solstice and equinox, a convenient method of doing this would be to observe the sun at the half-time interval, such that the same temple would serve on both occasions. This could be done by orienting the temple to the sun's place on the horizon when it had the declination 16° 20′ on its upward or downward journey.

What, then, are the non-equinoctial and non-solstitial days of the year when the sun has this declination?

They are, in the sun's journey from the vernal equinox to the summer solstice and back again,

May 6 and August 8 ... ... Sun's decn. N. 16° 20′.

Similarly, for the journey to the winter solstice and return we have

November 8 and February 4 ... Sun's decn. S. 16° 20′.

We get, then, a year symmetrical with the astronomical year, which can be indicated with it as in Fig. 3, a year roughly halving the intervals between the chief dates of the astronomical year.

With regard to the dates shown I have already pointed out that farming operations would not occur at the same time in different lands; that ploughing and seed time and harvest would vary with crops and latitudes; and I must now add that when we wish to determine the exact days of the month we have to struggle with all the difficulties introduced by the various systems adopted by different ancient nations to bring together the reckoning of months by the moon and of years by the sun.

In more recent times there is an additional difficulty owing to the incomplete reconstruction of the calendar by Julius Cæsar, who gave us the Julian year. Thus, while the spring equinox occurred on March 21 at the time of the Council of Nice, in 325 A.D., by the year 1751 the dating of the year on which it took place had slipped back to the 10th. Hence the Act 24 George II. c. 23, by which September 2, 1752, was followed by September 14 instead of by the 3rd, thus regaining the eleven days lost. This change from the so-called "old style" to the "new style" is responsible for a great deal of confusion.

Another cause of trouble was the forsaking by the Jews of the solar year, with which they commenced, in favour of the Babylonian lunar year, which has been continued for the purposes of worship by Christians, giving us "movable feasts" to such an extent that Easter Day, which once invariably marked the spring equinox, may vary from March 22 to April 25, and Whit Sunday from May 10 to June 13. It is at once obvious that no fixed operations of Nature can be indicated by such variable dates as these.

Hence in what follows I shall only deal with the months involved; these amply suffice for a general statement, but a discussion as to exact dates may come later.

With regard to the astronomical year it may be stated that each solstice and equinox has in turn in

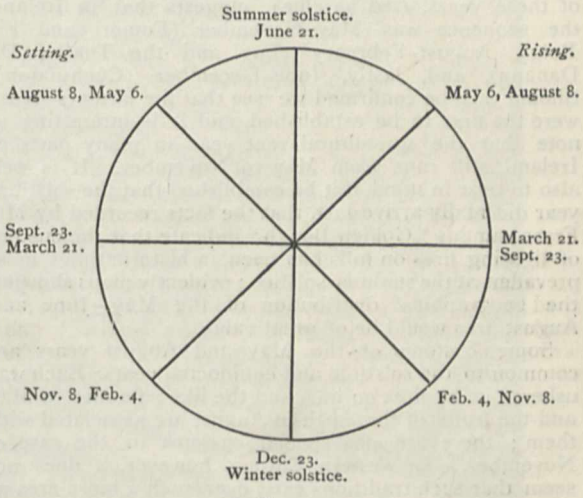


FIG. 3.

some country or another, and even in the same country, been taken as the beginning of the year.

We have, then, the following, so to speak, astronomical years:—

Solstitial Year.	June	December	June
	December	June	December
Equinoctial Year.	March	September	March
	September	March	September

Next, if we treat the intermediate points we have found in the same way, we have the following vegetation years:—

Flower Year.	May	November	May
	November	May	November
Harvest Year.	August	February	August
	February	August	February

It will have been gathered from Fig. 3 that the temples or cromlechs erected to watch the first sunrise of the May–November–May year could also perform the same office for the August–February–August year; and in a

stone circle the priests, by looking along the axis in an opposite direction, could note the sunsets marking the completion of the half of the sun's yearly round in November and February.

Now to those who know anything of the important contributions of Grimm, Rhŷs, Fraser, and many others we might name, to our knowledge of the mythology, worships and customs in the Mediterranean basin and western Europe, an inspection of the first columns in the above tables will show that here we have a common meeting ground for temple orientation, vegetation and customs depending on it, religious festivals and mythology. From the Egyptian times at least to our own a generic sun god has been specifically commemorated in each of the named months. Generic customs with specific differences are as easily traced in the same months; while generic vegetation with specific representatives proper to the season of the year has been so carefully regarded that even December, though without May flowers or August harvests, not to be outdone, brings forward its offering in the shape of the berries of the mistletoe and holly.

With regard especially to the particular time chosen for sun-worship and the worship of the gods and solar heroes connected with the years to which I have referred, I may add that a cursory examination of Prof. Rhŷs' book containing the Hibbert lectures of 1886, in the light of these years, used as clues, suggests that in Ireland the sequence was May–November (Fomori and Fir Bolg), August–February (Lug and the Tuatha Dé Danann), and, lastly, June–December (Cúchulainn). Should this be confirmed we see that the farmers' years were the first to be established, and it is interesting to note that the agricultural rent year in many parts of Ireland still runs from May to November. It is well also to bear in mind, if it be established that the solstitial year did really arrive last, that the facts recorded by Mr. Fraser in his "Golden Bough" indicate that the custom of lighting fires on hills has been in historic times most prevalent at the summer solstice; evidently maps showing the geographical distribution of the May, June and August fires would be of great value.

Some customs of the May and August years are common to the solstitial and equinoctial years. Each was ushered in by fires on hills and the like; flowers in May and the fruits of the earth in August are associated with them; there are also special customs in the case of November. In western Europe, however, it does not seem that such traditions exist over such a large area as that over which the remnants of the solstitial practices have been traced.

I have pointed out that both the May and August years began when the sun had the same declination (16° N.) or thereabouts; once, on its ascent from March to the summer solstice in June, again in its decline from the solstice to September. Hence it may be more difficult in this case to disentangle and follow the mythology, but the two years stand out here and there.

With regard to August, Mr. Penrose's orientation data for the panathenæa fix the 19th day (Gregorian) for the festival in the Hecatompedon; similar celebrations were not peculiar to western Europe and Greece, as a comparison of dates of worship will show.

Hecatompedon	April 28 and	August 16
Older Erectheum	April 29 ,,	August 13
Temple of Min, Thebes ...	May 1 ,,	August 12
,, Ptah, Memphis ...	April 18 ,,	August 24
,, ,, Annu ...	,, ,,	,,
,, Diana, Ephesus...	April 29 ,,	August 13

In the above table I have given both the dates on which the sunlight (at rising or setting) entered the temple, but we do not know for certain, except in the case of the Hecatompedon, on which of the two days the temples were used; it is likely they were all used on both days, and that the variation from the dates proper to the sun's declination of 16° indicates that they were very accurately oriented to fit the local vegetation conditions in the most important and extensive temple fields in the world.

This is the more probable because the Jews also after they had left Egypt established their feast of Pentecost fifty days after Easter = May 10,[1] on which day loaves made of newly harvested corn formed the chief offering.

With regard to the equinoctial year, the most complete account of the temple arrangements is to be found in Josephus touching that at Jerusalem. The temple had to be so erected that at the spring equinox the sunrise light should fall on, and be reflected to the worshippers by, the sardonyx stones on the high priest's garment. At this festival the first barley was laid upon the altar.

But this worship was in full swing in Egypt for thousands of years before we hear of it in connection with the Jews. It has left its temples at Ephesus, Athens and other places, and with the opening of this year as well as the solstitial one the custom of lighting fires is associated, not only on hills, but also in churches.

Here the sequence of cult cannot be mistaken. We begin with Isis and the young sun-god, Horus, at the pyramids and we end with "Lady day," a British legal date; while St. Peter's at Rome is as truly oriented to the equinox as the pyramids themselves, so that we have a distinct change of cult with no change of orientation.

If such considerations as these help us to connect Egyptian with Celtic worships we may hope that they will be no less useful when we go further afield. I gather from a study of Mr. Maudslay's admirable plans of Palenque and Chichén-Itzá that the solstitial and farmers' years' worships were provided for there. How did these worships and associated temples with naos and sphinxes get from Egypt to Yucatan? The more we know of ancient travel the more we are convinced that it was coastwise, that is, from one point of visible land to the next. Are the cults as old as differences in the coastlines which would most easily explain their wide distribution?

NORMAN LOCKYER.

(*To be continued.*)

HABITS OF INSECTS.[2]

SEVEN volumes of M. Fabre's observations on insects have been published between 1879 and 1890, under the title of "Souvenirs Entomologiques," containing the results of long and patient investigations into the habits of insects of the south of France; and we are glad to see the first volume translated into English in its entirety. It is much better to begin at the beginning, rather than to issue merely a selection from the seven volumes, which was what we had expected to find when we opened the book. The English edition is tastefully got up, and the illustrations are attractive. We may say that there are none in the French except a few text-illustrations in some of the later volumes of the series. The English title, "Insect Life," is, however, somewhat objectionable, as there are already other English and American books bearing the same title.

The first volume, now to be noticed, includes twenty-two chapters, relating to the habits of the Sacred Beetle,

[1] Compare this with the fifty maidens who ran away from the Ultonian court (Rhŷs, "Hibbert Lectures," p. 434).

[2] "Insect Life: Souvenirs of a Naturalist." By J. H. Fabre, Docteur ès Sciences. Translated from the French by the author of "Mademoiselle Mori." With a preface by David Sharp, M.A., F.R.S., and edited by F. Merrifield. With illustrations by M. Prendergast Parker. Pp. xii+320. (London: Macmillan and Co., Ltd., 1901.) Price 6s.

various fossorial Hymenoptera of the genera Cerceris, Sphex, Ammophila and Bembex, and the Mason Bees of the genus Chalicodoma; and the volume is varied by autobiographical reminiscences and an account of an ascent of Mont Ventoux. It is interesting to learn that M. Fabre's enthusiasm for entomological investigation was excited by his accidentally meeting with a pamphlet of Léon Dufour's on the habits of Cerceris as long ago as 1843. These observations, as the present volume shows, M. Fabre continued and completed with great success.

As regards the Sacred Beetle, M. Fabre considers that he has quite disproved the old idea that the balls of dung rolled by the beetle ever contain eggs; they are simply stores of food, and the real nest prepared for the egg is constructed underground later in the year.

M. Fabre's observations on the limitations of instinct in Hymenoptera are most curious and interesting, but are too long to be discussed here in detail; for these the book itself must be consulted. Suffice it to say, however, that they throw no light on the nature of instinct itself, which remains more mysterious than ever; but only illustrate its manner of working.

The translation is very readable, sufficiently so to arrest the attention of a mere child who feels an interest in insects, notwithstanding that it sometimes deals with problems that no man living can yet answer. As an instance of the style of the book we will quote a portion of M. Fabre's account of the Praying Mantis:—

"A word more of the 'Praying Mantis,' the *Prégo Diéou*, as it is called in Provence, *i.e.* the Pray-to-God. And indeed its long pale green wings, like ample veils, its head upraised to heaven, its arms folded and crossed on its breast, give it a false resemblance to a nun in ecstatic devotion. All the same, it is a ferocious creature, bent on carnage. Although not especially favourite hunting-grounds, the workshops of various burrowing Hymenoptera are often visited by it. Posted on some bush near the burrows, it waits until chance brings some Sphex returning home within reach, thus achieving a double capture, catching together Sphex and prey. Its patience is long tried; the Sphex is suspicious and on her guard, but from time to time a rash one lets herself be caught. By a sudden rustle of half-spread wings, as by a convulsive movement, the Mantis terrifies the approaching Sphex, which hesitates for a moment, and then with the suddenness of a spring the toothed forearm folds back on an arm also toothed, and the insect is seized between the blades of the double saw, as though the jaws of a wolf-trap were closing on the beast as it takes the bait. Then, without unclosing the cruel machine, the Mantis gnaws little mouthfuls of its victim. Such are the ecstasies, the prayers, and the mystic meditations of the *Prégo Diéou*."

We hope the work will be completed by the translation of the remaining volumes of the series. At the same time, we regret to note that a few glaring technical errors in the translation have escaped notice. "Pattes" is usually translated "feet," but in almost every case "legs" would be the proper rendering. But what are we to think of such a passage as this, on p. 36, where the word "doigt" of the original, used for the five-jointed tarsus, is translated "claw"? "One claw to each foot is the rule, and this claw, at least in the case of the superior Coleoptera, especially the scavenger beetles, contains five joints." Again, in chapter ix., it is clear that the translator does not understand the real meaning of the terms "grillon," "criquet" and "acridien," and has sadly mixed them up, reversing "grasshoppers" and "crickets" in more than one passage. But when we object to "*Bupresticis micans* and *Buprestis flavomaculata*" beneath the plate opposite p. 46, we have exhausted our fault-finding, and warmly recommend the book to the attention of all who are interested in the habits of insects and the many curious problems which they offer for our investigation.

FIG. 1.—The Sphex of Languedoc and its enemy, the Praying Mantis.

SOME SCIENTIFIC CENTRES.

III.—THE LABORATORY OF HENRI MOISSAN.

THE isolation of the element fluorine in 1886, the result of a long series of investigations carried out with an enthusiasm and manipulative skill and natural resourcefulness amounting to genius, has ensured Henri Moissan a high place in the history of modern chemistry.

His appointment in 1900 to fill the chair at the Sorbonne, rendered famous by its association with the names of the illustrious Dumas and Sainte-Claire Deville, sets a seal on a career of splendid activity.

Born in Paris in the year 1852, he commenced the systematic study of chemistry in the laboratory of the late M. Paul Dehérain at the Muséum d'Histoire naturelle. His first researches were in the direction of vegetable physiology, and in 1874 he made his *début* in a paper on the respiration of plants.

In the meantime, from 1872 until 1876, he was attending the course of Henri Sainte-Claire Deville. Under the influence of this teacher his interest was aroused in "la chimie minérale," and he carried out several investigations on the nature of the various oxides of iron, amalgams and the salts of chromium.

Obtaining his degree of "Docteur ès Sciences" in 1880, he received an appointment on the staff of the École de Pharmacie as "chef des travaux pratiques de I^re^ année." In spite of the laborious routine duties of his position, he found time to commence the examination of some of the compounds of fluorine "in the uncertain hope of at last being able to isolate the element." The next three years find him engaged on the problem which had baffled investigators from the time of Davy onwards. With patient and indefatigable zeal he continued, bearing up under repeated failure, and accumulating that valuable experience which enabled him to triumph over difficulties, and in 1886 to announce to the world that his efforts had been crowned with success. Fluorine was at length a chemical fact.

Before going on to describe the experiments by which Moissan led up to his final result, it will be interesting to glance at the attempts of previous workers and view them in the light of later discoveries; we shall then be in a better position to appreciate the value and the scope of his research.

Margaff and Scheele commenced the investigation of hydrofluoric acid in the latter half of the eighteenth century. Davy devoted considerable time to the isolation of the hypothetical element, and suffered a severe illness from breathing the fumes of the acid: he advised chemists to take special precautions against its action on the skin and lungs. Gay Lussac and Thénard fared in the same way. Knox, after repeating the work of Aimé, a French chemist, who attempted to replace fluorine by chlorine in silver fluoride, had to recruit his health in Italy for three years. Louyet, the next worker on the subject, paid the price of his enthusiasm with his life.

Frémy, in 1850, was the first to obtain anhydrous hydrofluoric acid, but the failure of his laborious researches seemed only to discourage further efforts in that direction; and, with the exception of some work by Gore in 1869, nothing more was attempted. Chemists accepted the inevitable, and were content to wait. Moissan, in approaching the subject in 1880, may be supposed to have recognised the dangers as well as the difficulties of his task.

The various experiments which culminated in the isolation of the element fall under four headings.

First of all Moissan made use of the fact that the high temperature of the electric spark is often capable of splitting up binary compounds into their constituent elements. He tried its effect on certain gaseous fluorides. Those of silicon and carbon were unaffected by it. The trifluoride of phosphorus was decomposed, probably into phosphorus and fluorine, but the latter element immediately combined with the excess of undecomposed trifluoride, and yielded the pentafluoride; thus

$$5PF_3 = 3PF_5 + 2P.$$

He then tried the pentafluoride, but found it far more stable than the corresponding chloride. It only split up under the influence of a very strong spark. Since the experiment had to be made in a glass vessel over mercury, it resulted only in the formation of the fluorides of mercury and silicon.

The trifluoride of arsenic was equally unsatisfactory. It was vaporised and sparked. There was reason to believe that decomposition occurred, but from the conditions of the experiment it was impossible to isolate the element.

Moissan now adopted a different plan of attack. Frémy had noticed that platinum fluoride, produced accidentally in one of his experiments, splits up under the influence of heat into platinum and fluorine. It was only logical to assume that, if the fluoride could be formed at a dull red heat, a sudden rise in temperature would result in the liberation of the element. The difficulty, however, was to obtain the platinum fluoride. On heating platinum in a current of the trifluoride of phosphorus, combination occurred, but not in the way desired, the chief product being a fluorophosphide of platinum.

Similar experiments with the pentafluoride of phosphorus indicated the hopelessness of expecting the desired result from work carried on at so high a temperature.

Moissan now had recourse to electrolysis. In the first instance he used trifluoride of arsenic contained in a platinum vessel, and found that if the material were quite pure and dry (B.P. 63°) it was decomposed into its elements. The fluorine, however, combined at once with the undecomposed trifluoride to form the penta-compound, while the arsenic sank to the bottom of the vessel, or remained suspended in the form of fine particles in the liquid.

It was found impossible to prepare the pentafluoride of arsenic by any chemical process, so that this substance, which would probably have solved the difficulty, had to be abandoned. The extremely poisonous nature of the arsenic compounds also rendered it desirable, if not indeed necessary, to find some more convenient electrolyte.

Moissan now returned to the early experiments of Davy, and took up the investigation of the effect of the electric current upon hydrofluoric acid. As both products of the electrolysis might be expected to be gaseous, a platinum U-tube had to be employed, so that the gases could be separated at the moment of their liberation. Further, to ensure the complete liquefaction of the acid, which boils at +19°·5 C., the apparatus was immersed in a bath of methyl chloride (B.P. −23° C.).

His first experiments confirmed the results which Davy had obtained, and which later on Faraday and Gore had explained, viz. that the anhydrous acid is a non-conductor. Moissan showed, in addition, that if the acid contains a small quantity of water, this latter is decomposed, until only the anhydrous acid remains in the U-tube, when the current ceases to pass. It was necessary, therefore, to add to the acid some substance which would enable it to conduct the electricity; such a substance is the acid potassium fluoride having the formula KF . HF. This can be obtained quite pure, and is very soluble in the anhydrous acid.

By this means it was found possible to decompose the hydrogen fluoride. The fluorine, however, immediately attacked the corks which had been covered with paraffin. Fluorspar stoppers were therefore substituted, and the experiment repeated. Hydrogen was evolved at the negative pole. In the other limb there collected an

apparently colourless gas with a penetrating disagreeable odour resembling that of hypochlorous acid. It was endowed with exceedingly active chemical properties. Hydrogen combined with it with explosive violence; most of the non-metals burnt in it, while the metals were less vigorously attacked. All organic substances were immediately decomposed.

Three hypotheses suggested themselves as to the nature of the gas. First, that it was a mixture of ozone and hydrofluoric acid. No such mixture, however, was found to exhibit the properties already described. Secondly, that it was a perfluoride of hydrogen; and thirdly, that it was the wished-for fluorine itself. This last point was settled by studying the action of water on the gas.

In the first case

$$\underset{4\text{ vols.}}{2HF_2} + H_2O = 4HF + \underset{1\text{ vol.}}{O}.$$

In the second

$$\underset{2\text{ vols.}}{F_2} + H_2O = 2HF + \underset{1\text{ vol.}}{O}.$$

By measuring the volume of oxygen liberated and titrating the quantity of hydrofluoric acid formed, Moissan was able to decide in favour of the third hypothesis: the gas must be fluorine.

The value of this work was at once recognised. Moissan was rewarded with the chair of "Toxicologie" at the "École de Pharmacie." "J'avais donc," he says, in a letter to the present writer, "très jeune un laboratoire, et un préparateur; quelques élèves vinrent se grouper autour de moi, et toute mon ambition fut satisfaite."

His faculties now had free play; he was able to work on a wider basis, and became one of the most prolific contributors to the *Comptes rendus*.

The isolation of fluorine was naturally followed by a systematic examination of its properties and derivatives. This work is still being carried on; recently, however, M. Moissan collected and published in one volume[1] the results he has obtained. They are all interesting, and some of great theoretical importance.

He found it more convenient and less costly to carry out the electrolysis of the anhydrous acid in a U-tube made of copper immersed in a mixture of acetone and solid carbonic acid, *i.e.*, at a temperature of $-50°$ C. The electrodes as before were of platinum isolated from the apparatus by means of stoppers of fluorspar. The fluorine thus obtained was purified by passing it through a spiral cooled to $-50°$ C., and then through a horizontal tube containing fragments of sodium fluoride; thus the hydrofluoric acid was removed. Perfectly dry fluorine which has been passed through a spiral immersed in liquid air, to solidify any traces of hydrofluoric acid remaining, has no action on dry glass even at the ordinary temperature.

It possesses a slightly greenish-yellow colour, paler than that of chlorine. It unites with greater or less violence with all the non-metals save oxygen, nitrogen and argon; the compounds being sometimes gaseous, and sometimes solid. The tri-, penta- and oxy-fluorides of phosphorus have been studied very completely; as also the fluoride of arsenic (AsF_3) and the tetrafluoride of carbon.

In the case of the metals the action is not so energetic the solid fluoride formed on the surface of the metal preventing further combination.

The metals of the alkalis and alkaline earths take fire in the gas; lead combines slowly. Magnesium, aluminium, nickel and silver on slightly heating burn brightly on contact with the gas. Manganese heated in a current of fluorine yields a sesquifluoride, Mn_2F_6; this on further heating splits up into the difluoride, MnF_2, and liberates fluorine. Gold and platinum are unattacked in the cold, but combine at a dull red heat; the platinum fluoride has the formula PtF_4; at a higher temperature the gold and platinum compounds are decomposed into fluorine and the respective metal.

FIG. 1.—Prof. Moissan in his private laboratory.

Organic compounds rich in hydrogen are violently attacked by fluorine, and totally decomposed into hydrofluoric acid, and fluorides of carbon. Organic acids are attacked more slowly; amines and alkaloids are rapidly burnt up or decomposed into volatile products.

By indirect reactions involving the use of the fluorides of silver and zinc, Moissan and Meslans have been able to prepare and examine the properties of methyl, ethyl and isobutyl fluorides, fluoroform, acetyl fluoride, and a few other derivatives.

The latest determination gives the atomic weight of the element as 19·05.

A general survey of its chemical and physical properties confirms the surmises of Ampère and Davy: fluorine falls naturally into place at the head of the so-called "natural group" chlorine, bromine, and iodine.

[1] "Le Fluor et ses composés." Par Henri Moissan. (G. Steinheil, Paris, 1900.)

In 1896, Moissan and Dewar, working in collaboration, effected the liquefaction of fluorine by passing it through a tube cooled in liquid air which was allowed to boil freely. The B.P. of liquid fluorine is about - 187°. The liquid does not solidify even at -210°. Its density is 1·14; it exhibits no absorption spectrum, and is not magnetic. It is soluble in all proportions in liquid air and oxygen. Liquid fluorine has no chemical action on liquid oxygen, solid mercury, or ice; but even at -210° it combines with hydrogen, and decomposes benzene with violence, and production of light and heat. It would be interesting to know the order in which the elements cease to react with fluorine as the temperature falls.

We must also refer to the hexafluoride of sulphur prepared by Moissan and Lebeau in April of 1900. It is obtained by the action of excess of fluorine on sulphur; it is one of the heaviest gases known, having a density of 5·03. Its composition, which is represented by the formula SF_6, completely establishes the hexatomic nature of the sulphur atom. It is of interest also on account of its inertness; it is unattacked by fused sodium or potassium. Resulting as it does from the union of two such active elements as sulphur and fluorine, which in combining seem thus to saturate one another completely, this compound may be regarded as additional evidence in favour of the theory of valency, though a chemical Ishmael might view it in a different light.

While engaged in studying the compounds of fluorine, Moissan's interest was aroused in the element boron; he obtained the amorphous variety in quantity, and caused it to unite with iodine, sulphur and phosphorus; he examined the action of alkali metals on boric acid, and, as we shall see later, in speaking of the electric furnace, prepared the carbide BC.

In 1891 the coveted honour of a seat in the Académie des Sciences was conferred upon him in recognition of his brilliant work. Cahours had died. To fill his place the names of Moissan, Grimaux, Ditte, Jungfleisch and Le Bel were submitted to the Comité. After a discussion lasting nearly two hours it was decided to nominate Moissan and Grimaux for election. The latter was defeated by eleven votes, and Moissan became the *confrère* of Berthelot, Friedel, Schützenberger and Troost.

The difficulty which was now hampering his work was one of temperature; he required a source of heat greater than that obtainable from the oxyhydrogen flame, and had recourse to the electric arc. In 1892 he devised the electric furnace, by means of which in its more perfect form a temperature of 3500° C. could be readily attained. The first result was the production of uranium from its oxide in fair quantities. Metals hitherto considered refractory yielded at once to the intense heat, and the electric furnace became in his hands the source of good specimens of chromium, tungsten, titanium, molybdenum, vanadium, zirconium, &c., all obtained from their oxides by reduction with charcoal.

In the following year, 1893, came the production of artificial diamonds, and Moissan's name became the prey of newspaper men and popular lecturers; chemistry began to appeal to the man in the street.

Moissan now took up the compounds of carbon with the metals, and obtained a whole series, comprising the carbides of sodium, potassium, calcium, strontium, barium, yttrium, lanthanum, thorium, aluminium, titanium, zirconium, chromium, uranium and manganese, and of the metalloids, boron and silicon. Quite recently he has added the carbides of neo- and praseo-dymium to the list. Proceeding in the same way with silicon and boron, he prepared the silicides of iron, chromium, tungsten, titanium, molybdenum, &c., and the borides of iron, nickel, cobalt, titanium, molybdenum, calcium, strontium and barium.

In 1898 he succeeded in his efforts to make calcium assume the crystalline form by dissolving it in sodium at a dull red heat, and dissolving away the sodium by absolute alcohol; from this crystalline variety he was able to pass to the hydride, nitride and phosphide of the element. By the electrolysis of fused calcium iodide he was the first to obtain the metal calcium in a state of purity.

When this series of experiments is completed, we shall be in a position to generalise from his results. Not the least interesting feature of the work is the bearing it will have on the Periodic classification; in this connection it should be of supreme importance.

But for the present we must be content with this necessarily brief *résumé* of the scientific work of Henri Moissan. As an experimenter he is unrivalled. "J'avais commencé à manipuler," he says, "de l'âge de 14 à 15 ans; et mes premières leçons de chimie, données par mon père, sont encore gravées dans ma mémoire." He is no theorist in the ordinary sense of the word. His work has been confined to the sphere of the purely practical; and for him a theory exists only that it may be submitted to the test of rigorous experiment, and for the sake of what it leads to. We can conceive of him working out a theory for the origin of diamonds; we find it difficult to conceive of him formulating a theory for the origin of man.

Unlike his distinguished compatriots, M. Berthelot and the late C. Friedel, who worked in both fields, organic and inorganic, Henri Moissan has remained true to the enthusiasm inspired by his first great teacher, Deville. "Je me suis appliqué à cultiver cette chimie minérale que l'on croyait épuisée, et je pense que mes travaux, ainsi que les belles recherches des savants anglais, ont pu démontrer que cette science réserve encore bien des dècouvertes à ceux qui voudront l'aimer et l'étudier avec tenacité." "To love it and pursue it with zeal" is the secret of Moissan's success, as it was of that of Davy and Faraday and Lavoisier.

In the midst of the gayest capital of Europe, but untouched by all the vicissitudes of its political life, he lives and works. "Ma vie a eu toute la simplicité de ma carrière de professeur, et mon existence s'est partagée, heureuse jusqu'ici, entre mon laboratoire et ma maison." We can only wish him a continuance of this happiness, and in his new sphere an equal measure of success. The Science Faculty of the University of Paris is to be congratulated on the acquisition of so eloquent and so distinguished a teacher.

NOTES.

THE Geological Society of London will this year award its medals and funds as follows:—The Wollaston medal to M. Friedrich Schmidt of St. Petersburg, the Murchison medal to Mr. F. W. Harmer, and the Lyell medals to Mr. R. Lydekker and Prof. Anton Fritsch, of Prague; the Wollaston fund to Mr. L. J. Spencer, the Murchison fund to Mr. T. H. Holland, the Lyell fund to Dr. Wheelton Hind, and the Barlow-Jameson fund to Mr. W. M. Hutchings.

PROF. J. H. MARSHALL, who for three years past has been associated with Mr. Bosanquet in archæological researches at Athens, has been appointed Director-General of the Archæological Survey of India, for a period of five years in the first instance.

THE objects found during the recent excavations at Stonehenge will be on view in the library of the Anthropological Institute, Hanover Square, until January 21.

A MEDALLION bust of Sir George Airy is to be placed in the north-east wall of St. Alphage Parish Church, Greenwich, by his daughters. The bust has been copied from the one in the Royal Observatory, Greenwich.

WE regret to see the announcement that Mr. Clarence King, the eminent geologist, died at Phœnix, Arizona, on December 24, 1901. Mr. King was born in Newport, R.I., and graduated from the Sheffield Scientific School of Yale University in 1852. He was instrumental in the organisation of the U.S. Geological Survey, of which he was director from 1878 to 1881.

WE learn from the *Victorian Naturalist* that the monument erected over the grave, in the St. Kilda Cemetery, of the late Baron Sir F. von Mueller, K.C.M.G., for nearly forty-five years Government Botanist of Victoria, was unveiled on November 26, 1901, by His Excellency the Govenor-General, Lord Hopetoun, in the presence of a large gathering of public and scientific men and personal friends. The monument is in the form of a tall column of polished stone, surmounted by an urn, and resting on a broad pedestal. A medallion in copper of the profile of the late Baron is let into the stone above the inscription.

IT is reported from Paris that M. Ducretet is engaged in carrying out experiments on wireless telephony from which he has already obtained results which he considers are very promising. M. Ducretet's name has been associated with that of M. Popoff in connection with some very successful work in the development of wireless telegraphy. His present experiments do not seem to have gone beyond the laboratory stage, the distance over which speaking has been conducted being only thirty yards. The telephone currents pass through the ground, and it is said that M. Ducretet is about to investigate the conduction through different soils. We hope that he will meet with success, though we are inclined to doubt the practical utility of such a telephonic system, as it is difficult to see in what way, except as a scientific curiosity, it is likely to be superior to present methods.

IT is announced in *Science* that Dr. Ales Hrdlicka is about to start on his fourth expedition among the Indians of the south-western United States and northern Mexico. These expeditions are a part of the system of anthropological exploration and investigation known as the Hyde Expedition, and are carried on under the direction of Prof. F. W. Putnam for the American Museum of Natural History. The expenses of the present undertaking are generously provided for by Mr. F. E. Hyde, jun., of New York City. Dr. Hrdlicka is in charge of the somatological work of the Hyde Expedition, and his plan, now more than half fulfilled, is, in the main, to ascertain the physical characteristics of the extinct as well as the living peoples in that area which has once been occupied by the Cliff-Dwellers and Pueblos, and by the Toltec, Aztec and Chechemec peoples. It is hoped that on the present journey the somatological part of the research in the field will be completed.

DR. J. EVERETT DUTTON, of the Liverpool Malaria Expedition to the Gambia River, gives in a short report a few details of a peculiar case of fever in which he found a parasite resembling that of "tsetse fly disease" of cattle. The case was that of a European, who presented peculiar symptoms, namely: "Irregular attacks of fever lasting over a few days, the temperature not exceeding 101°. The attacks occurred irregularly for a period of some months; abnormal frequent pulse; an increased frequency of respiration, especially on exertion, were noticed. Besides general weakness there was a peculiar œdema of the eyelids and a puffiness about the face, as well as œdema of the legs. The spleen was enlarged, but there were no organic lesions of the heart or kidney, and the urine was normal. An examination of the blood revealed, in somewhat scanty numbers, a parasite, which actively travelled across the field of the microscope backwards or forwards, butting against the red corpuscles, and which was roughly determined to measure 20μ long and 3μ broad. The anterior end tapered off into a long cilium; the lateral membrane was distinct. A drop of blood under a cover glass contained some four to fifteen organisms." The organism is certainly a Trypanosome, but whether *Trypanosoma lewisi* or *T. brucei* or a new species is not yet certain. A single stained blood specimen accompanying the report shows an organism having a long anterior cilium and a rather blunt posterior end. The case was seen and the blood examined several times at the Royal Southern Hospital in September last, but no parasite of any sort could then be demonstrated in the blood. The fever on that occasion was also peculiar.

SOME observations on the seiches of the lake of Lucerne, by M. Ed. Sarasin, of Geneva, are described in the recently issued *Comptes rendus de la Société helvétique*, containing the proceedings for 1899. These observations, which were made at Lucerne, Fluelen and near Vitznau, showed that the period of the uninodal oscillation was 44 minutes, and of the binodal 24 minutes.

A CIVIL SERVICE examination in statistics was held for the first time in June, 1901, in connection with an open competition for the situation of assistant to the head of the statistical branch of the Board of Agriculture. It has been, therefore, considered of interest to reprint the papers both in this subject and in political economy in the *Journal* of the Royal Statistical Society for 1901.

THE preliminary report as to the population of England and Wales in 1901 is discussed by Mr. Thomas A. Welton, in the *Journal* of the Royal Statistical Society for December 31. In the ten years 1891–1901 the increase has been about 12·15 per cent. The large towns have more than held their own, and the new places noted in 1891 have maintained an average high rate of increase. This has been shared by many places which, though they had but from 1000 to 2000 inhabitants in 1801, were nevertheless classed as "progressive." On the other hand, all the towns treated as "unprogressive" in 1801–1891 have shown poor rates of increase, as have also many "progressive" towns which numbered from 2000 to 4000 inhabitants in 1801.

THE *Journal de Physique* for January contains a short abstract of a paper by P. van der Vlieth on an apparatus for demonstrating the linear conduction of heat, the original paper being in the *Journal* of the Russian Physico-Chemical Society. A bar of iron of section 5×5 cm. is heated by a jet of steam at one end and cooled at the other by a stream of water. Its lateral surface is covered by a thick coating of felt and cork, and a series of six thermometers is placed in holes made in the bar. After about half an hour the distribution of heat is stationary, and the temperature gradient as shown by the thermometers is almost exactly a straight line.

PROF. P. ZEEMAN, writing in the *Archives néerlandaises*, describes an experiment relating to the change of phase which occurs when a pencil of light-waves passes through a focus or focal line, a phenomenon to which Gouy has given the name of anomalous propagation. The experiments were made with a plano-convex lens of Iceland spar placed between two crossed nicols, and consisted in observing the rings produced by interference of the ordinary and extraordinary rays. When the centre of the system is black or white between the two foci, M. Gouy's theorem shows that it must be white or black respectively beyond the foci. Prof. Zeeman also gives an independent mathematical investigation of the phenomenon based on treating the focus as a doublet.

A HISTORICAL and critical essay of considerable length, on the definitions of the Bernouillan function, has been published by Prof. H. Renfer, of St. Gallen, in the *Mittheilungen der*

naturforschenden Gesellschaft in Bern for 1900, of which Messrs. Williams and Norgate have forwarded a copy. The essay consists in a detailed examination of the treatments of Raabe, Schlömilch, Schäfli and J. W. L. Glaisher, and the author gives tables as well as graphs of the functions according to the four corresponding alternative definitions. As a result of the examination, Prof. Renfer decides that L. Schäfli's definition is to be preferred on account of (1) its wider limits of convergency, (2) the greater simplicity of form of the formulæ, (3) this form being the most general, and (4) the theory assuming a more compact form on account of the assumed fundamental relation between Bernouillan numbers and functions and the applications of the principle of indeterminate coefficients.

THE "Antonio Alzate" Society, of Mexico, has published the proceedings and reports of the first national meteorological congress held in that country, and convened under its auspices on November 1, 2 and 3, 1900. The congress was attended by thirty-one members, chiefly directors of observatories and delegates of the various States. Many questions of general interest, mostly tending to ensure uniformity in the methods employed, were discussed. Some of the reports handed in contain valuable discussions of the rainfall and climate of various localities in Mexico. A paper was also read by a lady member, Señorita R. Sánchez Suárez, on the barometer and the prediction of weather.

ON comparing the principal meteorological results of the year 1901 at Greenwich Observatory with those of the last sixty years, the mean temperature (49°·6) is found to be −0°·5 below the average; there was nothing remarkable in the absolute extremes of temperature, the maximum being 87°·9, on July 19, and the minimum, 20°·4, on February 14, giving an absolute range of 67°·5. The rainfall, as in several previous years, was below the mean, the amount of deficiency being 3·28 inches; there was a slight excess in March and April, and a large excess, 1·74 inch, in December, while deficiencies exceeding an inch occurred in January and November. The amount of bright sunshine exceeded the mean of the last twenty years by 290 hours; the largest amount was recorded in May (237 hours), and the least in February (27 hours).

IN an illustrated article on the boats of the Samoans, in *Globus* (vol. lxxx. 1901, p. 167), Prof. Thilenius points out that the remarkable migrations of the Polynesians were accomplished by means of the *alia* or double canoe. Some of these canoes can accommodate more than a hundred persons, and the type extends from Hawaii to New Zealand and from Viti to the Marquesas.

SO little is known about the brains of primitive peoples that we welcome with especial pleasure the careful study of the brain of an Eskimo man by Dr. A. Hrdlicka in the *American Anthropologist* (1901, p. 454). As a whole this brain is heavier and larger than the average brain of white men of similar stature, and the cerebrum rather exceeds that of an average white male in the number, extent and depth of the sulci and in the complexity of the gyrations.

G. PAUL-BONCOUR gives, in the *Bulletins de la Société d'Anthropologie de Paris* (v. sér. t. ii. 1901), the first of a series of studies on the skeletal modifications consequent on infantile hemiplegia. This detailed study deals with the femur, and the author gives a careful comparison of the healthy femur with that of the paralytic side of a number of subjects. The last of his conclusions is the only one that will interest the general reader; e says: "From the anthropological point of view it has been possible pathologically to establish reasonable and clear transitions between human femurs and the femurs of anthropoids."

"NOTES on the Ancient Model of a Boat and Warrior Crew found at Roos in Holderness," by Mr. Thomas Sheppard, is the title of the fourth of the *Hull Museum Publications*. This little brochure, which is illustrated by four figures and two plates, is sold to the public for one penny. The curator is to be congratulated on producing such an interesting little essay on a remarkable model, probably of Scandinavian manufacture, of a wooden boat, the prow of which is carved to represent a snake's head with small quartz eyes. On the boat are four nude male figures, each of which was originally provided with a club and a large and a small round shield; their eyes also were pieces of quartz. The figures are from 14 to 16 inches in height.

ARCHÆOLOGISTS have long been accustomed to accept the statement that there is a hiatus between the Palæolithic and Neolithic stages of culture; but of late years more detailed research has indicated evidence of a transitional culture in the south of France and elsewhere. Quite recently A. Laville has investigated sections of certain hills in the valley of the Seine, and he claims (*Bulletins et Mémoirs de la Soc. d'Anthropologie de Paris*, v. sér. t. ii. 1901, p. 206) to have discovered two layers which he terms "Infra-Neolithic." These correspond, according to him, with the layers B and C of the famous cave of Mas d'Azil, so admirably worked out by E. Piette, and to which the attention of readers of NATURE has been called. There is a second paper (p. 285) by the same author, in which he figures a specimen from a basement zone which he claims to be an implement of the Chellian type, but in which M. Verneau cannot discover any evidence of human workmanship.

FIRE is regarded by the Hopi Indians of Arizona as a living being, its cultus consisting primarily of rites for germination, and, secondarily, for rain making. The lesser new-fire ceremony, which is described by Dr. J. Walter Fewkes in the *American Anthropologist* (n.s., vol. iii. p. 438), has these two purposes. The special gods worshipped are the germ-father and the germ-mother; the former is the fire god and is communicated with by means of prayer-sticks placed in his shrine, or prayer-fires kindled in the vicinity of the same. The germ-mother, called in this ceremony by the name of her animal personation (spider woman), is communicated with by invocations consisting of archaic monosyllables shouted by the chief. The personators of the ancient priests wear face-shields or masks; the latter have magic power, and their presence on the altar is a symbolic or mute suggestion of the elaborate ceremony of the ancients.

WE have received specimens of wall maps of Africa and South America, compiled and drawn by Prof. Guido Cora and published by Messrs. Paravia and Co. These maps, which are the first of a new series, are on a scale of 1 : 8,000,000, and show the physical features correctly and clearly. Ethnographic and political maps, on a scale of 1 : 25,000,000, are shown as insets; and profiles on a vertical scale of 1 : 200,000, along the equator in the case of Africa, and the parallel of 19° S. in the case of South America, form useful additions.

THE December number of *Petermann's Mittheilungen* contains several articles of more than average general interest. Prof. Gerland writes on Italian earthquakes and Baratta's seismic map of Italy, Prof. Wieser on the oldest map bearing the name "America," and Dr. Ernest Stromer on Lake Tanganyika. Dr. Vogelgesang concludes the first part of an account of journeys in northern and central China. Dr. Henkel contributes a note on the distance limit of visibility of land of a certain elevation from the sea, and adds a map of Greece showing the limits for a number of mountain summits.

THE marine submergence of the Gobi during the Secondary period becomes more and more doubtful, in proportion as we

learn more about this region. The Russian geologist, Bogdanovich, notwithstanding a most careful search, has found during his three years' journey no traces of this submergence. Stoliczka's fossils are apparently similar to those found by the Russian explorers further north, which have proved to be Devonian. Obrucheff's fossils from the eastern Gobi belong to freshwater lacustrine deposits. And now we learn from Prof. Tschernyscheff (*Verhandlungen* of the St. Petersburg Mineralogical Society, xxxviii. 2) that the fossils brought in by D. A. Klements from the Dzungarian Gobi, from a spot, Nyursu, situated to the east of Pyevtsoff's route from Kobdo to Guchen, belong to the Permo-Carboniferous strata, which are known in the Urals as the Artinsk horizon. They contain Bryozoa (Polypora and Fenestella), the polypes *Stenopora columnaris*, var. *Ramosa multigemmata*, and the molluscs *Productus purdoni*, *P. asperulus*, *P. mexicanus*, *Chonetes transitionis*, *Rhynchopora nikitini*, *Reticularia lineata*, *Martinia semiglobosa*, *Spirifer cameratus* and *Bairdia curta*. The character of this fauna is also similar to the fauna which was found by Loczy in the provinces of Se-chuen and Yunnan.

IN the *Notes* of the Leyden Museum (vol. iv. p. 191) Dr. F. A. Jentink describes a skin of the rare Bornean bay cat (*Felis badia*), which he believes to be the fourth known specimen. In the same issue Dr. O. Finsch continues his catalogue of the ornithological collection at Leyden.

IN the *Sitzungsberichte* of the Vienna Academy (1901, No. 25), Prof. R. von Wettstein draws attention to the important zoological and botanical collections obtained by the recent expedition to south Brazil. He directs attention to the marked changes caused in the vegetation of the country by plants introduced, either accidentally or on purpose, during the last century.

IN the January number of the *Entomologist*, Mr. F. B. Dodd describes a peculiar instrument by means of which the silk-producing moths of the Australian genus Antheræa cut their way out of their hard cocoons. The instrument "is a short hard black and curved thorn, situated in the thick joints at the base of the fore-wings, one on each side; in a rubbed specimen the thorn is easily discernible, but in a good one it is concealed amongst the dense scales. . . . It would be interesting to know whether anyone can state whence the liquid issues which the moth discharges to soften the cocoon where he cuts through; it must issue from near the thorn, for, as a rule, the scales left at the base of the wing and alongside the thorax are wet and matted when the moth emerges."

TO the issue of the *Journal* of the Straits Branch of the Royal Asiatic Society for July last Captain S. S. Flower contributes an interesting series of notes on the millipedes, centipedes, scorpions and allied creatures of the Malay Peninsula and Siam. The author sets an excellent example to other naturalists in the way he grappled with an unknown subject. "When I arrived in the Straits Settlements," he writes, "in March 1895, I knew practically nothing of these animals, how they were classified, how to distinguish between them, or which were poisonous and which harmless, and in no book or paper could I find the information I wanted, so I set to work to collect and examine specimens, and compare them with such literature as was available." The result of this energy and perseverance is the long and well-annotated list before us.

MR. G. ARCHDALL REID contributes to the current number of the *Monthly Review* an instructive and clearly written account of "the rationale of vaccination." After an explanation of the causes of zymotic diseases, it is explained that there are two kinds of immunity from them—the inborn and the acquired. The former prevents infection, the latter prevents reinfection, and both kinds have arisen in the human race through a process of natural selection. When, as in the case of measles, immunity can be acquired by the individual, natural selection has evolved a power of recovering from infection. Thus, Englishmen, who have long been afflicted by measles, are as certainly infected, but recover much more easily than Polynesians, to whom the disease has only lately been introduced. After passing in review the theories which have previously been held to explain acquired immunity, Mr. Reid shows that it is due to an habituation to the toxins of that disease. This result is brought about by the digestion in the blood of the toxins, so that there are present in the animal's blood toxins in all stages of attenuation, from those newly produced by the microbes, and extremely virulent, to those produced in the beginning of the disease and now in a state of great enfeeblement. Up that graduated scale the cells of the animal react till complete immunity is attained. The serum treatment artificially supplies digestive substances and, what is even more important, a scale of attenuated toxins. Applying these principles to the case of small-pox, the necessity for periodical vaccination is established. It is pointed out that, since small-pox is an air-borne disease, isolation, by itself, has no greater power of controlling small-pox than the historic old lady with a broom had of sweeping back the Atlantic. In the absence of vaccination isolation would be worse than useless.

A NEW edition (the third) of "Practical Radiography," by Messrs. A. W. Isenthal and H. Snowden Ward, has been published by Messrs. Dawbarn and Ward. Many additions have been made to the original volume, and the position and possibilities of radiography at the present time are fairly represented. The book is a useful guide to many aspects of work with Röntgen rays, and in it the authors judiciously combine practical hints with descriptions of theoretical interest.

THE German weekly scientific periodical *Die Natur* has just commenced a new half century in its existence, the first number having appeared on January 3, 1852. The journal was founded by the late Dr. Otto Ule and Dr. Karl Müller, and has maintained a high position among scientific periodicals from the commencement. The present editor is Herr H. Behrens. The cordial relationship which has existed between the French and German periodical representatives of Nature and ourselves is one instance among many of the cosmopolitan character of scientific interests. We congratulate *Die Natur* upon its jubilee and trust that its work and influence in the future will be even more extensive than in the past.

MR. C. E. BENHAM has prepared a series of seven stereoscopic diagrams, published by Messrs. Newton and Co., illustrating the polarisation of light. These diagrams show, in stereoscopic relief, the various directions of vibration in a light-wave, the passage of a ray through a doubly refracting crystal, the action of Nicol's prisms, and polarisation by reflection. The figures are drawn in white lines on a black ground, and they should be very useful for demonstration purposes. The only fault we have to find with them is that the right-hand and left-hand blocks in several cases are of unequal size, and present in the stereoscope the appearance of pieces of black paper which have been turned up at one side and slant towards the observer instead of looking like screens placed behind the diagrams. This is particularly confusing when there are two diagrams on the same slide, and the black patches appear tilted in opposite directions.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas*), a Ground Hornbill (*Bucorvus abyssinicus*) from Kontagora, Nigeria, presented by Captain E. H. Lewis; a Common For

(*Canis vulgaris*) from Savoy, presented by M. Leon Montaigne; a White-crested Tiger-Bittern (*Tigriosoma leucolophum*) from West Africa, presented by Mrs. F. M. Hand; nine Pheasant-tailed Jacanas (*Hydrophasianus chirurgus*) from India, presented by Mr. Frank Finn; a Horned Capuchin (*Cebus apella*) from South America, a Feline Douroucouli (*Nyctipithecus vociferans*) from South Brazil, four Crowned Partridges (*Rollulus cristatus*) from Malacca, deposited; a White-tailed Gnu (*Connochaetus gnu*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DIAMETER OF JUPITER.—In continuation of his series of determinations of planetary diameters with the 26-inch refractor at Washington, Prof. T. J. J. See gives the reduced measures of Jupiter in *Astronomische Nachrichten*, Bd. 157, No. 3757. The observations were made during daylight, using the colour screen over the eye-piece for eliminating the secondary fringes, &c. For the final evaluation of the diameter sixty-eight measures are employed, extending over the period 1901 September 6-October 1; from these he gives:—

Equatorial diameter of Jupiter = 37″·646 ± 0″·014
= 141,950 ± 53 km.

Prof. See thinks this very closely approximates to the absolute value of the diameter, and by comparing it with the value obtained at night, when the planet is seen as a very brilliant object on a dark background, he obtains a measure of the irradiation. The night value is 38″·40, which gives for the irradiation:—

I = 0″·755 ± 0″·040
= 2847 ± 150 km.

As these values are so different, the suggestion is made of the advisability of adopting two sets of planetary diameters, one representing the apparent size of the planet as seen at night, to be used in physical observations and ephemerides, work on satellites, &c., the other representing the true dimensions of the spheroid independent of its illumination by the sun, to be employed in the theory of the planet's figure, constitution, &c.

The resulting absolute dimensions of the Jovian spheroid referred to the distance 5·20 are:—

Equatorial diameter	= 37″·646	= 141,950 km.
Polar diameter ...	= 35·222	= 132,810 km.
Oblateness	= 1:15·53.	
Assumed mass ...	= 1:1047·35 (Newcomb).	
Density	= 1·35 (water = 1).	

"THE HEAVENS AT A GLANCE," 1902.—This handy little publication for the present year is issued in a slightly modified form. The author has repeatedly had inquiries respecting the inclusion of one or more star maps, and the present edition is furnished with two, one showing the northern stars, the other the southern objects visible from Great Britain. Another additional feature is the small map of the moon, showing the principal lunar formations.

All the more important phenomena are given for the year, and a series of summaries of the particulars relating to variable and coloured stars, nebulæ, &c.

VARIABLE STAR CATALOGUE.—In the *Astronomical Journal*, vol. xxii. No. 514, the committee appointed by the Council of the Astronomische Gesellschaft publish a further catalogue giving the elements of stars which have been certainly recognised as variable since the publication of Chandler's third catalogue (*Astronomical Journal*, vol. xvi., pp. 145–172). The present list gives the definitive designations for 191 variables, and also for the three Novæ in Perseus, Sagittarius and Aquila.

CATALOGUE OF 100 NEW DOUBLE STARS.—*Bulletin* No. 12 from the Lick Observatory comprises the fourth catalogue of new double stars having distances under 5″, discovered by W. J. Hussey with the 36-inch telescope at Mount Hamilton. (The first three catalogues appeared in the *Astronomical Journal*, Nos. 480, 485, 494.)

The search is being conducted in a systematic manner, and it is hoped that the work when more advanced will afford data for an investigation into the distribution of close double stars in various parts of the sky, and of their numbers with respect to magnitude.

THE TEACHING OF MATHEMATICS IN PUBLIC SCHOOLS.

THE following letter has been sent to the Committee appointed by the British Association to report upon the teaching of elementary mathematics.

GENTLEMEN,—At the invitation of one of your own body, we venture to address to you some remarks on the problems with which you are dealing, from the point of view of teachers in public schools.

As regards geometry, we are of opinion that the most practical direction for reform is towards a wide extension of accurate drawing and measuring in the geometry lesson. This work is found to be easy and to interest boys; while many teachers believe that it leads to a logical habit of mind more gently and naturally than does the sudden introduction of a rigid deductive system.

It is clear that room must be found for this work by some unloading elsewhere. It may be felt convenient to retain Euclid; but perhaps the amount to be memorised might be curtailed by omitting all propositions except such as may serve for landmarks. We can well dispense with many propositions in the first book. The second book, or whatever part of it we may think essential, should be postponed till it is needed for III, 35. The third book is easy and interesting; but Euclid proves several propositions whose truth is obvious to all but the most stupid and the most intellectual. These propositions should be passed over. The fourth book is a collection of pleasant problems for geometrical drawing; and, in many cases, the proofs are tedious and uninstructive. No one teaches Book V. A serious question to be settled is—how are we to introduce proportion? Euclid's treatment is perhaps perfect. But it is clear that a simple arithmetical or algebraical explanation covers everything but the case of incommensurables. Now this case of incommensurables, though in truth the general case, is tacitly passed over in every other field of elementary work. Much of the theory of similar figures is clear to intuition. The subject provides a multitude of easy exercises in arithmetic and geometrical drawing; we run the risk of making it difficult of access by guarding the approaches with this formidable theory of proportion. We wish to suggest that Euclid's theory of proportion is properly part of higher mathematics, and that it shall not in future form part of a course of elementary geometry. To sum up our position with regard to the teaching of geometry, we are of opinion—

(1) That the subject should be made arithmetical and practical by the constant use of instruments for drawing and measuring.

(2) That a substantial course of such experimental work should precede any attack upon Euclid's text.

(3) That a considerable number of Euclid's propositions should be omitted; and in particular

(4) That the second book ought to be treated slightly, and postponed till III, 35, is reached.

(5) That Euclid's treatment of proportion is unsuitable for elementary work.

Arithmetic might well be simplified by the abolition of a good many rules which are given in text-books. Elaborate exercises in vulgar fractions are dull and of doubtful utility; the same amount of time given to the use of decimals would be better spent. The contracted methods of multiplying and dividing with decimals are probably taught in most schools; when these rules are understood, there is little left to do but to apply them. Four-figure logarithms should be explained and used as soon as possible; a surprising amount of practice is needed before the pupil uses tables with confidence.

It is generally admitted that we have a duty to perform towards the metric system; this is best discharged by providing all boys with a centimetre scale and giving them exercise in verifying geometrical propositions by measurement. Perhaps we may look forward to a time when an elementary mathematical course will include at least a term's work of such easy experiments in weighing and measuring as are now carried on in many schools under the name of physics.

Probably it is right to teach square root as an arithmetical rule. It is unsatisfactory to deal with surds unless they can be evaluated, and the process of working out a square root to five places provides a telling introduction to a discourse on incommensurables; furthermore, it is very convenient to be able to assume a knowledge of square root in teaching graphs. The

same rule is needed in dealing with mean proportionals in geometry.

Cube root is harder and should be postponed until it can be studied as a particular case of Horner's method of solving equations approximately.

Passing to algebra, we find that a teacher's chief difficulty is the tendency of his pupils to use their symbols in a mechanical and unintelligent way. A boy may be able to solve equations with great readiness without having even a remote idea of the connection between the number he obtains and the equation he started from. And throughout his work he is inclined to regard algebra as a very arbitrary affair, involving the application of a number of fanciful rules to the letters of the alphabet.

If this diagnosis is accepted, we shall be led naturally to certain conclusions. It will follow that elementary work in algebra should be made to a great extent arithmetical. The pupil should be brought back continually to numerical illustrations of his work. The evaluations of complicated expressions in a, b and c may of course become wearisome; a better way of giving this very necessary practice is by the tracing of easy graphs. Such an exercise as plotting the graph $y = 2x - \frac{x^2}{4}$ provides a series of useful arithmetical examples, which have the advantage of being connected together in an interesting way. Subsequently, curve-tracing gives a valuable interpretation of the solutions of equations. Experience shows that this work is found to be easy and attractive.

With the desire of concentrating the attention of the pupil on the meaning rather than the form of his algebraical work, we shall be led to postpone certain branches of the subject to a somewhat later stage than is usual at present. Long division, the rule for H.C.F., literal equations and the like will be studied at a period when the meaning of algebra has been sufficiently inculcated by arithmetical work. Then, and not till then, will be the time to attend to questions of algebraic form.

But at no early stage can we afford to forget the danger of relapse into mechanical work. For this reason it is much to be wished that examining bodies would agree to lay less stress upon facility of manipulation in algebra. Such facility can generally be attained by practice, but probably at the price of diminished interest and injurious economy of thought. The educational value of the subject is sacrificed to the perfecting of an instrument which in most cases is not destined for use.

To come to particulars, we think that undue weight is often given to such subjects as algebraic fractions and factors. The only types of factors which crop up continually are those of $x^2 - a^2$, $x^2 \pm 2ax + a^2$, and, generally, the quadratic function of x with numerical coefficients.

In most elementary algebra books there is a chapter on theory of quadratic equations in which a good deal of attention is paid to symmetric functions of roots of quadratics. No further use is to be made of this until the analytical theory of conics is being studied. Might not the theory of quadratics be deferred until it can be dealt with in connection with that of equations of higher degree?

Indices may be treated very slightly. The interpretation of negative and fractional indices must of course precede any attempt to introduce logarithms; but when the extension of meaning is grasped, it is not necessary to spend much more time on the subject of indices; we may push on at once to the use of tables.

It will be seen that our recommendations under the head of algebra are corollaries of two or three simple guiding thoughts, the object in view being—to discourage mechanical work; the means suggested—to postpone the more abstract and formal topics and, broadly speaking, to arithmeticise the whole subject.

The omission of part of what is commonly taught will enable the pupil to study, concurrently with Euclid VI., a certain type of diluted trigonometry which is found to be within the power of every sensible boy. He will be told what is the meaning of sine, cosine, and tangent of an acute angle, and will be set to calculate these functions for a few angles by drawing and measurement. He will then be shown where to find the functions tabulated, and his subsequent work for that term will consist largely in the use of instruments, tables and common sense. A considerable choice of problems is available at once. He may solve right-angled triangles, work sums on "heights and distances," plot the graphs of functions of angles, and make some progress in the general solution of triangles by dividing the triangle into right-angled triangles. Only two trigonometrical identities should be introduced—

$$\sin^2\theta + \cos^2\theta = 1, \text{ and } \frac{\sin\theta}{\cos\theta} = \tan\theta.$$

In short, the work should be arithmetic, and not algebra.

Formal algebra cannot be postponed indefinitely; perhaps now will be the time to return to that neglected science. We might introduce here a revision course of algebra, bringing in literal equations, irrational equations, and simultaneous quadratics illustrated by graphs, partial fractions, and binomial theorem for positive integral index. Side by side with this it ought to be possible to do some easy work in mechanics. Graphical statics may be made very simple; if it is taken up at this stage, it might be well to begin with an experimental verification of the parallelogram of forces, though some teachers prefer to follow the historical order and start from machines and parallel forces. Dynamics is rather more abstract; a first course ought probably to be confined to the dynamics of rectilinear motion.

It is not necessary to discuss any later developments. The plan we have advocated will have the advantage of bringing the pupil at a comparatively early stage within view of the elements of new subjects. Even if this is effected at the sacrifice of some deftness in handing a, b and c, one may hope that the gain in interest will be a motive power of sufficient strength to carry the student over the drudgery at a later stage. Some drudgery is inevitable, if he is ultimately to make any use of mathematics. But it must be borne in mind that this will not be required of the great majority of boys at a public school.

We beg to remain, gentlemen,

Yours faithfully,

G. M. BELL, Winchester.
H. H. CHAMPION, Uppingham.
H. CRABTREE, Charterhouse.
F. W. DOBBS, Eton.
C. GODFREY, Winchester.
H. T. HOLMES, Merchant Taylors' School.
G. H. J. HURST, Eton.
C. H. JONES, Uppingham.
H. H. KEMBLE, Charterhouse.
T. KENSINGTON, Winchester.
E. M. LANGLEY, Bedford Modern School.
R. LEVETT, King Edward's School, Birmingham.
J. W. MARSHALL, Charterhouse.
L. MARSHALL, Charterhouse.
C. W. PAYNE, Merchant Taylors' School.
E. A. PRICE, Winchester.
D. S. SHORTO, Rugby.
A. W. SIDDONS, Harrow.
R. C. SLATER, Charterhouse.
H. C. STEEL, Winchester.
C. O. TUCKEY, Charterhouse.
F. J. WHIPPLE, Merchant Taylors' School.

CONFERENCE OF SCIENCE TEACHERS.

ONE of the most important of the many educational conferences which it has become customary to hold during the Christmas vacation is that arranged under the auspices of the Technical Education Board of the London County Council. The custom of inviting teachers of science from all parts of the country to attend meetings in London, to discuss the best methods of imparting instruction in the branches of science taught in schools and colleges, was inaugurated four years ago, and each successive year has seen a substantial increase in the attendance. While in 1899 fewer than a hundred teachers, inspectors and others responded to the invitation of the Technical Education Board, there were present at the meetings held on Thursday and Friday last at the South-Western Polytechnic, Chelsea, upwards of four hundred persons, among whom were representatives of every stage of science teaching.

The vice-chairman of the London Technical Education Board, Mr. T. A. Organ, presided at the first meeting and, in a speech welcoming the teachers present, referred to the neglect of science teaching in this country in the past and contrasted this with the admirable efforts made in Germany since the opening of their first chemical laboratories in 1827. As indicating the amount of leeway we have as a nation to make up, he pointed to the fact that there are nearly 10,000 more or less well-trained chemists employed in German factories, and, as half of them have undergone a complete course of several years' training in the technical high schools, it is not surprising that Germany should be gradually securing markets in which originally British trade was supreme. It is unnecessary to repeat

here the examples which Mr. Organ cited, since they have been many times referred to in NATURE. The Technical Education Board could profitably expend, said the chairman, two millions on the improvement of the provision for research in the chemical and engineering sciences alone.

Hygiene as a School Subject.

Papers were read by Miss Alice Ravenhill, on the teaching of hygiene, and by Dr. Francis Warner, on mental school hygiene. The former paper discussed several points. Can our schools be made to contribute to the work of raising the standard of health in the country? If it is desirable to teach hygiene in schools, how will the curriculum be affected by the addition of this subject? In what grades of schools should hygiene find a place, and what are the best methods of teaching it? It was rightly pointed out that hygiene is really the application to the health of the individual of most other sciences, and that instruction in physics and chemistry may very well be given a useful bias by pointing out their applications in the particular problems with which hygiene is concerned. Miss Ravenhill compared the teaching of hygiene in this country with what she had seen in the American schools during her recent visit to the States, and indicated several customs which might very well be imitated by English teachers.

Dr. Warner explained how the study of mental hygiene could be made to assist the work of the teacher. Since all mental action is expressed in movement and its results, the teacher can, by noting carefully the expression, balance and action in movement and response, of the pupil, learn much of the modes of action in the brain centres.

Natural History Teaching.

At the second meeting the chair was taken by Prof. Tilden, F.R.S., who in the course of his remarks gave it as his opinion that every educated man should possess a broad general acquaintance with the facts of biological science, and that consequently all boys and girls should have an opportunity of studying natural history. The best time for such study is probably in the holidays, for in these days of crowded school time-tables and compulsory organised games the children have no leisure hours in term time. This holiday work should not be in the hands of the ordinary school staffs, who cannot dispense with the rest of vacation weeks, but be under the care of special holiday instructors.

Addresses were delivered by Mr. F. E. Beddard, F.R.S., on the teaching of natural history, and by Prof. W. B. Bottomley, on the value of natural history collections for teaching purposes. Both speakers gave a number of reasons why natural history should be taught in schools, urging that in educative influence it is second to no subject. Mr. Beddard maintained that the teaching should be in the hands of experts, who might very well be itinerant lecturers visiting each school once or twice a week. He showed by means of a brief comparison of the horse and the donkey how natural history teaching can be conducted on research lines and so form an excellent way of training the observation and reasoning powers. He also made it clear that there need not be much expense attending the introduction of natural history into school teaching. Prof. Bottomley distinguished between natural history collections and museums; while the former are capable of assisting the teacher very much, the ordinary museum is of little value. The natural surroundings of all animals exhibited should be imitated as closely as possible, and the objects should be typical of the neighbourhood in the first place, but be supplemented by others characteristic of the great divisions of the animal kingdom.

Schemes of Nature-Study.

The principal of the University of London, Prof. A. W. Rücker, F.R.S., presided at the third meeting. Mr. R. Hedger-Wallace described American systems of nature-study. He followed the classification of the methods in common use in the United States which was recently made by Prof. Hodge, of Clark University, and gave the distinguishing characteristics of each of the eleven divisions recognised by Prof. Hodge. Most of the American schemes of nature-study are marked by an undesirable pretentiousness which teachers in this country would do well to avoid. Perhaps the best of the American methods is that of Cornell University, drawn up by Prof. Bailey, and many of the schedules and instructions issued to teachers throughout the States by the authorities of Cornell University might be copied in this country with great advantage to the teaching of nature-study in our own rural schools. Mr. Hedger-Wallace particularly condemned the sentimentality developed by much of the teaching in American schools.

Mr. D. Houston gave an eminently practical account of the plan for teaching nature-study in schools which he has worked out for the Essex County Council. In this scheme it is rightly recognised that the success of any method depends ultimately upon the equipment and enthusiasm of the instructor. Consequently great stress is, in Essex, laid upon the preparation of teachers for their work. A three years' course has been inaugurated, and in the first two of these teachers are trained by lectures and laboratory work in the branches of science which underlie any serious work in nature-study; while in the third year the student prepares a detailed monograph upon a special plant, a course which is found to give an insight into the methods of research and to help the teachers to put the children into the right attitude towards the work. Mr. Houston exhibited an interesting series of exercises performed by teachers in training and by children in schools, which showed very conclusively that the work in Essex is being done on scientific lines.

Prof. Rücker summarised the addresses and indicated the lines the subsequent discussion might profitably take. He insisted that, in the education of children, science must be brought into close connection with art and literature. Science should teach how to observe and how to reason from the observations made, but for the due expression of what has in this way been learnt a course in drawing and literature is imperative. He also pointed out that while schemes of study which have been found to work well in some schools in certain circumstances are valuable to all teachers, such courses of study must not be adopted *en bloc* by teachers. Every instructor should be continually improving his scheme of study, modifying it to meet the peculiar needs of his own classes.

During the short discussion which followed, Dr. Gladstone, F.R.S., referred to the work under the London School Board which he helped to systematise.

Technical Education in Rural Districts.

In the absence of the Countess of Warwick, Prof. H. E. Armstrong, F.R.S., presided at the concluding meeting of the conference. Mr. Hennesey, the principal of Lady Warwick's School, Bigods Hall, Dunmow, described the equipment and curriculum of his school, which he explained was a school of science in which the courses of study for rural schools drawn up by the Board of Education were adopted. The school at Bigods is attended by both boys and girls, and no disadvantages have been found to result from the plan of co-education. Mr. Hennesey explained that a difficulty is experienced when the third year is reached, since it is found that only 50 per cent. of the third-year students intend to remain in the country to take up agricultural and horticultural pursuits. Instead of making the work of the third and fourth years purely technical a compromise is effected, so that those children who will work in urban centres may not suffer. Purely technical subjects are excluded, and great care is taken to make all subjects as educative as possible. It has not been found that the general education of the pupils suffers from the agricultural bias given to the teaching.

Prof. Meldola, F.R.S., passed in review the pioneer work in secondary and technical education in rural districts which has been accomplished in Essex. He concerned himself chiefly with the difficulties which have been overcome. He said that the sporadic teaching of insufficiently educated adults which is so common in many counties does little good. The best kind of technical education is that given by experts to classes of suitably trained youths. Rural technical education will not be satisfactory until an intimate connection between the elementary and secondary school is established. At present few children from the elementary school pass on for a further period of study to the secondary school provided, like the school at Bigods, with every facility for teaching the broad principles of agricultural and horticultural practice. A thorough system of scholarships by which the best children of the elementary school could pass on to the secondary school would have excellent results.

Prof. Armstrong, in bringing the conference to a close, insisted that the success of schemes of technical instruction is in no way proportionate to the costliness of the equipment. Simple appliances are best, and workshops are more productive of good

work than elaborately fitted laboratories. Desk work must be dethroned to a large extent and the pupils be given more time in the open air.

The exhibition of home-made apparatus was not so good as usual this year. Judging from the remarks of many teachers present at the conference, this exhibition has in previous years been regarded as one of the most helpful of the items on the programme of events, and Dr. Kimmins, to whose energy the success of the conferences is due, should develop this side of the annual meetings as largely as possible in future.

A. T. SIMMONS.

A NEW RANGE-FINDER.[1]

THE instrument designed by Prof. Forbes is intended only for use with rifle fire. It is not suitable for long-range artillery, or for the Navy. This infantry type is by far the most difficult to produce, because, in addition to accuracy, extreme portability is an essential feature. At the same time, the infantry are more in need of some addition to their present resources than any one else, and the urgent need of such an instrument has been proclaimed and re-echoed by all our officers who have returned from the war in South Africa.

All methods of optically measuring the distance of an inaccessible object depend on using a base of known length, which must be measured on the ground, or else be part of the instrument. In the latter case the instrument can usually be worked by one man, who can find the distance without changing his position. This class of instrument is sometimes spoken of as short-base range-finders. Numerous patents for such instruments have been applied for; but the difficulties in the way of ensuring accuracy are so great that only one type has ever been perfected and generally used. The Barr and Stroud range-finder has been adopted by the Navy with most satisfactory results, and this has proved the fact that a short base (4½ feet) is not inconsistent with accuracy. For the use of infantry, however, where extreme probability, and accuracy, and suitability for ill-defined objects, such as men, bushes, rocks, &c., are essentials, this is an unsuitable instrument.

In the Barr and Stroud instrument the two images of a distant object are seen with one eye, hence the object appears to be double until the micrometer arrangement has been so moved as to make a coincidence of the two images, when the scale reading of the micrometer gives the distance directly. Now in naval work, for which this instrument is made, a ship, or its mast or funnel, is very sharp against the sky, and the coincidence can easily be made; but this method is almost valueless in the field. A bush, or a rock, or a man is an object so ill-defined, especially against certain backgrounds, that in attempting to make a coincidence you may move one picture in the telescope over the other for a considerable angle before you are sure that it is double. The difficulty has been got over by Messrs. Carl Zeiss and Prof. Forbes, who make use of stereoscopic vision in the new range-finder.

The instrument consists of a folding aluminium base, 6 feet in length, and a field glass. The base is a square tube hinged at its middle, and folds up to 3 feet 6 inches. Each half has at each end a doubly reflecting prism. The rays of light from a distant object strike the outer pair of these four prisms, are reflected at right angles along each tube, and are then reflected at the two middle prisms into the two telescopes of the binocular fixed to the base, in directions parallel to the original rays intercepted by the outer prisms. It is the measurement of the angle between these rays that tells the distance of the object looked at. This angle is measured by two vertical wires, one in each telescope, seen by the two eyes. One of the wires is fixed, the other is moved by a micrometer-screw until the two wires appear as one, while the object is seen distinctly. This gives the distance accurately to 2 per cent. even at 3000 yards. But now stereoscopic vision comes in and gives far greater accuracy. The wire seems to stand out solid in space, and the slightest turn of the micrometer screw causes the wire to appear to be nearer or farther than the object looked at, and when the wire appears to be at exactly the same distance the micrometer reading gives the distance with an accuracy far greater than that attainable by observing the duplication of images on the retina.

This range-finder can be used in a variety of positions. The more steadily it is held the more accurate the result. A standing position is the least steady. When kneeling, using only half the base, the other half may be bent down at right angles, and so form a leg which serves as a rest on the ground. The most easy position is sitting with the elbows resting on the knees. Another steady position is lying flat on the ground facing the object (Fig. 1). In every one of these positions you can take advantage of cover. Since the eyes are virtually at the extremities of the base, the observer may stand, sit, kneel, or lie behind a tree, bush, rock, ant-hill, horse, comrade, or waggon, and will not only be more able to work without sensation of danger, but without drawing the fire of the enemy on his comrades.

Lord Kitchener having expressed a desire to see the range-finder tested in the field, Prof. Forbes has proceeded to South Africa with his instrument, and a thorough examination of its efficiency will be made under practical conditions.

FIG. 1.—Range-Finder in use behind cover.

[1] Abstract of a paper read before the Society of Arts on December 18, 1901, by Prof. George Forbes, F.R.S.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Prince of Wales having consented to be nominated as Chancellor of the University of Wales, has been elected to that office in succession to His Majesty the King, who has assumed the title of Protector of the University.

THE executive committee of the Carnegie Trust met at Edinburgh on Monday. The secretary and treasurer submitted their reports for the period ended December 31, 1901, showing that fees have been paid by the Trust to 2441 students, amounting to the sum of 22,941*l.* 16*s.* 6*d.* It was arranged to hold the annual meeting of the trustees in London, at which the first report of the executive will be submitted.

AT a special meeting of the Governors of University College Dundee, on January 8, Sir W. O. Dalgleish intimated that he would provide a sum of 5000*l.* for the building of the new medical school, and an additional sum of 5000*l.* towards the extinction of the debt on the College. This latter sum will be payable only if within a certain reasonable time sufficient money is subscribed to make up the remaining sum, the balance of

the debt—7500*l.*—in order that the debt of the College may be extinguished altogether.

AT a special meeting of the Court of the Victoria University, the recent movements to establish separate Universities in Liverpool, Manchester and Leeds were discussed. As the University College, Liverpool; Owens College, Manchester; and the Yorkshire College are the three constituent colleges of the Victoria University, the establishment of the three proposed Universities would mean the disruption of the present federated University. The two alternatives which the Court had to consider were as follows:—"Having regard to the resolutions of the three constituent colleges of the University, the question for decision must be whether (*a*) the three colleges are to remain as constituent colleges of the University; or whether (*b*) there should be a separate University in Liverpool and a 'University in Manchester without liability to admit or to remain in association with any other college,' and also a 'University established having its seat in Leeds.'" The latter view was accepted, and a committee was appointed to consider the terms and conditions on which it should be carried into effect.

THE New York correspondent of the *Morning Leader* says that the gifts to education in the United States in 1901 amount to more than 15,000,000*l.* Of this sum 9,000,000*l.* was contributed by three individuals. Mrs. Leland Sanford gave the magnificent sum of 6,000,000*l.* to the western University which bears her husband's name. Mr. John D. Rockefeller made an endowment of 1,000,000*l.* for the law school in the University of Chicago, and Mr. Andrew Carnegie has given 2,000,000*l.* to found an institution for scientific research at Washington. Mrs. Leland Sanford's gift of 6,000,000*l.* was in real estate and bonds and stocks. In making her gift Mrs. Sanford was actuated by the example of many wealthy persons in making bequests before their death in order to avoid possible will contests which might tie up the property for years. Mr. Carnegie's gift to endow research provides the United States with a fund which, wisely administered, will greatly strengthen university work in America and give an impetus to investigation which will have a profound influence upon the progress of the country.

THAT there is a widespread desire to modify the traditional methods of teaching the subjects of the ordinary secondary school curriculum and to bring them more into harmony with the practical needs of present everyday life, is strikingly shown by the frequent discussions on the desirability of reform in the teaching of mathematics which have taken place in the last few months. One of the most recent of such discussions was that which followed an address by Mr. W. C. Fletcher, headmaster of Liverpool Institute, at the meeting of the Incorporated Association of Headmasters held in London last week. Mr. Fletcher moved the following resolution, which was eventually adopted: "That this Association desires to press upon the universities and other examining bodies the desirability of greater elasticity in their regulations as to mathematical teaching, and is of opinion that to insist upon adherence to the order of propositions in Euclid is mischievous." Mr. Fletcher said that six years' experience of teaching geometry has led him to believe that Euclid is a great hindrance to ninety-nine boys out of every hundred in training and knowledge. A great deal of damage is done by insistence, not only upon the particular method, but on the particular order, of Euclid. As the result of his experience he had re-written the first half of Euclid's first book, omitted the second book, and introduced two or three propositions about proportion, in this way forming an interesting, sound and coherent plan. The headmasters were so impressed with the value of Mr. Fletcher's remarks that they decided to have his speech printed and circulated among teachers.

THE position of the University of Birmingham was described by the Vice-Chancellor, Mr. Chamberlain, at the second annual Court of Governors held on January 8. On the occasion of the former annual meeting the fund raised for the purpose of the University amounted to 330,000*l.*; it has now reached 420,000*l.* The Birmingham City Council has made a grant equal to a halfpenny in the pound on the borough rate, and this will provide about 5500*l.* per annum towards the ordinary maintenance of the University. The Staffordshire County Council has similarly identified itself with the aims of the University by making a grant of 500*l.* a year for five years in aid of the School of Mining and Metallurgy. It is hoped that the example will be followed by the county councils of Worcestershire, Warwickshire and Shropshire, and that the annual contributions from all these sources will amount to at least 7000*l.* per annum. With the practical assurance of this income, a sum of 300,000*l.* is available for the new buildings of the University. It is estimated that the buildings contemplated cannot be erected and equipped for a less sum than a million sterling. Out of the ten departmental blocks of the University, three are to be commenced, in the first instance, to accommodate the schools of mining and metallurgy, and of civil, mechanical and electrical engineering. A University Hall will also be erected. While the University buildings are being erected, the Mason College must be extended in some way and its equipment increased, in order to accommodate the additional students who have entered since the University was founded. For this purpose 10,000*l.* will be required, and Mr. Chamberlain announced that 6000*l.* had already been subscribed.

SCIENTIFIC SERIALS.

Annals of Mathematics (July and October, 1901).—Concerning Du Bois Reymond's two relative integrability theorems. The two theorems considered by E. H. Moore are, (1) a continuous function of (properly) integrable functions is integrable; (2) an integrable function of an integrable function is integrable. (1) was announced in 1880 and a proof published two years later (*Math. Ann.*, vols. xvi. and xx.). In connection with this proof (2) was announced. Dr. Moore in this note shows, by means of a simple example, that (2) is not true. Reference is made to a proof of (1) by Dini with an extension which is not applicable to the general case, but Dr. Moore extends Du Bois Reymond's general proof (1882).—P. Saurel, on a theorem of kinematics, gives an elementary demonstration of the well-known theorem that every displacement of a rigid body is equivalent to a rotation followed by a translation parallel to the axis of rotation.—The collineations of space which transform a non-degenerate quadric surface into itself, by Ruth G. Wood, discusses the ∞^6 collineations of space which transform the surface.—J. Westland contributes a note on multiply perfect numbers, with a view to determine all numbers of multiplicity 3 of the form $m = p_1^{a_1} p_2^{a_2} p_3$ where p_1, p_2, p_3 are three distinct primes and $p_1 < p_2 < p_3$.—The isoperimetrical problem on any surface, by J. K. Whittemore, gives a generalisation of the problem known to Pappus (see W. Thomson, "Popular Lectures and Addresses," vol. ii. p. 578). He solves Pappus's problem by the calculus of variations, and then solves, by an apparently novel method, the problem "Find a curve, $v = \phi(u)$, joining the two given points (u_0, v_0) and (u_1, v_1) having a given length L, and such that the area of the portion of the surface between the two curves, $v = f(u)$ and $v = \phi(u)$, shall be a maximum."—On a surface of the sixth order which is touched by the axes of all screws reciprocal to three given screws, by E. W. Hyde, has for its main object the determination and discussion of the envelope of a certain conicoid, which is touched by the axes of all screws of a certain system, so enabling one to grasp the nature of the system. The surface possesses other features of interest. The paper is illustrated with diagrams.—D. Sintsof, in a note sur l'évaluation d'une intégrale définie, discusses a previous note by M. Pell (evaluation of a definite integral, *Annals* (2), tome 1, No. 3).—The October number opens with a lengthy article (18 pp.) on the convergence of the continued fraction of Gauss and other continued fractions, by E. B. Van Vleck. Numerous references are given.—M. B. Porter supplies a short note on the differentiation of an infinite series term by term.—A note on geodesic circles, by J. K. Whittemore, discusses these circles in Bianchi's sense, viz. their definition is the locus of a point on a surface at a constant geodesic distance from a fixed point of the surface ("Vorlesungen über Differentialgeometrie," p. 160). Darboux ("Théorie Générale des Surfaces," vol. iii. p. 151) calls such a circle a curve of constant geodesic curvature. Mr. Whittemore gives three theorems—the first is, If, on a surface, there exists a family of concentric geodesic circles, such that the geodesic curvature of each curve of the family is constant, then the total curvature of the surface is constant along each curve of the family, and the surface is applicable to a surface of revolution, so that the geodesic circles fall on the circles of latitude of this surface.—Prof. Osgood gives a note on the functions defined by infinite series whose terms are analytic functions of a complex variable, with cor-

responding theorems for definite integrals. References to other memoirs abound.—Mr. C. L. Bouton gives an account of a game which he entitles "Nim" (a game with a complete mathematical theory). It is a game played at a number of American colleges and fairs and has been called "Fan-tan," though it does not correspond with the Chinese game of that name. He gives a description of the game (too curt, we think), and also discusses the theory of it.—Dr. G. A. Miller discusses the groups generated by two operators of order three whose product is also of order three, a short note, as is also the concluding one, on the invariants of a quadrangle under the largest subgroup, having a fixed point, of the general projective group in the plane, by W. A. Granville.

American Journal of Science, January.—An experimental investigation into the "skin" effect in electrical oscillators, by C. A. Chant. The skin effect was studied on sixteen cylindrical oscillators of various materials, including brass, iron, copper, gold, tin and silver, and of thicknesses varying from ·0000114 cm. upwards. The expected effect was not realised, as in the case of both the cylindrical and spherical oscillators the excessively thin gold shells were quite as efficient as the solid metal bodies.—The effect of hydrochloric acid upon the precipitation of cuprous sulphocyanide, by R. G. Van Name. In the presence of free hydrochloric acid the precipitation of copper sulphocyanide by a small excess of ammonium sulphocyanide is incomplete. The error can be reduced to a negligible amount by increasing the amount of the ammonium sulphocyanide.—The action of ammonium chloride upon certain silicates, by F. W. Clarke and G. Steiger. The minerals submitted to the action of the ammonium salt included stilbite, heulandite, chabazite, thomsonite, ilvaite, riebeckite, aegirite, serpentine, leuchtenbergite and phlogopite.—Studies of Eocene Mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman. The present instalment deals with *Mesonyx obtusidens*.—A cosmic cycle, by F. L. Very.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, January 7.—Mr. Charles Bailey, president, in the chair.—The president announced that the Society was indebted to Dr. Edward Schunck, F.R.S., for a mural tablet, placed in the secretaries' room, bearing the following inscription: "This room was the laboratory of John Dalton; here his great discoveries were made, and here he conceived and worked out his atomic theory."—Mr. J. Cosmo Melvill exhibited many species of the genus Chrysanthemum, L., and described its affinities and subdivisions. He directed special attention to wild examples of *C. sinense* from China and *C. indicum* from both China and Japan, these two species being the origins of all the garden varieties, the former of the long-petalled kinds and the latter of the short-rayed and pom-pom forms.—Mr. R. S. Hutton described experiments which he had carried out at the Owens College on the fusion of quartz by means of the electric arc. He finds that, with suitable arrangement, there is no inconvenience caused by the reducing action of the arc, and that, owing to the much higher temperature, the fusion takes place with greater rapidity than with the oxy-hydrogen blowpipe. Methods were described for making tubes of quartz of any desired length in an electric arc furnace, and specimens of tubes were shown.—Dr. George Wilson read a paper on the failure of certain cast-steel dies used in the manufacture of drawn tubes. During the process of manufacturing tubes, the dies have occasionally fractured, to the danger of those using them, and an attempt has therefore been made to estimate some of the stresses to which such dies may be subjected. The results show that out of six fractured dies of which particulars were obtained, five had a factor of safety too small to cover flaws and dynamic effects. An example of the stress in a die is fully worked out, showing by curve the nature of the stresses and distortions.—Mr. C. E. Stromeyer exhibited some chemical gas washers which he had designed for dealing with relatively large volumes of gas. The largest apparatus was capable of dealing with about 50 litres per hour, and one of the smaller ones, designed to hold only six cubic centimetres of fluid and weighing only 40 grammes, was able to deal with 5 litres per hour.

PARIS.

Academy of Sciences, January 6.—M. Bouquet de la Grye in the chair.—On the focussing of a collimator or a telescope by means of the measurement of a parallax, by M. G. Lippmann. A point P at a finite distance from the collimator is viewed through an auxiliary telescope and brought on to the cross-wire of its eyepiece. The auxiliary telescope is now displaced parallel to itself through a known distance; if the image of P still remains on the cross-wire the collimator is correctly adjusted for parallel rays. If not, the collimator is adjusted until this condition is satisfied. The sensibility of the method depends on the magnifying power of the auxiliary telescope, and increases rapidly with the dimensions of the latter.—A method for verifying if a slider or a rule is rectilinear, by M. G. Lippmann.—The preparation and properties of potassium hydride, by M. Henri Moissan. The existence of a a hydride of potassium has been known for some time; in the present paper an account is given of the difficulties encountered in the preparation of this body in a pure state. Hydrogen acts very slowly at a temperature of 360° C. upon potassium, giving a white crystalline hydride of the formula KH. This is instantly decomposed by water, takes fire at the ordinary temperature in fluorine, chlorine and in dry oxygen. It possesses very energetic reducing properties, comparable to those of calcium hydride.—On a tumour of the tendon of Achilles, by M. Lannelongue. The changes in this tumour, which was not malignant, were followed by radiography. It was cured without treatment in two years, and as an operation was not necessary its exact nature remained doubtful.—The stability of a system, for any perturbations, affected by a movement of uniform rotation, by M. P. Duhem.—On the geographical position of In-Salah, an oasis of the Touatian archipelago in the Central Sahara, by M. G. B. M. Flamand. The latitude and longitude of this point, about which there has been some controversy, as well as of five other points, were redetermined by the Tidikelt expedition.—On certain systems of total differential linear equations, by M. Émile Cotton.—On the universal vibrations of matter, by M. A. Korn.—On the electrostatic field round an electric current, and on a theorem by Poynting, by M. W. de Nicolaiève. An experimental study the results of which are in exact accord with Poynting's theorem.—The general equations of electrodynamics in conductors and perfect dielectrics at rest, by M. E. Carvallo. An analytical expression and a dynamical interpretation for the two general laws of electrodynamics given in a previous paper is here deduced and the results compared with those of Maxwell.—A new method for the measurement and recording of high temperatures, by M. André Job. An application of the fact that the viscosity of a gas varies rapidly with the temperature. Oxygen gas is evolved at a constant rate from a voltameter and allowed to escape alternately through two capillary tubes, one of which is at a known temperature and the other at the high temperature to be measured. The pressure under which the gas escapes in each case is measured with a manometer, and by a direct comparison with a Le Chatelier couple it was found that the ratio of the excess of pressure in the two cases is a linear function of the temperature.—On the absolute value of the magnetic elements on January 1, 1902, by M. Th. Moureaux. The values given are for the observatory of Val-Joyeux.—The action of copper hydrate upon aqueous solutions of metallic salts, by M. A. Mailhe. The salts studied were the sulphates of cadmium, nickel, cobalt, zinc, manganese, mercury, aluminium and iron.—On the condensation of hydrocarbons of the acetylene series with esters. The synthesis of acetylenic acetones and β-ketonic ethers, by MM. Ch. Moureu and R. Delange. The reaction between the sodium derivatives of œnanthyl-acetylene and phenyl-acetylene with ten alkyl esters has been studied. The reaction takes place in two ways; in some cases the acyl derivative R—CO—C≡C—R′ is produced, which can be hydrolysed to the β-diketone R—CO—CH_2—CO—R′, in others the β-ketonic ester is obtained directly.—The utilisation of hexoses by the organism, by MM. Charrin and Brocard. From the point of view of utilisation by the organism, lævulose occupies the first place, galactose the second and glycose the third.—The presence of a parasite in the blood of epileptics, by M. M. Bra. Three microphotographs of the blood in epileptic patients under different conditions are given. The results appear to show that a microorganism is always present at the approach of and during the attack. This organism is a streptococcus, which would appear to have special morphological

and biological characteristics.—Contribution to the study of phosphorus as a plant food, by M. Th. Schlœsing, jun.—New observations on the evolution and origin of Peripatus, by M. E. L. Bouvier.—On the orientation of the Crinorhiza, by M. E. Topsent.—On the discovery of a nummulitic layer in a boring executed at St. Louis, Senegal, by M. G. Vasseur. From these observations the conclusion is drawn that towards the end of the lower Eocene period the sea, forming a vast gulf in the eastern portion of the Lybian desert and in the Arabian desert, and covering a part of Algeria, bent round to the north-west of the African continent and followed at a distance the line of the Atlantic coast, reaching on the south the basin of St. Louis.—Comparison of the Cretaceous basins of Eaux-Chaudes, Gèdre and Gavarnie, by M. A. Bresson.

ST. LOUIS.

Academy of Science, December 16, 1901.—A paper by Messrs. K. K. MacKenzie and B. F. Bush, entitled "The Lespedezas of Missouri," was presented by title.—Prof. F. L. Soldan delivered an address on the advance made in education during the nineteenth century, stating that the most characteristic feature of the century's progress lay in the epoch of expansion and organisation which it marked. The influence of Pestalozzi, Froebel, Horace Mann, William T. Harris and other distinguished educators was traced, the marked change in opinion concerning the commercial value of education brought out by the Centennial Exposition of 1876 was indicated, and the establishment of a true University grade in the United States with the opening of the Johns Hopkins University, the year following, was commented on.—Prof. F. E. Nipher stated that he had continued his experiments on the production of ether disturbances by explosions, and by the motion of masses of matter. He had apparently succeeded in eliminating the effects of the shock of the air-wave upon the magnet-needle. The needle is adjusted to a condition approaching maximum sensitiveness. There is no iron about the apparatus, except what is contained in the needle and in the compensating magnets. The latter are clamped in place so that the structure on which they are mounted may be pounded by a mallet without disturbing the needle. Rowland effects due to convection of electrified particles have also been eliminated. There remains a marked deflection of the needle, seeming to indicate that an ether distortion or wave originates in a sharp or violent explosion. This result is so amazing that it is announced with the statement that the whole subject is yet under the most searching examination. The coherer and the receiver of the telephone are to be used in two wholly different plans of experiment, in one of which the effects along the entire track of a leaden bullet are to be summed up in an alternating current. The results which seem to have been reached are in entire harmony with the well-known experiment of Michelson and Morley, who found that the ether within the building in which they worked was being carried along with the building and with the earth in its orbital motion.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 16.

LINNEAN SOCIETY, at 8.—On the Use of Linnean Specific Names: H. and J. Groves.—Exhibitions: Branches of Cherry affected by the Gnomonia Disease, with Remarks on its Effects and Climatic Causes: A. O. Walker.—Photographs and Specimens of Heads of Wild Sheep, to Illustrate a recent Suggestion as to the Use of Large Horns in Feral Species: J. E. Harting.

CHEMICAL SOCIETY, at 8.—Myricetin, Part II.: A. G. Perkin.—The Colouring Matters of Green Ebony: A. G. Perkin and S. H. C. Briggs.—An Investigation of the Radioactive Emanation produced by Thorium Compounds, I.: E. Rutherford and F. Soddy.

FRIDAY, JANUARY 17.

ROYAL INSTITUTION, at 9.—Interference of Sound: Lord Rayleigh.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Theory of Heat-Engines: Captain H. Riall Sankey.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Modern Machine Methods: H. F. L. Orcutt.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Dysentery in Asylums: Dr. Mott, F.R.S.—The Relation of the Dysentery of Asylums to that of South Africa: Dr. Washbourn, C.M.G.

MONDAY, JANUARY 20.

SOCIETY OF ARTS, at 8.—The Purification and Sterilisation of Water: Dr. Samuel Rideal.

TUESDAY, JANUARY 21.

ROYAL INSTITUTION, at 3.—The Cell: its Means of Offence and Defence: Prof. A. Macfadyen.

SOCIETY OF ARTS, at 8.—The Architect's Use of Enamelled Tiles: Halsey Ricardo.

ROYAL STATISTICAL SOCIETY, at 5.—Tonnage Statistics of the Decade 1891–1900: Sir John Glover.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—On some Rude Stone Monuments in Yorkshire: A. L. Lewis.—On a Group of Cairns with Megalithic Cists in the West of Scotland, and the Human Remains associated therewith: Dr. T. H. Bryce.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: American Workshop Methods in Steel Construction: H. B. Molesworth.

WEDNESDAY, JANUARY 22.

SOCIETY OF ARTS, at 8.—Scientific Observations at High Altitudes: Rev. J. M. Bacon.

GEOLOGICAL SOCIETY, at 8.—The Fossiliferous Silurian Beds and Associated Igneous Rocks of the Clogher Head District (Co. Kerry): Prof. S. H. Reynolds and C. I. Gardiner.—A Process for the Mineral Analysis of Rocks: Prof. W. J. Sollas, F.R.S.

THURSDAY, JANUARY 23.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: (1) Mathematical Contributions to the Theory of Evolution. XI. On the Influence of Natural Selection on the Variability and Correlation of Organs; (2) On the Correlation of Intellectual Ability with the Size and Shape of the Head. Preliminary Notice: Prof. K. Pearson, F.R.S.—A Short Description of the Culicidæ of India, with Descriptions of New Species of Anopheles: F. V. Theobald.—The Affinity of Tmesipteris with the Sphenophyllales: Prof. A. P. W. Thomas.—On the Excretory Organs of Amphioxus: E. S. Goodrich.

ROYAL INSTITUTION, at 3.—Recent Excavations at Delphi and in the Greek Islands: Dr. A. S. Murray.

SOCIETY OF ARTS, at 4.30.—Bengal: the Land and its People: F. H. Skrine.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Earth Currents derived from Distributing Systems: E. B. Wedmore.

FRIDAY, JANUARY 24.

ROYAL INSTITUTION, at 9.—The Discovery of the Future: H. G. Wells.

PHYSICAL SOCIETY, at 5.—The Factors of Heat. Part I.: James Swinburne.—Exhibition of some Twinned Crystals of Selenite: Eustace Large.

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