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PROF. PERRY'S PRACTICAL MATHEMATICS.

Elementary Practical Mathematics. With Numerous Exercises for the Use of Students, and especially of Mechanical and Electrical Engineering Students. By Prof. John Perry, F.R.S. Pp. xiv+335. (London: Macmillan and Co., Ltd., 1913.) Price 6*s*.

DURING the past ten or fifteen years a great deal of work has been done by mathematical teachers in wiping old scores off the slate and redeveloping their teaching on more sensible and rational lines. It is well known that this revolution owes its success largely to the indefatigable exertions of Prof. John Perry. We cordially agree with many of the remarks contained in the preface to the present book. It is impossible to quote the whole of the author's attacks on the old-fashioned drudgery in algebra which has disgusted many would-be mathematicians in the past, and made it quite impossible for the present reviewer ever to appreciate anything but applied mathematics. We can only quote the first few lines:—

"Academic methods of teaching mathematics succeed with about five per cent. of all students, the small minority who are fond of abstract reasoning; they fail altogether with the average student. Mathematical study may be made of great value to the average man if only it is made interesting to him."

Now one difficulty that most teachers have experienced in developing mathematics on more rational lines has certainly been the difficulty of constructing suitable exercises, examples, and examination questions. It is not that it is intrinsically more difficult to construct practical questions than it was to devise the old "pretty" question to the effect that "if tweedledum" (meaning one jumbled mass of symbols) "shew" (never show) "that tweedledee" (an equally meaningless formula). Still, to stock a book with practical intelligent questions is so difficult a task that the author's statement, "In many cases each of the questions has taken several hours, and in some cases several days, to construct," will be well understood by everyone who has worked or tried to work on similar lines.

If Prof. Perry had only published his collection of questions under the title "Exercises in Practical Mathematics," we should have given the book our unqualified praise. Unfortunately, however, when he comes to deal with *bookwork*, we fail to find much difference between his "practical" mathematics and the old-fashioned "academic" mathematics, except that his methods are less logical, less interesting, and less convincing than those now adopted by our best teachers.

In fact, most of the bad features of our existing methods of teaching, which the author so violently attacks in his preface, will be found reproduced in his own text. The book, to some extent, resembles a recent volume which might be called "The Fool's Calculus," and which justified this title from the way the author had made an easy subject appear difficult. Let us now examine a few points in detail.

Prof. Perry is quite correct in saying that "when calculating from observed quantities it is *dishonest* to use more figures than we are sure of," although, perhaps, this mistake might be rather described as "unmathematical inaccuracy," than as dishonesty. But the only remedy he can suggest in the case of contracted multiplication is to multiply by 8651 when he wants to multiply by 1568. Very few teachers adopt this absurd and unnecessary method. A boy who has any common sense ought to learn not only to multiply numbers the right way round, but to be able to fix the position of the decimal point in any line of the products.

His definition of a logarithm is as follows:—

"If $a^n=N$ then $n=\log_a N$ and we read this as 'n is the logarithm of N to the base a.'"

Now the average schoolboy ought to learn to multiply and divide by means of a table of logarithms long before he knows what is the meaning of a^n. Besides, the definition is not a logical one unless n is a positive integer, because the very existence of quantities with fractional indices depends for its proof on the existence of a system of logarithms. By making up successive integral powers of 1·01 or 1·0001 or 1·0000001, we can prove the existence of logarithmic scales capable of performing numerical calculations to any required degree of accuracy, and these lead to the conception of the natural scale. Prof. Perry then says that "in many important calculations we need to use Napierian logarithms, whose base is 2·71828." "Why 2·71828?" asks the intelligent student. No answer is given; and this is what Prof. Perry calls "practical mathematics." We should call it cram. But the author continues to drag in this apparently useless and meaningless symbol e throughout the book, and when it occurs in such examples as the following (p. 30):—

"If $\log_e\frac{853}{493}+0\cdot9\times\frac{836}{853}=\log_e\frac{677}{493}+\frac{961}{677}x$, find the value of x to three significant figures"

—we fail to see the superiority of Prof. Perry's questions over the worst examples of the old Cambridge school.

A very few lines of explanation, based on the definition as a limit, would make the student take an intelligent interest in e. But having started on the wrong tack, Prof. Perry, on p. 150, fails to find a satisfactory proof of the differentiation formulæ involving e without assuming the exponential series, and by the time he uses the formulæ, on p. 189, it is too late to exhibit the significance of this important limit. An intelligent boy ought to be able to understand the compound interest law and the ordinary differentiation formulæ long before he learns how to differentiate the infinite series employed in Prof. Perry's proof. Take next the formula for the belt slipping on the pulley (p. 37). The formula $N/M = e^{i\theta}$ conveys no meaning to the student of average intelligence, and it is not the method that anyone with common sense would employ in experimental work. What he would do would be to use the formula $N/M = c^n$, where c is a constant and n the number of turns, c being found by experiment.

The same mistake is made with the radian. Prof. Perry (p. 62) expects his students to be as ready to *think* in *radians* as in degrees, but he conspicuously fails to impress his readers sufficiently with the *utility of the radian* in connection with the relation between angular and linear velocity and differentiation formulæ.

The chapter on algebra is a good feature, if for no other reason than the fact that existing textbooks on algebra are still so unsatisfactory. The proper method of introducing algebra is in connection with the *use of formulae*, and the converse use of formulæ naturally leads to the problem of *solving an equation*. In the conventional treatment the utility of the subject is completely ignored, and the study is presented in the form of hateful drudgery. But here, again, Prof. Perry lays stress on such problems as, "Divide a number into two parts," or "A father is 3·5 times as old as his son," of which we have had too many already.

In the chapters on mensuration, squared paper, and important curves, Prof. Perry is working on what is now well-known ground; at the same time his treatment is in many respects unsatisfactory, particularly in connection with curves. Thus we all know the importance of the cycloid in geometry, mechanics, and physics. But all that Prof. Perry does is to make the student plot this curve on squared paper by means of the equations $x = a(\phi - \sin\phi)$ and $y = a(1 - \cos\phi)$. When this is done the student knows nothing whatever about what a cycloid really is. An intelligent boy should learn to plot curves not only from their equations, but from their geometrical definitions; and, further, he should be trained to plot envelopes as well as loci. The mere drawing of graphs may easily degenerate into unintelligent drudgery quite as objectionable as any of the old algebraical drill of our schooldays. What is the use of asking boys such questions as the following?

"Find a value of x to satisfy

$$5{\cdot}3\, e^{0{\cdot}104x} \sin^2 0{\cdot}8x + 0{\cdot}78x^{1{\cdot}52} \cos x - 2{\cdot}126 = 0.$$

"The student must remember that $0{\cdot}8x$ is in radians, and must be multiplied by 57·296 to convert it into degrees. Ans. $x = 0{\cdot}74$."

In the sections on the calculus there is not very much fault to find with the practical illustrations, and, indeed, most of them are based on fairly reasonable views. But when the author comes to establishing differentiation formulæ he falls into the error of defining a differential coefficient as the limit of

$$\frac{f(x+\delta x) - f(x)}{\delta x},$$

instead of regarding it as the limit of

$$\frac{f(x_2) - f(x_1)}{x_2 - x_1},$$

when x_2 and x_1 both approach a common limit x, which may or may not be taken to be equal to either x_2 or x_1. Consequently he introduces higher powers of δx, which he afterwards has to neglect, and which ought never to have come in. The alternative definition here suggested leads at once to Lagrange's remainder theorem in the form,

$$f(x_2) = f(x_1) + (x_2 - x_1) f'(x),$$

where x has some value between x_1 and x_2.

The result is that in differentiating x^n Prof. Perry assumes the binomial theorem plus certain other assumptions not stated, whereas any pupil ought to differentiate x^n long before he has heard of the binomial theorem. In speaking of limits Prof. Perry says:—

"The plain man of common sense finds no difficulty in catching the idea. Two thousand years ago neither he nor a small boy would have had a difficulty in understanding that a hare would beat a tortoise in a race; it is the mathematical philosopher who makes a difficulty about such matters, and in these days he says that this fundamental idea of the calculus can only be comprehended by a mathematician. This would not matter if these philosophers were not entrusted with the education of youth, a trust for which all their training has unfitted them. When they come to explain the essential idea of the limiting value of $\delta s/\delta t$, they talk foolishly."

Readers of "Elementary Practical Mathematics"

will have no hesitation whatever in endorsing this statement!

While a great many notions are introduced into the text in such a way as to make them appear useless, uninteresting, and unintelligible, many of the most important points in a rational system of mathematical education receive little or no attention. Take the broad, general notion of a function, so simple that it can be explained to anyone who is sufficiently unmathematical to understand common sense. It is well illustrated in the case of the senior wrangler who entered the Stock Exchange and began to apply algebraic methods to the money market. He failed because he had omitted to take account of political considerations. Here was a case where the result was a function of a number of variables, and he treated some of these variables as constant. The senior wrangler was not sufficient of a mathematician. The mere failure to enumerate all the variables in a function occurring in everyday life represents a national loss of millions per annum. Prof. Perry says:—

"I must confess, however, that the compilers of modern school algebras must make the gods laugh over the uses to which they put this plotting of functions."

They certainly will do so when they read this book.

All this is a very great pity. Most modern mathematical teachers are only too glad to get "formula" questions for their pupils dealing with beams, expansion of steam, flow of water through pipes, electrical resistances, and other practical considerations which familiarise the student in the use of algebraic formulæ and equations. We believe they *can* get the questions they want from this book, and, on the other hand, when it comes to methods of teaching, every teacher naturally prefers his own. But if the substance of the text is a fair indication of what is meant by "practical mathematics," we agree with Prof. Perry's remark (p. xiii.), which, when quoted without its context, reads to the effect that

"The subject of practical mathematics is, I am happy to say, a subject which is not likely to commend itself to such institutions, nor are such text-books likely to be of much use to real students."

Evidently neither "academic" nor "practical" mathematics supplies exactly what is wanted. They both have one fault in common, namely, that they place difficulties before the student without any rhyme or reason. Mathematics is not in itself difficult or uninteresting; a child of three can invent a theory and notation for minus quantities without any assistance, help, or encouragement whatever. What we want is a subject that might be better described as "common-sense mathematics." Teachers are striving after this ideal, and it is very valuable and important to see clearly, as this book shows, that for the attainment of this ideal something more than "practical" mathematics is necessary.

G. H. BRYAN.

AN EGYPTIAN DESERT.

The Geography and Geology of South-eastern Egypt. By Dr. John Ball. (Survey Department of Egypt, Cairo.) Pp. 394. With Maps and many Illustrations.

THE area described in this latest monograph issued by the Geological Survey of Egypt is the southern part of the Eastern Desert—a district little known, and inhabited only by nomad Arabs of the Ababda and Bisharin tribes.

From north to south, this country is intersected by a mountainous axis which rises to heights of from 3000 to more than 5000 feet, and consists mainly of granite, diorite, gabbro, and other plutonic rocks. Eastward from this axis a series of Wadys run down, somewhat steeply, to the shores of the Red Sea on the east, these shores being almost everywhere bordered by coral reefs, which render the coast one of the foulest in the world for shipping. Westward from the mountain axis another series of Wadys lead down more gradually to the basin of the Nile. Dr. Ball, who is an accomplished surveyor as well as a geologist, has been able to add much to our knowledge of the physiography and scenery of this almost unexplored country. While devoting his chief attention to the geological features of the district—his discussion of the petrology being especially full and well illustrated—the author has been able to supply much new and interesting information concerning the antiquities, the plant and animal life, and the inhabitants—their languages, industries, and customs.

From a very early period the district has been credited with the possession of considerable mineral wealth, especially famous having been its gold-mines and emerald workings. Dr. Ball's researches, however, do not give much support to the belief that the district may in the future become a great mining centre.

It is true that very numerous small workings scattered all over the country show how wide and persistent has been the search for gold within the area. There do not appear to have been any alluvial workings, but numerous quartz veins, intersecting all the crystalline rocks of the district, sometimes containing calcite with ores of copper and iron, yield minute quantities of gold,

the particles of which are seldom visible. In small handmills of diorite this quartz appears to have been ground up and the gold extracted from it, but this appears to have been only profitable when done by convict labour. Prospectors in modern times, guided by the presence of these old workings, have attempted to carry on the extraction of the gold on a larger scale by modern methods, but only in a few cases has it been found that this can be done with profit, and most of the concessions have been surrendered.

The once-famous emerald-workings of Zabara and Sikait in this district are opened in masses of mica-schist, which alternate with gneiss, and contain crystals of tourmaline and beryl—the clear green varieties of this latter mineral constituting the valuable gem emerald. It would appear, however, that the ancients were satisfied with specimens which, owing to their clouded or flawed characters, do not appeal to the jewellers of the present day, and, extensive as the old workings undoubtedly were, there appears to be little chance of the industry being revived.

At several points on the Red-Sea coast, deposits of gypsum and anhydrite, with pockets of sulphur, occur, and concessions for the working of the latter mineral have been granted.

One successful mining industry, however, would appear to be in full operation in the little island of Tuberged, or St. John's, lying out in the Red Sea, forty or fifty miles from the coast. Here, in the midst of serpentine rocks, numerous beautiful crystals of peridot (oliome) are obtained, and the work of exploitation is being successfully carried on.

But although the expectations that this desert region might become a centre of a great mining industry do not seem likely of fulfilment, the district is not devoid of interest to the man of science. The rocks of the country exhibit, as shown by Dr. Ball, a very great variety and not a few remarkable characters, and the book before us, with its abundant photographic and other illustrations, is well worthy of the attention which it cannot fail to attract. J. W. J.

THE PROBLEM OF A PURE MILK SUPPLY.

The Milk Question. By Prof. M. J. Rosenau. Pp. xiv + 309. (London: Constable and Co.; Boston and New York: Houghton Mifflin Co., 1913.) Price 7*s.* 6*d.* net.

THE milk question is very much to the fore at the present time, and the appearance of this work is therefore opportune, and, although it embodies American views and practice, a great deal of it is applicable to our conditions. The author is well known as the present professor of hygiene at Harvard, and former director of the Hygienic Laboratory, Public Health and Marine Service, U.S.A., who has contributed much to the scientific investigation of milk and its bacteriology. From the sanitary point of view the book is sound, but, in addition, its author shows a knowledge of the subject from the producer's point of view, a side of the question which is frequently overlooked by sanitary reformers in this country. Written in simple language, it is a book for the educated public generally, and many striking cartoons and diagrams and terse sayings serve to drive home the views enunciated, *e.g.*—

"It (milk) requires scrupulous care from pasture to pail, and from pail to palate."

"The milk problem starts with the cradle, and ends with the grave. Sometimes it leads to an untimely grave."

One or two considerations may be quoted as illustrating the author's appreciation of the producer's point of view. As regards the question as to where the blame lies for an unhygienic milk supply, the author says the tendency is for the consumer to blame the producer, for the producer to blame the consumer, for the middleman to blame both of these, and for the health officer to blame all three. Really, society must blame itself; we are suffering the inevitable penalties we must pay for modern conditions of life, and of all those concerned the farmer is least to blame for the situation as it exists, and the consumer in the city should be ever mindful that he has largely brought the conditions upon himself.

While expressing the opinion that bottled milk is the ideal method of distribution, Prof. Rosenau fully recognises its dangers and difficulties—difficulties in the cleansing and handling of the bottles and in transportation, which, he points out, is expensive, bulky, the breakage is considerable, and the return freight adds to the cost. He looks forward to the time when milk will be dispensed in some form of cardboard non-returnable package.

On the mixing of milk from several cows, this the author says is desirable, as it furnishes a more uniform product, and tends to dilute infection if present; this the framers of Bills in this country might note.

On the cells present in milk, it is stated that normal milk has relatively few or no leucocytes, and, when critically examined, the majority of cells distinctly differs from leucocytes.

The author would ascribe from 5 to 7 per cent. of all human tuberculosis to infection with the bovine bacillus, but he is careful *not* to suggest that this is necessarily derived from milk, and quotes Weber's observations (made for the

German Imperial Board of Health), which seem to show that the risk of infection from tuberculous milk is surprisingly small.

Clean milk, and methods of producing and controlling it, are dealt with at some length, and some interesting details are given respecting certified milk.

A long chapter is devoted to pasteurisation of milk, and this process is strongly advocated, under proper safeguards, such as labelling with the time, temperature, and date of pasteurising, as a general method for treating the milk supply if a pure milk cannot otherwise be guaranteed.

Singularly little is said respecting infants' milk depôts. In view of the comparison made by some between the United States and this country in this respect, we should have expected more information had this method of dealing with infant mortality the importance which some would ascribe to it. Altogether the book is a valuable one, and one to read, ponder, and digest.

R. T. HEWLETT.

OUR BOOKSHELF.

Theoretische Astronomie. By Dr. W. Klinkerfues. Neubearbeitung von Dr. H. Buchholz. Dritte verbesserte und vermehrte Ausgabe. Pp. xxxviii + 1070. (Braunschweig: F. Vieweg und Sohn, 1912.) Price 50 marks.

THE claims of Klinkerfues and Buchholz are readily admitted by all acquainted with the calculation of orbits. The classical treatises of Oppolzer and Watson having run out of print, it was most fortunate that this, the practical, side of gravitational astronomy was taken up by Buchholz, who extended the original work of Klinkerfues to make it fit to take the place of the former works. The plan of dividing the subject-matter into lectures (*Vorlesungen*) is still continued, although much is unsuitable for verbal exposition. Lecture 14, for example, extends to ninety pages, and gives, besides the general theory of the earth's rotation, all the formulæ necessary for the reduction of observations.

The greater part of this edition agrees exactly with the last, but the additions are well worthy of attention. The new preface runs to twenty pages, and gives a historical treatment of recent advances in the theory of orbits. Although Gyldén's work in no way enters into the subject treated in the work, Buchholz has described at some length the claims of the great Swedish astronomer. We believe that posterity will give to Gyldén the place which is due to one who did much for the cause of dynamical astronomy as applied to real, in contrast with merely ideal, problems. The criticisms of Bauschinger and others have led to Harzer's method not being developed, but the vector method of Willard Gibbs is retained. We are glad to see that Leuschner's method has been introduced. The method is carefully explained, the formulæ are collected, and a considerable number of examples are worked out. The necessary new table is given, and Oppolzer's M- and N-tables have been reproduced.

An appendix gives the known errors in the works of Bauschinger and Oppolzer on the determination of orbits.

The greatest fault of the book is its bulk. For a work intended to assist in the numerical calculation of orbits it is almost essential that the auxiliary tables should be easily manipulated. This work could with advantage be divided into several volumes. J. JACKSON.

New Contour Map of the Near and Middle East (The Land of the Five Seas). (London: G. W. Bacon and Co., Ltd.) Price 7*s.* 6*d.*

THIS wall-map includes the empires of Babylon, Persia, Parthia, Egypt, and Rome. It shows the routes of Alexander the Great, Pompey, and St. Paul, and illustrates classical history from the earliest times. The scheme of ten colours makes it possible to show with impressive clearness the close relation between land configuration and the spread of civilisation. The scale of the map is ninety-five miles to an inch. In the bottom left corner an inset orographical map of Palestine is provided. The size of the map as a whole—40 by 30 in.—will indicate that it is scarcely large enough for use in big classes, but it should prove of service to individual students in the higher forms of secondary schools.

The Tarn and the Lake. Thoughts on Life in the Italian Renaissance. By C. J. Holmes. Pp. xi + 48. (London: Philip Lee Warner, 1913.) Price 2*s.* 6*d.* net.

THIS essay of Mr. Holmes forms very pleasant reading; originally designed as an introduction to a few studies of Italian painting and sculpture, it overran its intended bounds and became eventually the present little volume. Entertaining analogies are drawn between certain communities of fish and certain societies of men, and though the appeal is more directly to anglers, all readers who appreciate literary expression will enjoy the essay.

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.*]

Pianoforte Touch.

THE question as to whether what is known as touch is due to any peculiarity, apart from the energy, with which the hammer strikes the strings, and, consequently, with which the fingers strike the keys, would appear to be determinable by direct experiment. Personally I have always held, probably with the majority of people, that touch is dependent on such peculiarities, but the evidence seems to be decidedly against it. A note was struck one hundred times in succession so as to produce sound of as nearly as possible the same intensity; on half these occasions it was struck in a pressing, or caressing, manner; in the other cases it was struck sharply; the different

kinds of blows were intermingled irregularly, and according to a list previously drawn up, and the damper was held up while the note was being struck. As each note was struck a verdict as to its quality was given by a person sitting out of view of the piano, and this verdict was compared with the character of the blow given. The observer, it should be mentioned, was not a trained musician, but was exceptionally appreciative of what is called touch.

Discarding all cases where the note had accidentally been more or less loud than the average, it was found that in 49 per cent. of the cases of uniform loudness the effect on the auditor coincided with the character of the blow given, in 51 per cent. the reverse. In another series of 100 notes the values were 51 and 49 respectively. It is evident, therefore, according to this, that different quality of touch produces no difference in the quality of the sound produced. No doubt further evidence should be obtained by a repetition of such experiments with other performers and other observers, and a further test would be obtained by having two performers alternately striking the same note, and ascertaining whether the observer could detect the difference.

Even if the independence of "touch" on the character of the stroke is fully established, there is no difficulty in explaining the apparent difference in touch of a performance with the fingers and one with a piano-player. At least seven factors may be specified as determining touch:—(1) Differences in loudness of a note (or notes) as compared with that of the preceding notes, (2) deviation from the theoretical value, according to the score, of the duration of the note as compared with that adopted for the preceding and succeeding notes (*i.e.* different degrees of *staccato* or *legato*); (3) variations in time as compared with that of the preceding notes; (4, 5, and 6) similar differences in loudness, duration, and time of one note in reference to its nominally contemporary notes; (7) the use of the loud pedal. The use of the soft pedal is so specialised that it need not be considered; it is used more for modifying a whole passage than for modifying individual notes, and it practically gives the performer the command of a second instrument; but, perhaps, an eighth factor of a general character should be included, namely the extent to which the above means of emphasising notes is made to harmonise with the rhythm and sense of the music.

Now, in the piano-player we have the means, either by moving levers or by pressure on the bellows, of altering the loudness (1) or time (3) of a note as compared with that of preceding notes, but such alterations are gross and sluggish in comparison with those possible in finger playing; the inertia of the mechanism has to be overcome, and the result depends directly or indirectly on the pressure of air in the bellows, which cannot be altered instantaneously. The least unsatisfactory operation is a retardation of the time. The duration of the note as compared with that of its neighbours (2), or of its fellow-notes (5), as well as the loudness of it as compared with its fellow-notes (4), can only be accomplished by modifications in the slots of the roll, and they are, therefore, stereotyped and always the same; this produces a very unsatisfactory result.

When hearing for the first time a well-played piece with the air strongly brought out in this way, the impression produced is decidedly favourable, but at the second hearing a sense of irritation is felt; we know exactly the degree of emphasis which is going to be placed on each note of the air, and the monotony is even more trying than where no emphasis is attempted. It is a case similar to that of a beautiful landscape which never changes; the charm of music lies largely in its imperfections, or, at least, in the varying and unexpected degree in which its beauties are brought out. An alteration in the time of contemporaneous notes (6) is, I believe, attempted on some rolls, but the effect, I should imagine, would be even less satisfactory than in the other cases. The use of the loud pedal is a potent defect in the piano-player. Needless to say, this pedal is not used in good finger playing only to produce loudness, but more generally to produce softness, and a smooth flow of sound. In a slow movement a good performer will often depress and raise the pedal for nearly every note, and the effect produced depends entirely on the correct timing of these movements with the depression of the keys; this is impossible unless the messages from the brain to the fingers and to the feet are simultaneous. This cannot be so with a piano-player, where the sound is produced by a separate mechanism; this sound (either of the particular note in question or of its predecessor) must travel to the brain, which then has to interpret it, and to send a message to the finger which controls the pedal lever; the performer is conscious of an act of thought being necessary in using the pedal of a player, whereas in finger playing its use appears as if it were instinctive. With the player it is practically only used for producing loudness.

I believe that the thud of the air on the keys is another defect in the player. When in the same room as the instrument, it seems possible to decide after hearing one bar whether the player or fingers are being used, and this is certainly so, as I have ascertained by trial, and apparently more easily so, when one is in a distant room, the reason of this being that the thud penetrates the walls more easily than the note, and hence attains more relative predominance. I have an instance of this in a striking clock, of which the note is inaudible in the next room, while the thud can be distinctly heard.

No doubt many of the defects of the piano-player will be diminished in time, especially by such devices as those of Prof. Bryan. Already one of the best piano-makers is putting on the market an instrument which is a great advance on its predecessors, the chief feature of it being a reduction in the size of the bellows, which admits of much greater control over the sound production. Still, it is a case of playing with the feet, instead of with ten independent fingers.

When the damper is allowed to act in the ordinary way, it is possible that the effect produced (touch) may be modified by the character of the blow given to the keys, for this blow results in the damper being raised, as well as in the hammer striking the strings, and these two actions may not synchronise to the same extent with blows of different character.

SPENCER PICKERING.

A Danger of so-called "Automatic Stability."

FROM time to time devices have been proposed for securing "automatic stability" in aëroplanes by means of a suspended weight or "pendulum," which operates on rudder-planes governing the motion of the machine. A similar device is also in actual use for governing the motion of torpedoes in a vertical plane, in conjunction with a further device for maintaining the torpedoes at a constant depth below the surface, or more strictly at a level where the hydrostatic pressure is constant. "Pendulum" arrangements for automatic stability of aëroplanes have frequently figured in the pages of such journals as *The Scientific American*, and it must be admitted that such devices are calculated to appeal strongly to the imagination of readers whose knowledge of dynamical principles is limited in range or *nil*.

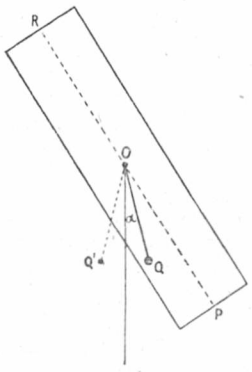
The statement, which stands in my name, to the

effect that such a device increases the number of degrees of freedom of the apparatus with an accompanying increase in the number of possible oscillations and of conditions necessary for stability is, I believe, incontrovertible. One form of dynamical instability that may result in such cases is the setting up of violent oscillations, ever increasing in amplitude, in the pendulum itself, accompanied by flapping of the control planes, in which case this particular method of control becomes worse than useless.

The remedy which naturally suggests itself, in such circumstances, is to damp down the oscillations of the pendulum by means of frictional or other resistances, and it is probable that few university graduates who have taken first-class honours in mathematics would think that such a contrivance could possibly be wrong. The following test case will show how very dangerous it is to attempt to draw conclusions from general considerations.

For the aëroplane or torpedo, we substitute a heavy, rigid body POR, free to rotate without resistance about a horizontal axis through its centre of gravity O, perpendicular to the plane of the paper, and therefore, in the absence of other causes, in neutral equilibrium, and we assume that the moment of inertia of this body is considerable.

We next imagine a light, small pendulum OQ to be fixed in bearings in the body POR, so that it can turn about the same axis, but we suppose that a frictional couple is called into play between the large body and the pendulum at these bearings. The pendulum being light, this frictional couple exerts no appreciable effect on the large body POR, but the friction is sufficient rapidly to damp out the oscillations of the pendulum itself. The effect of a rudder plane controlled by the pendulum we represent by the assumption that the pendulum operates some mechanism which impresses on the large body a couple proportional to the angle QOP, tending to make it revolve towards OQ, the object of this couple being to bring that body into a position of rest in which OP is pointing vertically downwards.



When the large body is rotating in the counter-clockwise direction (as in the figure) the small pendulum assumes a position of equilibrium OQ on the right-hand side of the vertical, and inclined to the vertical at a certain angle α, the moment of its weight then just balancing the frictional couple. When the body begins to swing backwards the pendulum swings with it until both have described an angle 2α, so that the pendulum occupies the position OQ′, now making an angle α on the opposite side of the vertical. During this portion of the motion the controlling mechanism impresses on the body a constant angular acceleration, because the angle QOP remains constant. Consequently in the new position the body is rotating with a certain angular velocity set up by this acceleration. In the subsequent motion the pendulum remains at rest in the position OQ′, and the body performs a simple harmonic rotation about OQ′, but owing to its initial angular velocity it does not come to rest until its angular distance from OQ′ is greater than the angle QOP. It follows by this reasoning that the oscillations increase in amplitude, and this effect owes its existence to the frictional couple.

G. H. BRYAN.

The Structure of the Diamond.

WE have applied the new methods of investigation involving the use of X-rays to the case of the diamond, and have arrived at a result which seems of considerable interest. The structure is extremely simple. Every carbon atom has four neighbours at equal distances from it, and in directions symmetrically related to each other. The directions are perpendicular to the four cleavage or (111) planes of the diamond; parallel, therefore, to the four lines which join the centre of a given regular tetrahedron to the four corners. The elements of the whole structure are four directions and one length, the latter being, in fact, $1{\cdot}52 \times 10^{-8}$ cm. There is no acute angle in the figure. These facts supply enough information for the construction of a model which is easier to understand than a written description.

If we proceed from any atom, using only standard directions, to the next but one, the straight line joining the first to the last is a diagonal of a face of the cubical element of structure; if we move in the same way through four stages, using all four standard directions in turn, the straight line joining the first and the last is a cube edge. Starting from any atom we can return to it after six stages, using three standard directions twice each. In this way we always link together rings of six carbon atoms.

If the structure is looked at along a cleavage plane it is seen that the atoms are arranged in parallel planes containing equal numbers of atoms, but separated by distances which alternate and are in the ratio 3 : 1 (actually $1{\cdot}52 \times 10^{-8}$ cm. and $0{\cdot}51 \times 10^{-8}$ cm.). It is a consequence of this arrangement that no second order spectrum is reflected by the (111) planes, although spectra of the first, third, fourth, and fifth orders are found. It was this fact that suggested the structure described above. Several other tests, however, may be applied, and all are satisfied.

Zincblende appears to have the same structure, but the (111) planes contain alternately only zinc and only sulphur atoms. In this way the crystal acquires polarity and becomes hemihedral.

W. H. BRAGG.
Leeds, July 28. W. L. BRAGG.

Artificial Hiss.

REPLYING to the inquiry of Lord Rayleigh (in NATURE of May 29, vol. xci., p. 319) as to the way in which an artificial hiss may be produced with a moderate pressure of air, I suggest that a current of air directed against a sharp edge of a knife held somewhat obliquely may answer his purpose.

In this connection it is interesting to note that for the formation of the hissing sound in our mouth the presence of saliva seems necessary. If I dry the tongue and the other parts which are needed for the pronunciation of the hissing "s," it is almost impossible to produce an audible "s," and the tongue—instinctively, as it were—makes an effort to gather some saliva and to wet itself.

I would therefore suggest that Lord Rayleigh wet the end of the rubber tube with which he experimented.

FRED J. HILLIG.
Kioicho 7, Kojimachi, Tokyo, July 1.

IT had occurred to me also that the moisture of the mouth might play a part in the production of a hiss, but I do not find that such drying as I can give makes an important difference.

I have to thank several correspondents for suggestions. In particular, Mr. G. Beilby sent me two pipes suitable for a 4 in. water pressure, which gave a better effect than anything I had then tried, but still, in my estimation, much short of a well-developed

hiss. I doubt much whether any pure tone gives the full impression of an "s," having often experimented with bird-calls of about the right pitch. Perhaps a rapid *change* of pitch is essential. RAYLEIGH.

Prof. Armstrong and Atomic Constitution.

IN the April number of the quarterly journal called *Science Progress* appears an article signed H. E. A., in which that distinguished chemist at length accepts, though not without hesitation and sustained scepticism, some of the results deduced by physicists from the phenomena of radio-activity; but he takes the opportunity of restating and reinforcing his opinion that the inert gases—helium, for instance—are not really monatomic—an opinion expressed by Prof. Armstrong soon after the discovery of argon.

To maintain this rather strained position in face of experimental facts, a considerable amount of what seems to me gratuitous hypothesis is required; and since it is desirable to come to a better understanding of this matter, I propose to criticise his attitude, in a friendly way, in the October number of the same journal. OLIVER LODGE.

Distribution of Amphidinium.

BIOLOGICAL readers of NATURE will perhaps recollect the record of the finding of the dinoflagellate, *Amphidinium operculatum* (previously unknown in Britain), on the beach at Port Erin a couple of years ago. Since then it has been present in great abundance at Port Erin on many occasions; Mr. R. D. Laurie has found it at Hoylake, near Liverpool, two of our young Liverpool zoologists (R. J. Daniel and J. E. Hamilton) now at the Belmullet Whaling Station, co. Mayo, inform me that they have noticed it on the shores of Blacksod Bay, and now I have to-day found it here in abundance, staining slightly in patches and streaks the beautiful white shell-sands of Iona.

Both the forms found at Port Erin—viz. the shorter discoid (the typical *A. operculatum*) and the larger more ovate form which I have described from Port Erin—occur here, associated with a few Naviculoid diatoms.

It seems probable that this curious dinoflagellate, known in the living state so far as I can ascertain to very few biologists, and previously recorded from only three or four far-distant localities, is really very generally distributed, and might be found by careful searching on many sandy beaches.

W. A. HERDMAN.

S.Y. *Runa*, Sound of Iona, N.B., July 20.

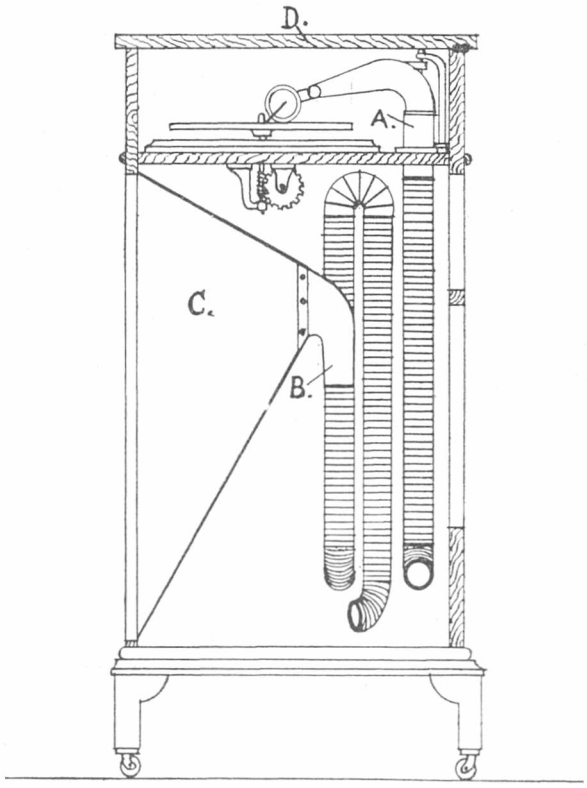
Gramophone Improvements.

I HAVE greatly improved my gramophone, at any rate for use in rooms of moderate dimensions, by applying to it both the long tube arrangement for eliminating scraping noises—described by Mr. Ernest De la Rue in NATURE of November 14, 1912—and also the "donkey's ear" form of trumpet, devised by Mr. Sidney G. Brown, which I have the latter's permission to describe.

The accompanying illustration shows an elevational section through the instrument as altered. From the sound-box, the sound passes through the usual movable arm and the socket A into one end of about 14 ft. of 2 in. flexible steel pipe, arranged in six vertical lengths, of which four are shown in the illustration; the other end of the pipe, B, being connected to the trumpet C. As in the case of Mr. De la Rue's machine, the bends in the pipe are made of zinc, and it seems that it is chiefly these bends that almost entirely eliminate the scraping noise due to the friction of the needle on the record.

The "donkey's ear" trumpet devised by Mr. Brown is shown in section at C. It is made of four flat pieces of three-ply Birch fretwork wood of about $\frac{1}{8}$ in. total thickness. It has an oblong mouth, and its special feature is that, like the ears of donkeys and many other animals, it is shaped with a top and bottom of unequal lengths so as to resonate comparatively equally to sounds of widely different pitch.

It has been found desirable to put a felt seating for the lid D to rest on, as though previous to the alteration the amount of scraping noise that came



out through the trumpet was so considerable that it made very little difference whether the lid was closed or open; with the new arrangement this scraping is eliminated to so great an extent that until the felt was inserted quite an appreciable amount of noise was found to come out round the lid.

Though the instrument is not so loud as previously, the reproduction of sounds of all descriptions seems now much more accurate than before, while the objectionable scraping noise has been virtually done away with. A. A. CAMPBELL SWINTON.

66 Victoria Street, London, S.W., July 24.

The Maximum Density of Water.

I FEAR Mr. W. B. Croft will get few to agree with him in supposing that it would make little difference in the conditions existing on the earth whether water was at its maximum density at 0° or at 4° above it (NATURE, July 17). If water was densest at 0° there would be little surface ice, as water does not change to ice at 0° unless in the presence of ice crystals or other solids. The ice-cold water would therefore, after sinking, freeze when it came in contact with the solid bottom, and we would have much anchor ice and but little on the surface. The small margin of only 4° does not seem to be quite enough entirely to prevent anchor ice; still we have reason to be thankful for these few degrees.

JOHN AITKEN.

THE UNPUBLISHED PAPERS OF J. J. LISTER.

A LARGE parcel of miscellaneous papers by J. J. Lister, and some pieces of apparatus, were left to the Royal Microscopical Society by the late Lord Lister. The papers were eventually submitted to me for examination, and this resulted in the discovery of the important paper on the limit of defining power in vision with the unassisted eye, the telescope, and the microscope now published in the society's journal.[1]

The underlying remarkable experiments were made, and a first—still existing—MS. prepared in 1831–2, shortly after Lister had published his famous paper on the improvement of the achromatic compound microscope (Phil. Trans., 1830, pp. 187–200). The manuscript was entirely rewritten, practically as now published, in 1842–3, and again revised in 1853; but although the author lived until 1863, he never published this excellent piece of work, which is interesting and instructive even now, fully eighty years after the doing of it and just fifty years after the author's death.

The original paper is now so easily accessible, and is so well worth reading, that instead of giving a detailed account of the contents I propose discussing more particularly those of Lister's results which are either of real interest even at the present time, or open to criticism as to their validity.

The most striking feature of the work—and undoubtedly so intended by the author—is its absolute homogeneity; for precisely the same objects were used in experimentally determining the limit of resolving power of the naked eye with full aperture and through circular apertures down to 0·90059 in. diameter, of telescopes of various apertures up to 4 in., and of a large number of good microscope objectives covering a wide range of angular apertures.

The objects, which are still in existence, being included among those now in the keeping of the Royal Microscopical Society, were very accurately made coarse gratings, produced by sticking paper on glass plates, cutting parallel lines through it, and removing strips at equal intervals. There was also a similarly produced chess-board pattern on glass, the separation from line to line or square to square being of the order of 1/10 in. This coarseness of the objects leads to the principal point worth discussing; for, as only 400 ft. distance was available, the objects could not be observed directly, even in the telescopic experiments, a diminished image of the actual object in a convex mirror having to be used instead.

In the microscopic observations a very greatly diminished image was employed which an auxiliary objective of higher power and wider angular aperture than that to be tested projected in the common focal plane of both. To most people this will appear as a perfectly legitimate proceeding involving only the most elementary optical assumptions and therefore not open to objection. But a crude method of carrying out this process with the microscope by observation of the small images formed by air-bubbles or fat-globules in a watery liquid has been severely criticised by Abbe for two reasons: first, because such images, when received by microscope objectives of wide aperture, must be affected to such an extent by aberrations as to render any calculation as to their size and nature utterly futile. Little can be said against this, but it does not apply to Lister, as he takes great care to state that the projecting lens was a perfectly corrected and carefully adjusted microscope objective. But Abbe raised a second objection of more serious aspect:—

"Even supposing that a perfectly corrected projection-system be used, the observation is not really a microscopical one at all; it is a quasi-telescopic observation of the actual object by an instrument giving erect images, consisting of the projecting system and the real microscope, which latter acts merely the part of an erecting eye-piece."

There is no answer to this argument *so far as it goes*. But it really misses the crucial point, the only point of interest, altogether. And if we concentrate our attention on this, the question to be answered becomes this: Does the light received by the microscope from a perfectly corrected projecting lens differ in any essential respect from that which it would receive from a real object similar in every respect to the large one actually used, but diminished in size according to its distance from, and according to the focal length of, the projecting system?

The only answer to this question seems to me to be that there is no essential difference, and that Lister's results are perfectly valid. For on the older theory, which assumes that objects may be treated as if they were self-luminous, each point in the real object will send out spherical waves towards the projecting system, which turns them into perfectly spherical waves converging towards the conjugate point of the aërial image, from which they expand again so as to form, at a little distance, perfectly spherical waves *from* the same conjugate point as a centre, precisely as if the conjugate point itself were the true origin. The complicated interference phenomena which arise close to the focal plane, in what the late Dr. Johnstone-Stoney so aptly called the region of turmoil, have no effect on the form of the waves beyond that region. And if we adopt the Abbe theory we are led to substantially the same conclusion, for by the combined effects of the principle of equal optical paths between conjugate points and of the optical sine-condition we can easily show that the diffracted waves received by the projecting system are turned into such directions as to correspond exactly in every respect to those which would be sent out by an actual object of the size and structure of the ideal image of the real object.

We may indeed say that Lister not only gained the advantage of absolute homogeneity by his procedure, but that he avoided a very grave objection which, in fact, renders open to doubt,

[1] Journ. R. Micr. Soc., 1913, pp. 27–55.

if not absolutely futile, much of the work done by amateur theorists—namely, that observations for theoretical purposes must be made on objects of a structure which is perfectly known by some independent method, as otherwise we are moving in a "vicious circle." It is clear that in the case of the higher powers of the microscope this difficulty cannot be avoided with delicately marked natural objects examined directly.

The numerical results obtained by Lister are still of great value.

For the naked eye he finds that there is practically no gain in resolving power when the pupil is opened beyond 0·095 in.; that the difference in keenness of vision of different individuals rapidly decreases when smaller and smaller apertures are placed before the eye, and that with apertures below about 0·025 in. all reasonably normal eyes have the same resolving power which corresponds to his general formula. In this section we find a remarkable instance of the accuracy of his observations; for he records the fact that—contrary to his preconceived idea—two or three lines are more easily separated than a larger number; this has in recent times been theoretically confirmed!

The telescopic section is the shortest, owing to difficulties from unsteady air and bad light. But it includes interesting measurements of the diffraction rings of the spurious star-disc. The limit of resolution arrived at is 4·33 seconds of arc divided by the diameter of the object-glass in inches.

Probably the most remarkable results are those recorded in the microscopical section, which also contains the most surprising proof of the extraordinary accuracy of Lister's observations. For these enabled him to deduce that the resolving power of microscope objectives did not increase in proportion to the angle of aperture, but to the chord of that angle—in modern language, to what Abbe, forty years later, called numerical aperture. When it is considered that the widest angle accessible to Lister was one of 80°, and that even for that the ratio of chord to angle is merely that of 10 : 13, it will be realised that this was a very creditable feat.

The limit of resolution for the microscope arrived at by Lister, when translated into modern terms, is 95,240 lines per inch for N.A. 1·00. It should, however, be stated that although there are a very few observations reaching or slightly exceeding the figures finally adopted in the paper, these are not the *mean* of all the observations. Unlike some modern microscopists, Lister understood the meaning of the word limit as a practically unsurmountable barrier which should only be closely approximated under extremely favourable conditions, and he adopted his final numbers accordingly.

In conclusion I should like once more to advise those interested in instrumental optics to read this extremely interesting paper *in extenso*.

A. E. CONRADY.

THE ANCIENT ARTISTS OF SOUTH-WESTERN EUROPE.

THE attention of readers of NATURE has been directed from time to time to the numerous and interesting archæological discoveries in the caves and rock-shelters of central and southern France and northern Spain, which are due to the energy and skill of Prof. l'Abbé H. Breuil, MM. L. Capitan, E. Cartailhac, Prof. H. Obermaier, E. Piette, and others. During the last two or three years similar investigations have been made in other parts of Spain, mainly by the indefatigable Abbé Breuil with the co-operation of Juan Cabré Aguilo, Pascual Serrano Gomez, and Gomez Moreno, and we should like to take this opportunity of congratulating the Spanish archæologists on pursuing this fascinating line of inquiry, which already has led to important results.

The epoch-making monograph "La Caverne d'Altamira," by E. Cartailhac and H. Breuil (1906), is being followed by the publication of equally sumptuous memoirs on the more important French caves. These, together with the numerous papers and smaller memoirs that have already appeared (mainly in *l'Anthropologie*), prove that central and southern France and Spain north of the Cantabrian Mountains constituted an area throughout which the later stages of Palæolithic culture were spread with remarkable uniformity. This sequence consists of the Aurignacian, Solutrian, Magdalenian and Azilian industries, with their accompanying manifestations of glyptic and pictorial art.

The earliest phases of the art of the Franco-Cantabrian area are characterised by rude statuettes of the human figure, which are followed by beautifully executed carvings of animals in the round or in relief, and by large numbers of engravings on bone, ivory, and stone. The earliest engravings are linear scrawls, and even rude but vigorous drawings of animals on clay surfaces. The walls of numerous caves were also decorated with engravings and paintings of animals, of which the following sequence has been established.

First phase: the engravings consist of broad deep incisions; many of them are unrecognisable; some are profile representations of animals with but two legs drawn; the paintings have a similar character, but the earliest efforts were simple impressions in colour of the human hand and timid attempts at linear designs and grouped dots. Second phase: the incisions are still broad and deep, but the drawings are more lifelike; the four legs are shown, and hair is often indicated; the clever brush outlines of the earlier part of this phase are replaced by monochromes, some of which are beautifully shaded. Third phase: the engravings are now in thin lines; they vary in excellence, but some are real masterpieces; the paintings are deplorable, owing to an excessive use of pigment. Fourth phase: the engravings lose their importance, and in some cases are merely

employed as subsidiary to painting; the artists try to regain by the use of various colours the modelling lost in the preceding phase; at first they are timid, the animals are outlined in black and the paint laid on in masses, but they soon obtain a mastery of the technique, and produce wonderful shaded polychrome paintings of bisons, boars, and other animals in various positions. Fifth phase: there is no longer any mural engraving; nor are there paintings of animals, but merely painted bands, branched designs, dots, and so forth. With this decadence that marks the Azilian period comes the close of the Palæolithic age.

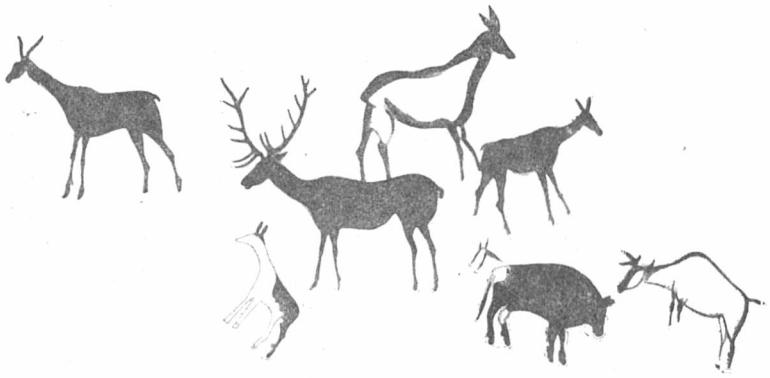


FIG. 1.—Group of red animals on a rock at Cogul: stag surrounded by hinds; to the right an ox and elk. Behind the ox is a black head of a hind of earlier date. Length of panel, 0·75 m.

The question naturally arises, whether the simple decoration and absence of naturalistic drawings of the Azilian period are due to a degeneration of the Magdalenian art, or whether they reflect a movement from elsewhere. The evidence certainly points to the latter explanation, as the implements are also different from the Magdalenian and agree with those from pre-Neolithic sites in Italy, Sicily, Tunis, Algeria, and south Spain.

In various other parts of Spain pictographs have been found in rock-shelters and on rocks in the open; these form an eastern and a southern group. The rock-paintings in the lower valley of the Ebro at Cretas were first noted in 1903, but not studied till 1908, while those at Cogul were discovered in 1907 (Fig. 1). In every case they are in full daylight and often exposed to the weather, whereas all those previously considered are in the deep recesses of dark and usually tortuous caves. The paintings of the Dordogne include bears, lions, mammoths, rhinoceroses, horses, bisons, wild oxen and goats, deer, and reindeer. The reindeer and mammoth scarcely occur in the caves of the French Pyrenees, while in those of Cantabria the reindeer is entirely absent, and there are two elephants and one bear. Throughout the whole region representations of human beings are practically absent.

In the frescoes of eastern Spain the deer, primitive ox, and wild goat are very abundant; there are also a few wolves, one horse, one male elk, some fallow deer, and a bison. We are here in a different zoological area. With the exception of two very diagrammatic deer at Cogul (Fig. 2), all the animals are depicted with the same artistic feeling that is exhibited in the Magdalenian art of France and Cantabria; there is the same ability to seize forms and attitudes, the same certainty of execution. The number of human beings that are drawn marks a sharp contrast to the art of the north. At Cogul there was found a remarkable fresco representing a group of nine partially clothed women apparently dancing round a small nude male figure—doubtless a representation of a ceremony that may have had fecundity for its object; 300 kilometres south of Cogul, near Alpéra, two very similar women were painted in the midst of a wonderful assemblage of men and animals. The men are always nude, often they wear feather head-dresses and tasselled leglets; they are drawn in various attitudes, and the majority of them are shooting with bow and arrows at deer and other animals (Fig. 3). The investigators have satisfied themselves that the paintings belong to the Magdalenian period, and now we have indisputable evidence that at all events in the latter part of the Palæolithic age the bow was a common weapon in Spain; its presence has not yet been proved in the Franco-Cantabrian area, but we know that the spear-thrower was employed by the French Magdalenians. Two large male figures at Alpéra in a dancing attitude, wearing a feather head-dress and flourishing a bow and arrows, have doubtless a ceremonial significance, and may represent magicians.

There is nothing to show whether the above-mentioned schematic figures at Cogul were earlier or later than the other naturalistic paintings, for assuredly they were not done by the same artists. The same style reappears at Alpéra, in the eastern area, where it is easy to see that it is later than the fine style.

FIG. 2.—Hunting scene painted in red on the rock at Cogul: man shooting a deer; the figure to the right is a dead deer lying on its back with legs in air. Length of fresco, 0·75 m.

At Batuecas, in west-central Spain, enormous panels are covered with dots, rows of lines, branched, scaliform, pectiform, and other signs, circles, and rayed figures, together with very schematic men and animals (Fig. 4), which are later than certain more naturalistic drawings. Precisely similar diagrammatic signs occur in pro-

fusion in Andalusia, and below a few of them l'Abbé Breuil has found small, poorly executed, but realistic figures of the same kind as those at Batuecas. The signs agree with those that are found superimposed on Magdalenian drawings in the Franco-Cantabrian area, so there is little doubt that they characterise the Azilian culture.

FIG. 3.—Hunting scene painted in a brownish red, older than the very diagrammatic red signs (in cross-hatching) and later than the light red hind in the centre. Scale, about ⅓.

Prof. Breuil has given in *Rev. Arch.*, xix., 1912, p. 193, a large number of sketches from central and south Spain which are evidently degraded representations of the human form.

In the same article he points out that, so far as is known, the art of the Franco-Cantabrian area developed *in situ* throughout a considerable period during which the climate, vegetation, and fauna were modified several times, while migrations of peoples, all of whom were hunters and collectors, took place in different directions. The realistic representations of animals by the Aurignacians continued through Solutrian to the end of Magdalenian times, and until the extinction of the reindeer in France and central Europe. Human figures, as we have seen, were rarely portrayed except at the beginning of this series of cultures. Then an invasion from the Italian and Iberian peninsulas brought other peoples to north-west Europe, who painted schematic and geometric forms, often very like those painted on rocks in south and west Spain. These latter seem attributable for the most part to peoples who, while in the Palæolithic stage of evolution, did not progress through the Aurignacian-Solutrian-Magdalenian line of evolution that extends from Cantabria to Poland, but advanced in the direction of the industries termed "Capsian" by de Morgan and "Getulian" by Pallary. The eastern Spanish art may have been derived from north of the Pyrenees or influenced by it, at the same time undergoing a local development. On the other hand, Breuil notes that influences of the schematic art of the south-west were felt in the Magdalenian art of Cantabria and even of the Pyrenees, and that a cave in Ariège also shows pictorial influence from the artistic province of east and north-east Spain.

"As a result of the arrival of Neolithic man in the south of the Iberian peninsula, the Capsians flowed over the Magdalenian world, substituting their schematic art for the realistic art of the Magdalenians; borrowing from them some slightly modified industrial objects, like the harpoon, they spread not only to Gascony and Aquitaine, but to Dauphiné, Switzerland, Bavaria, and even to Scotland. On the other hand, some Capsians of Andalusia and Murcia seem to have rallied to the new state of things, since certain painted rocks represent 'idols' known only in the ancient Neolithic age in these regions, and certain Portuguese dolmens preserve a mural decoration conceived in their style. Perhaps other Capsian groups, driven from Morocco by the newcomers, migrated into central Sudan, unless the strange analogy of the paintings found there with those of Andalusia be purely fortuitous."

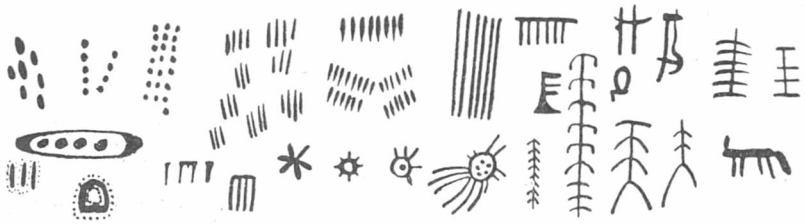


FIG. 4.—Azilian signs at Batuecas (Salamanca) which recall the coloured pebbles and petroglyphs of Andalusia.

A. C. HADDON.

EXPERIMENTAL CANCER RESEARCH.

EXPERIMENTAL cancer research can be undertaken with two main objects in view: (1) The investigation of the origin of cancer; (2) The study of the properties and life-history of the developed tumour. In regard to the first of these objects the staff of the Imperial Cancer Research Fund has confined its attention to the question of heredity. In the present report [1] there is a summary of observations on this point which confirm the conclusions previously published. In mice with recent cancerous ancestry, 20 per cent. of all deaths were due to cancer, while in those with remote cancerous ancestry the ratio was 11·6 per cent. It will be interesting to see whether further research in this direction will reveal any relation between the types of tumour in the ancestors and their progeny, and whether there will be any appearance of the Mendelian phenomenon.

The main efforts of experimental cancer research are, however, directed towards an investigation of the properties and life-histories of spontaneous and propagated cancer. In this direction the record is one of steady progress; the scope of investigation is continually expanding, and new problems are constantly offering themselves for solution.

Perhaps the most striking phenomenon in experimental cancer research is the appearance of a sarcoma during the propagation of a carcinoma. Recent work brings out the interesting fact that the power of inducing sarcoma formation is not necessarily a permanent property of a particular carcinoma, but may be only transitory. Two tumours have been previously observed to have this property. In one of these, sarcoma formation was irregular, and was promoted by rapid repetition of transplantation. In the other, sarcoma formation occurred with remarkable regularity if the tumours were allowed to grow for about two months before transplantation, but did not occur if transplantation was effected rapidly. The recent history of these tumours has shown that the first has completely lost the power of inducing sarcoma formation. Of the second tumour four carcinomatous substrains have been kept growing. In one of these, sarcoma development has occurred earlier at each transplantation until it has occurred so early that it has been impossible to retain the carcinoma in propagation, and this strain has become purely sarcomatous. In another strain the appearance of sarcoma has become progressively later until the power of inducing sarcoma formation has been lost. In the other two strains the same process is apparently going on.

In this phenomenon of sarcoma formation there thus await consideration not only the problem, What causes the production of a sarcoma during the propagation of a carcinoma? but also the problems, Why does a tumour which at one stage of its propagation shows the power of inducing sarcoma formation subsequently lose this property? and What is the explanation of the variability in this power displayed by different strains of the same tumour? All we can say at present in answer to these problems is that the sarcoma formation is not due to any filterable virus or other material derived from the carcinoma cells, but requires the presence of living cells for its induction.

The curious variability of the properties of mouse-cancer is also shown in other directions. In some tumours the structure remains constant during propagation for several years, while others show great variability. An acinous carcinoma may become alveolar in type; a tumour originally showing keratinisation, sebaceous transformation, or glycogen formation may lose these properties temporarily or permanently. Similarly in its power of growth a tumour may show constancy or variability. From a single tumour two strains may be isolated, one of which constantly disappears after a short period of growth, while the other regularly grows progressively and gives rise to metastases. The power of growth in a particular tumour depends inversely on its power of inducing in the host resistance to its own growth.

In all these cases of variability the question arises, Does the variability reside in the tumour-cells, or in the tissues of the host? The available evidence goes to show that the variability centres in the tumour itself. When, for instance, a slow-growing tumour arises from one which grows rapidly, when the structure of a tumour changes in the course of propagation, or when a sarcoma arises during the propagation of a carcinoma, the changes must be ascribed to variations in the tumour-cells, the transplantation subsequently effecting the isolation of the different characters evolved. It is well to note that this variation is not always in one direction. The change in the tumour-cell is not always from one of lower to one of higher differentiation and *vice versâ*. Also tumours showing high differentiation are not necessarily the most constant, nor those of low differentiation the most variable.

One important point should be noticed; that is, the increasing evidence as to the identity in nature of the mouse-cancer with the human disease. Every feature of cancer in mice finds its parallel in man. Squamous-celled carcinomata in mice sometimes show the formation in them of cysts lined with typical squamous epithelium, and this property may remain constant during propagation. The same feature is frequently found in human squamous-celled carcinomata, and is repeated in the metastatic growth. Similarly sarcoma formation may take place in human carcinoma, as it does in propagated and spontaneous carcinoma in mice. Again, in man the structure of the primary tumour is often repeated with great constancy in the metastatic tumours, whereas in some cases there may be great variability, and tumours of the same structure in man may show great differences in the power of growth, one

[1] Eleventh Annual Report of the Imperial Cancer Research Fund. Presented July 24.

confining its growth locally, and the other early giving rise to metastases. In these respects, as in many others, the similarity in nature between mouse-cancer and cancer in man is placed on a firm basis, and the importance of experimental cancer research in relation to human cancer established.

Experimental research continues to throw discredit on the hypothesis that cancer is caused by a specific parasite.

NOTES.

IT is announced that the Admiralty has accepted a tender for the construction of a large laboratory, which is to be built on the high land at Crombie and used for purposes of chemical research in connection with the ordnance works there.

PROF. W. A. BONE, F.R.S., has been awarded the Howard N. Potts gold medal for distinguished work in science or the mechanic arts by the Franklin Institute of Philadelphia, in recognition of his work upon surface combustion. Prof. Bone lectured before the institute upon this subject in October, 1911.

THE KING decorated the members of the British Antarctic Expedition on July 26 with the Antarctic medal and clasp. The medals and clasps awarded to those who lost their lives were presented by the King to the widows, and in other cases to the mothers. Chief Stoker W. Lashley, R.N., and Petty Officer T. Crean, R.N., were decorated also with the Albert Medal of the Second Class for gallant conduct in connection with the heroic saving of the life of Commander Evans, with the details of which readers of NATURE are already familiar.

A CORRESPONDENT of *The Birkenhead News* directs attention to the submerged forest at Leasowe, lying north-west of that city. Numerous relics, including coins, have from time to time been discovered, and it has been suggested that these are remains of an ancient port now submerged. It is much to be desired that this important archæological site should be thoroughly examined, and the suggestion that a committee of local geologists and archæologists should be formed for the purpose will meet with general approval. The local archæological and scientific societies might with advantage cooperate in the proposed inquiry.

A DEMAND for a Royal Commission on the subject of venereal disease has been issued by the leaders of the medical profession. It is pointed out that the State has compelled local authorities to provide asylums for the insane, it has insisted on the notification of many infectious diseases, it has undertaken the inspection of school children, it has introduced an elaborate system to ensure the purity of food, and is building up a vast system of public health legislation. Yet the subject of venereal disease has been left severely alone. In London alone the disease claims 40,000 new victims every year, innocent members of the public are sometimes infected, it is transmissible from the parent to the offspring, and the effects of the disease are dire and widespread.

A COMMITTEE, including the names of Sir H. Read, Profs. Haverfield, Ridgeway, and Dr. M. R. James, provost of King's College, Cambridge, has issued an appeal for funds to be devoted to the excavation of the Romano-British city of Wroxeter, which stands beside the Severn, five miles east of Shrewsbury. In its first phase it was a legionary post intended to watch the Welsh hills; but on the removal of the Roman troops to Chester there sprang up on the site a Romano-British town, which flourished for some three centuries, and became the capital of the Canton of the Cornovii. The city was laid out like Caerwent and Silchester, in Roman fashion, with a forum and baths, and streets crossing at right angles; but the area within its walls was more spacious than Silchester and Caerwent together. At the close of the Roman period it was destroyed by barbarian invaders, and since then has remained practically undisturbed. The excavation promises to throw much light on the later Roman period. The work will be carried on by an experienced archæologist, Mr. J. P. Bushe-Fox, with the aid of Oxford and Cambridge scholars. The scheme may be confidently recommended to the liberality of English antiquaries.

THE Secretary of State for the Colonies has nominated a Committee to report:—(1) Upon the present knowledge available on the questions of the parts played by wild animals and tsetse-flies in Africa in the maintenance and spread of trypanosome infections of man and stock; (2) whether it is necessary and feasible to carry out an experiment of game destruction in a localised area in order to gain further knowledge on these questions, and, if so, to decide the locality, probable cost, and other details of such an experiment, and to provide a scheme for its conduct; (3) whether it is advisable to attempt the extermination of wild animals, either generally or locally, with the view of checking the trypanosome diseases of man and stock; (4) whether any other measures should be taken in order to obtain means of controlling these diseases. The Committee is constituted as follows:—Lord Desart (chairman), Mr. E. E. Austen, Dr. A. G. Bagshawe, Dr. Andrew Balfour, Sir John R. Bradford, F.R.S., Mr. E. North Buxton, Dr. W. A. Chapple, M.P., Sir Mackenzie D. Chalmers, Lieut.-Col. Sir W. B. Leishman, F.R.S., Sir Edmund G. Loder, Dr. C. J. Martin, F.R.S., Mr. J. Duncan Miller, M.P., Dr. P. Chalmers Mitchell, F.R.S., Prof. R. Newstead, F.R.S., Mr. H. J. Read, the Hon. L. Walter Rothschild, F.R.S., and Sir Stewart Stockman. Mr. A. C. C. Parkinson, of the Colonial Office, will act as secretary.

IN the House of Commons on July 24 Mr. Runciman was able to give a very satisfactory account of the work of the Board of Agriculture during the past session. Energetic steps have been taken to stamp out animal disease, and the result is that the country is now freer from disease than any other in Europe. For a time last year there were outbreaks, and the export of pedigree live-stock ceased, but the foreign ports are now open to us again, and the result has been an unprecedented export during June, the total value of the animals sold being nearly 62,000*l.*,

against 28,000*l.*, the highest previously reached. Arrangements have been made for research on agricultural subjects to be carried on at a number of centres, including Rothamsted, Manchester, Birmingham, Oxford, Cambridge, the Royal Veterinary College, Leeds, Wye, Bristol, and Kew, and grants amounting to 20,000*l.* a year have been made for the purpose. In addition, 3900*l.* has been given for special investigations lying outside the scope of the programme of the special institutes. All these investigations have reference to the great fundamental problems lying at the root of the agricultural and horticultural work of the country; the work is wholly scientific. In order to bring the scientific results into the region of practical farming a number of advisers have been set up whose function it is to advise farmers or county organisers in the light of the results of the scientific knowledge that is gained. A grant of 9000*l.* per annum has been made towards the salaries of these advisers.

Now that we are at the end of the second month of summer some anxiety is being felt as to the general character of the weather to be experienced during August. June was a fair month with a generally deficient rainfall, but the conditions were mostly seasonable. July has had many shortcomings. During the early part of the month the weather was very unsettled, and the rainfall in the first three weeks was equal to the average for the whole of July except in parts of the Midlands and in the south-west of England. The special feature of the weather has been the persistent absence of bright sunshine and the consequent low day temperatures. At Greenwich there were only eight days to July 28 with a temperature of 70° or above, and there was only one day in the four weeks with the maximum day temperature above the average, the highest reading during the period being 76°. In July, 1910, the maximum temperature for the month was 76°, and in 1888 July had no higher reading than 74°. According to the average of the past seventy years July has twenty-two days with a temperature of 70° or above. The aggregate sunshine at Greenwich to July 27 is sixty-six hours, and the least sunshine for July previously since sunshine records were established, rather more than thirty years ago, is ninety-six hours in 1888, the next lowest record in July being 113 hours in 1910. July this year bids fair to be the least sunny July on record. There were only four days to July 27 with more than five hours' sunshine, whilst in 1911 July had twenty days with more than ten hours' sunshine, and the total duration for the month was 335 hours at Greenwich.

THE Institute of Metals will hold its first foreign meeting on August 28 and 29 at Ghent. Prof. A. K. Huntington will preside. The congress will commence with an official welcome of the members on behalf of the University and the municipality of Ghent. A number of important scientific papers will be read and discussed. The second report to the corrosion committee by Dr. G. D. Bengough and Mr. R. Jones will be presented. The report indicates not only the causes of the corrosion of condenser tubes, but how such corrosion may be eliminated. Among the papers arranged for the meeting the following may be mentioned:—Mr. H. Garland, "Metallographical Researches on Egyptian Metal Antiquities"; Dr. W. M. Guertler (Berlin), "The Specific Volume and Constitution of Alloys"; Prof. S. L. Hoyt (University of Minneapolis), "Copper Rich Alloys"; Dr. T. K. Rose, "The Annealing of Gold"; Dr. W. Rosenhain, F.R.S., and Mr. D. Ewen, "The Intercrystalline Cohesion of Metals—Second Paper"; Mr. J. H. Chamberlain, "A Further Study of Volume Changes in Alloys"; Dr. C. H. Desch and Mr. S. Whyte, "The Micro-Chemistry of Corrosion: I., Some Copper-Zinc Alloys"; Mr. F. Johnson, "A Method of Improving the Quality of Arsenical Copper"; Prof. A. A. Read, "The Influence of Phosphorus on Some Copper-Aluminium Alloys"; and Mr. T. West, "The Determination of Oxygen in Copper and Brass." Visits will be paid to factories of importance, and numerous social functions have been arranged. Those who desire to attend the meeting should communicate with the secretary of the Institute of Metals, Mr. G. Shaw Scott, Caxton House, Westminster, S.W.

THE Brighton meeting of the British Medical Association was held on July 22–26, the scientific business being conducted in sixteen sections. Among these the majority was of purely technical interest, all important problems of medical practice in its various branches having been ventilated. The section of State medicine dealt with questions regarding the Insurance Act, the importation of disease into seaports, school hygiene, and popular education in hygiene. The section of medical sociology held discussions on eugenics (Dr. E. Schuster, Dr. J. Scott, and many others), on hospitals in relation to State, public, and medical profession (Prof. B. Moore, Mr. C. F. Masterman, M.P., and various authorities, including foreign guests). Questions of general scientific interest were raised and discussed in the sections of medicine (the internal secretion in disease, by Prof. G. R. Murray), the section of electro-therapeutics (on secondary X-ray radiations in medicine, by Prof. C. G. Barkla, F.R.S.), the section of bacteriology and pathology (general pathological, experimental, bacteriological, and clinical aspects of anaphylaxis, by Profs. W. G. Dixon and G. Sims Woodhead, and Drs. Thiele, Embleton, G. W. Goodall, and H. H. Dale), the section of neurology and psychological medicine (discussion on sleep and sleeplessness, by Sir George Savage and others), and the section of tropical medicine (discussion on filariasis, by Dr. G. Low and others). We hope next week to give a descriptive article dealing in more detail with some of these discussions of general importance. The Brighton meeting was very largely attended, and was a great success in spite of the International Congress of Medicine to be held in London next week.

ON account of the deadlock reached by the Committee of the House of Commons considering the Dogs (Protection) Bill, referred to last week (p. 536), it was decided at the meeting of the Committee on July 23 not to proceed with the Bill. The question of the exclusion of dogs as subjects of all experiments in this country—not only experiments under

anæsthetics, but all inoculations—has given rise to an interesting correspondence in *The Times*. Mr. John Galsworthy urged that the affectionate relationship existing between the dog and man gave dogs claims to consideration over those possessed by other animals. But, as Mr. Stephen Paget pointed out, 30,000 dogs are put to death annually at the Battersea Home for Lost Dogs, whereas the total number used for experiments of all kinds in Great Britain and Ireland is only 500. Nothing can be learned, nothing can be gained, by the killing of these 30,000 dogs; and they suffer neither more nor less than dogs anæsthetised for an experiment and killed under the anæsthetic. The physiologist is so often pictured as a man who has no tender or sentimental feelings that a letter from Sir E. A. Schäfer, published in *The Times* of July 26, is particularly appropriate to the discussion. Sir E. A. Schäfer is not prepared to let Mr. Galsworthy have it all his own way in the matter of ethics and sentiment. He says:—"I also love my dog even more, I confess, than many of my own kind. If the question arose of sacrificing my dog to save my own life I might hesitate. But if it were a question of choosing between the life of my dog and that of my wife, or child, or friend; nay, even between the life of any man, woman, or child—were it the meanest beggar in the street—and that of my dog, I should not hesitate to sacrifice the dog. This I would do—and I believe Mr. Galsworthy also would do the same—to save even a single human life. And when I consider that the employment of a few uncared-for animals, which would otherwise have been uselessly sacrificed for the mere sake of getting rid of them, has been the means of saving the lives and mitigating the sufferings of many thousands of our fellow-beings, it seems to me to be beyond a doubt that both ethics and sentiment are on the side of science."

THE *Scientific American* for June 14 contains an illustrated article by Dr. Bolduan entitled "Bacteriology and Your Health," in which antitoxins and other curative serums, vaccine treatment, and bacteriological methods for the diagnosis of disease conditions are dealt with in a popular manner.

TO Vol. xxxv., No. 2, of Notes from the Leyden Museum Mr. R. Van Eecke communicates an article, illustrated by four plates, on variation in the beautiful "long-tailed" Indo-Malay butterfly, *Actias maenas*, of the family Saturniidæ. Four varieties, or races, are indicated, which exhibit a complete transition in the matter of colouring from dark-brown to greenish-yellow, the females of one race being more advanced in this respect than the males. In Java the females, which differ markedly from the males, are more numerous than the latter, whereas in Celebes the reverse of this condition obtains.

IN connection with experiments to find parasites capable of successfully combating the spread of the gipsy moth, the Entomological Bureau of the U.S. Department of Agriculture has issued a pamphlet, by Mr. P. H. Timberlake, on the life-history of *Limnerium validum*, an hymenopterous parasite normally attacking the fall web-worm (*Hyphantria cunea*). This parasite will attack caterpillars of the brown-tail and gipsy moths, as well as the tent-caterpillar, but will only undergo its full transformation, and then but seldom, in the last. It is, therefore, a failure in the matter of checking the gipsy moth.

FROM the Imperial Department of Agriculture for the West Indies we have received a copy of a pamphlet on the insect pests of the Lesser Antilles, by Mr. H. A. Ballon. The work, which is well illustrated, describes in popular language the chief species of insects, mites, and ticks injurious to plants and animals. It is interesting to note that, with the great increase of cotton-growing which has taken place of late years in the West Indies, "insects which were not previously recognised as pests, and in some cases even were not known to science, have assumed an important position as serious pests."

IN a report on calf-feeding experiments (North of Scotland College of Agriculture, Bulletin 17), Prof. Hendrick discusses the use of separated milk and oils as substitutes for whole milk. The data obtained from three series of experiments show that separated milk with either cod liver oil or cottonseed oil may be substituted for whole milk with good results. The average cost per pound of increase was found to be 1·83, 1·85, and 4·77 pence respectively up to the time of weaning, and both in regard to health and quality of carcase at the age of two years, the different sets of animals were indistinguishable. Although the stock which received whole milk were slightly heavier than those fed on substitutes, this difference was not great, and would be more than counterbalanced by the reduced cost of rearing.

IN the current number of *Bedrock*, Prof. Punnett replies to Prof. Poulton's article on mimicry, mutation, and Mendelism, which appeared in the April number of that publication. The main point of difference between the two writers is stated by the former to be concerned with "the conception of the function of natural selection with regard to these [mimetic] resemblances." "Both of us," he says, "are agreed as to the reality of natural selection," but while Prof. Poulton believes in the establishment of mimetic resemblance by the accumulation of small variations, Prof. Punnett holds that the mimicking form has in all cases suddenly arisen as a definite "mutation." This mimetic form, he allows in theory though apparently not in concrete instances, may when once produced be "conserved" by natural selection. To Prof. Poulton's argument from the existence of transitional forms, as in the females of *Papilio dardanus*, Prof. Punnett replies that apparently continuous transitional series may occur in cases of strict Mendelian inheritance.

THE Buenos Aires *Handels-Zeitung* (No. 1297) of May 3 discusses the recent discoveries of petroleum in the northern districts of Argentina, and reports the presence there of oil-bearing horizons for a distance north and south of 300 kilometres, and beside a series of moderately inclined anticlinals. This discovery is the more valuable as analyses show that the petroleum is rich in light illuminating oils, whereas that previously found in the Argentine Pata-

gonia is rich in heavy oils. The article discusses the geological relations of the oil-fields; it points out that those in Patagonia are connected with great transcontinental fracture lines. The northern oil-fields are connected with the middle part of the South American Pacific coast, which is dominated by the great subsidence that causes the sudden change in the course of the coast near Arica. The author of the article connects this subsidence to the antipodal disturbance of the western coast of the Pacific on the Gulf of Tongking.

THOUGH it had long been known that sudden displacements take place during strong earthquakes, the first case in which such displacements were established by geodetic measurements was that of the Sumatra earthquake of May 17, 1892. The movements of the crust were then entirely horizontal. Though no trace of any fault is visible at the surface, Prof. H. F. Reid shows (Bulletin of the Seis. Soc. of America, vol. iii., pp. 72–9) that the measured displacements imply the existence of a fault trending N.N.W. and S.S.E., and that the crust on the west side was shifted towards the north, and that on the east side towards the south. The total relative slip of the two walls of the fault amounted to $3\frac{1}{2}$ or 4 metres, or about the same as that of the San Andreas fault during the Californian earthquake of 1906. As in that earthquake, also, the displacement diminished rapidly as the distance from the fault increased. Judging from the great displacements at the limits of the measured area (about 55 km. apart), Prof. Reid estimates that the ruptured part of the fault may have been from 150 to 200 km. in length.

IN *Symons's Meteorological Magazine* for July Dr. Mill refers to the message recently received from Dr. Mawson at the winter camp of the Australian Antarctic Expedition and to the "interesting and remarkable fact" that daily meteorological reports are being received in Melbourne from Commonwealth Bay and from Macquarie Island. He remarks:—"No more striking advance in the study of world meteorology has ever been made than this inclusion of the Antarctic regions within the system of daily meteorological weather reports; and meteorologists must pay a tribute of gratitude to Dr. Mawson for his triumphant realisation of what, a very short time ago, would have been held to be a fantastic dream."

A PAMPHLET on the "Démonstration du théorème de Fermat," by Prof. E. Fabry (Paris: A. Hermann et Fils, price 1.50 francs), does not contain what its title seems to indicate. Assuming that all the details of the analysis are correct, the net conclusion is that if $x^p+y^p+z^p=0$, with p an odd prime, has an integral solution for which x, y, z, have no common factor, one of these integers must be divisible by p^2. But although this result is not much in itself, M. Fabry's tract deserves study, and may suggest some new way of attacking this famous problem. Another recent attempt by M. de Bouffall is of no value at all, as the author assumes that two equations are identical, when all that he has proved is that they have a common root.

THE June number of the Proceedings of the American Academy of Arts and Sciences contains a contribution from Prof. B. Osgood Peirce, of the Jefferson Physical Laboratory of Harvard, on the maximum value of the magnetisation of iron. The recent measurements of Sir R. Hadfield and Prof. Hopkinson, by what is known as the "isthmus method," gave 1680 as the maximum. By building a large solenoid capable of giving a magnetic field of 5000 units, Prof. Peirce has been able to obviate the uncertainties which attach to the determinations of the magnetising field in the isthmus method, and has arrived at results for twenty-five examples of commercial iron which vary from 1735 for American ingot iron to 1533 for a sample of drill-rod iron. Curves are given for a number of these materials which all show how closely the reciprocal of the magnetic susceptibility of any specimen is a linear function of the magnetising field for fields above about 50 units.

PART 6 of each of the two sections—Physics and Electrical Engineering—of Science Abstracts has reached us. Each part extends to sixty-three pages, and the average length of an abstract in the Physics Section is one-third, and in the Electrical Engineering Section one-half, of a page. The engineering abstracts are in many cases accompanied by figures which are not invariably so clear as they might be. The greater length of these abstracts seems to be due to the descriptive details of apparatus and machinery on which the interest of the articles abstracted in many cases depends. So far as the dates of the articles abstracted are concerned, a glance through the two sections shows that the great bulk of them are of February, March, and April, so that the periodical is reasonably up to date. The Institution of Electrical Engineers and the Physical Society of London have earned the thanks of all workers in these two fields for their enterprise in maintaining so useful a publication.

THE July number of *Science Progress* (No. 29) marks the commencement of a new volume, and a change of editorship. Sir Ronald Ross will in future guide the destinies of this well-known journal. The present number contains several articles of a wide general interest, of which the following may be named:—Enzymes as synthetic agents, by Prof. J. H. Priestley; the seats of the soul in history, by Dr. D. Fraser Harris; and scientific national defence, by Colonel Charles Ross. Drs. M. S. Pembery and O. A. Craggs cross swords on the vexed question of woman's place in nature, and Prof. H. E. Armstrong destructively criticises recent experimental work on the perennially interesting subject of the corrosion or rusting of iron, which, it is maintained, cannot possibly be brought about by the action of pure water and pure oxygen only.

IN *The Biochemical Journal* (vol. vii., p. 268) Mr. E. Ashley Cooper describes the isolation from animal tissues, such as horseflesh, or ox-heart, of a substance which rapidly cures polyneuritis in birds induced by a diet of polished rice; it can be precipitated from

the fats and lipoids present in an alcoholic extract of the tissue by means of ether, and, thus obtained, is extremely active. Ordinary quinine and cinchonine exert a temporary curative action upon birds affected with polyneuritis, but as this action is destroyed by heating the alkaloids at 125°, it is probable that the curative properties are due to the presence of traces of an anti-neuritic substance derived from the cinchona-bark, which is destroyed by this treatment. The same number of *The Biochemical Journal* also contains an account by Dr. R. H. A. Plimmer of a very useful method for quantitatively separating tyrosine from cystine by means of absolute alcohol saturated with hydrogen chloride, which converts the former into its ester, whilst the cystine does not undergo esterification.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR AUGUST :—

August 1. 1h. 44m. Neptune in conjunction with the Moon (Neptune 4° 59′ S.).
4. oh. om. Mercury in inferior conjunction with the Sun.
12. 16h. 29m. Jupiter in conjunction with the Moon (Jupiter 4° 52′ N.).
14. 18h. 9m. Uranus in conjunction with the Moon (Uranus 3° 28′ N.).
22. 1h. om. Mercury at greatest elongation west of the Sun (18° 25′).
24. 5h. 23m. Mars in conjunction with Saturn (Mars 1° 9′ N.).
25. 18h. 54m. Saturn in conjunction with the Moon (Saturn 6° 53′ S.).
,, 20h. 29m. Mars in conjunction with the Moon (Mars 5° 43′ S.).
28. 11h. 43m. Venus in conjunction with the Moon (Venus 5° 25′ S.).
,, 13h. 38m. Neptune in conjunction with the Moon (Neptune 5° 0′ S.).
29. 12h. 38m. Venus in conjunction with Neptune (Venus 0° 18′ S.).
31. 8h. 52m. Sun eclipsed, invisible at Greenwich.

NOVA GEMINORUM No. 2.—Among recent references to Nova Geminorum No. 2 may be mentioned a communication by Herr C. Wirtz (*Astronomische Nachrichten*, No. 4667, p. 219), who gives the values derived from his observations of its magnitude. The observations extended from March 14 to May 12 of last year, from the time when the star was about 3·5 mag. to that when it had diminished to about 7·0 mag.

Another communication in the same number of the *Astronomische Nachrichten*, by Mr. F. P. Leavenworth, gives the position of the nova from photographs taken at the University of Minnesota, the arithmetical mean of eleven observatory positions being given as—

R.A. 6h. 49m. 11·793s. Decl. +32° 15′ 5·65″.

Another excellent series of magnitude observations of this nova is one which appears in the *Memorie della Società degli Spettroscopisti Italiani* (disp. 6, vol. ii., ser. 2, p. 105), by Dr. E. Guerrieri, at the Royal Astronomical Observatory at Capodimonte. These observations cover the period March 28, 1912, to April 29, 1913, and are accompanied by a chart. The curve shows the curious fluctuations which the light of the nova was undergoing during its gradual diminution in brilliancy.

VARIATION OF LATITUDE.—No. 4665 of the *Astronomische Nachrichten*, p. 161, contains the provisional results of the International Latitude Service of the north parallel for the period 1912·0 to 1913·0, communicated by Prof. Th. Albrecht. The author states that the method for the determination of the path of the pole is the same as that employed in his previous publications, and he gives here the mean values of the latitude of the six stations according to group on which his values are based. In one table he shows the values of the variation in latitude, and in another the values of an expression from which the variations in azimuth and longitude can be computed for every 30° of longitude from 1912·0 to 1913·0. The paper is accompanied by a chart of the now well-known form showing the polar track from 1906·0 to 1913·0. During these years the amplitude is small at first and then increases up to 1911, afterwards decreasing rapidly up to the last-mentioned year.

THE INTENSITY DISTRIBUTION OF INDIVIDUAL LINES IN STELLAR SPECTRA.—Those familiar with the lines in the spectra of new stars know that at some stages of development the lines, such as those of hydrogen, have a complicated structure, the intensity distribution being very far from uniform. Herr K. F. Bottlinger has recently taken up the study of the question of the intensity distribution of lines in many of the type stars, and communicates his results to the *Astronomische Nachrichten*, No. 4662, p. 117. The spectra were secured at the Astrophysical Observatory at Potsdam, and measured with a Hartmann's microphotometer. The investigation chiefly consisted in the study of Hγ and a few other lines in the spectra of the following stars :—α Can. maj., α Cygni, η Leonis, ζ Orionis, δ Orionis, and γ Cassiopeiæ. The paper is accompanied by a series of curves showing the form of the distribution, and brings out the fact that a systematic study on a more extensive scale might lead to important conclusions.

RECENT WORK OF THE GEOLOGICAL SURVEY OF GREAT BRITAIN.

THE memoirs here referred to bear witness to the publishing activity of the Geological Survey during 1912 and the present year. In explanation of Sheet 299, H. J. O. White describes the country around Winchester and Stockbridge (1*s.* 6*d.*), where the broad stretch of chalk is cut by the valley of the Test. Though Crawley stands out isolated on its dome, few of our Upper Cretaceous areas show more clearly the dependence of the villages on permanent streams. It is interesting to notice that the pre-Eocene denudation of the Chalk has not entirely removed the zone of *Belemnitella mucronata* (p. 40). On the accompanying map, the unusual feature of knolls of calcareous tufa, some 5 or 6 ft. thick, is represented in the valleys of the Itchen and the Test.

The description of Devon and Cornwall is continued in three memoirs. Numerous authors are associated in "The Geology of Dartmoor" (2*s.* 3*d.*), accompanied by Sheet 338 of the one-inch map. The great mass of granite, penetrating Carboniferous strata, occupies almost all the area. Its upper surface probably lay at no time much above the present undulating surface of the moor. The Culm-Measure rocks on its margins are regarded as representing the Millstone Grit, and perhaps the higher zones of the Avonian Series. Chapter vii. directs attention to the probability that the valleys of the small streams, with a general north-westerly and south-easterly trend, are controlled by earth-fractures. The rapid deepening of the valleys

during the Pliocene uplift is illustrated (p. 70) by the case of the Dart, which lowered its floor below the general platform of the country by 700 ft. The freshness of the rock on such valley-sides is in marked contrast with the depth of decomposed rock found (p. 27) across the moor. So well-written a memoir on a district visited by thousands of tourists would gain much in popularity if it were illustrated by views of scenery. Wistman's Wood (p. 60) in its desolate surroundings is a geographical feature in itself. Such appeals to the general taxpayer seem, however, to be largely the privilege of the Scottish branch of the Survey, and, as we have remarked on previous occasions, England, with all its rich associations, still awaits adequate illustration.

A considerable step, however, is made in this direction in W. A. E. Ussher's memoir on Ivybridge and appear to belong to the Ordovician killas series. At Lizard Head, however, they strike north-north-west, and this is taken as strong evidence of their pre-Cambrian age. To mention quite another feature among the many described in this important memoir, on Crousa Down a gravel of blocks of vein-quartz resting on gabbro is regarded (p. 231) as probably a marine deposit of Pliocene age. It is now 364 ft. above the sea. The map (1*s.* 6*d.*), covering the country from Constantine to the Lizard, will surely accompany all future scientific visitors.

W. Gibson, in a special memoir (1913, price 1*s.* 6*d.*), describes the concealed coalfield of Yorkshire and Nottinghamshire, with a map showing by contours the depth of the Coal-Measure surface below the Triassic and Permian covering. North-east of Leeds 5000 ft. of Upper Carboniferous strata were removed

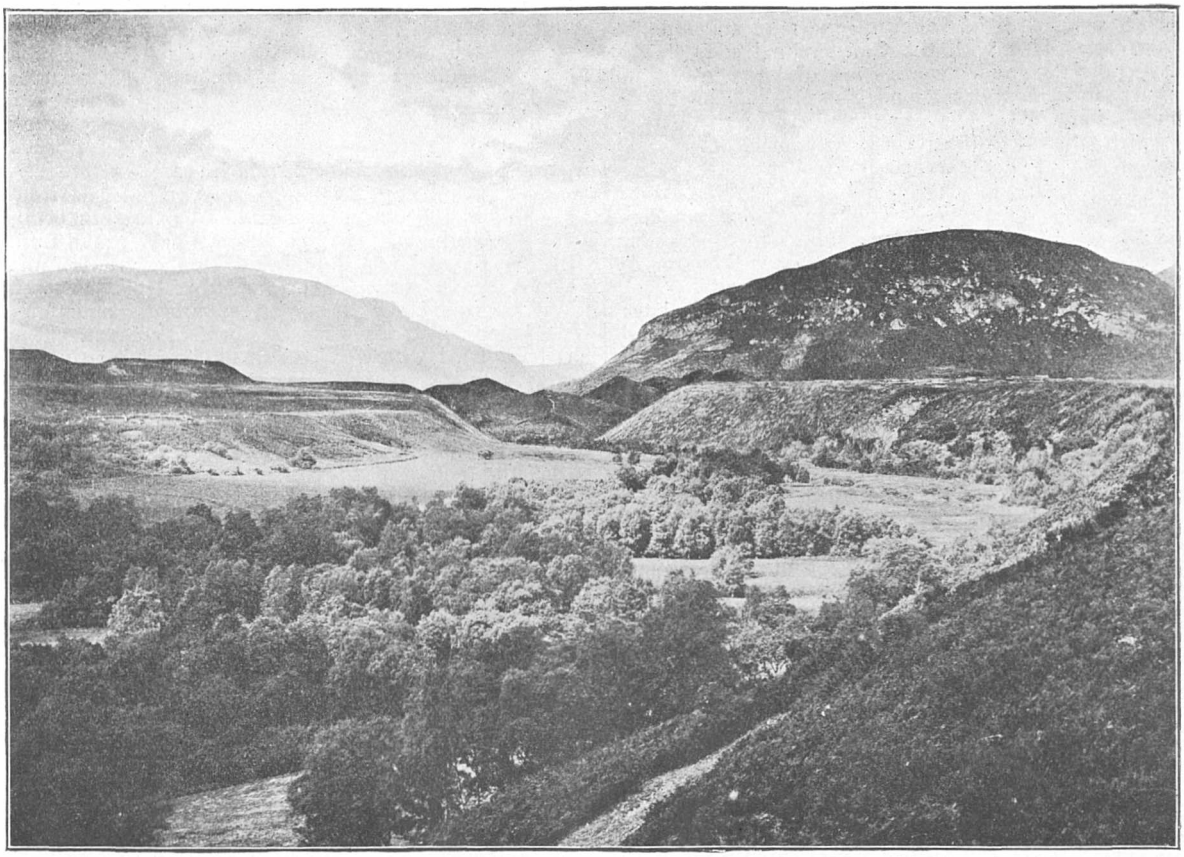


FIG. 1.—Fluvio-glacial erraces, Glen Glass, eastern Ross-shire. Terminal moraine beyond. (Reproduced by permission of the Controller of H.M. Stationery Office.)

Modbury (3*s.*), in explanation of Sheet 349, and by J. S. Flett and J. B. Hill in dealing with Sheet 359, the Lizard and Meneage area. In the former, we see the romantic crag of the Dewerstone, and in the latter the purple rocks of Kynance Cove and the folded schists on Lizard Head. The Lizard memoir (5*s.*) naturally has immense petrographic interest. New analyses are given of rocks that serve as types to English students, and the changes are traced from massive intrusive bodies to foliated schists (p. 97, &c.). The Kennack Gneisses (p. 129) afford a clear example of the penetration of a dolerite by a granitic magma, the gneissic structure being due (p. 140) to "injection foliation." Sedimentary schists are also present in the south and in the north-east of the area (pp. 34 and 167), and in the latter district, near Manaccan, they by denudation before first Permian beds were laid down (p. 27).

The Scottish branch deals in Memoir 93 (4*s.*) with a moorland district, where Ben Wyvis rises as a flat-topped relic of an old plateau of metamorphic rocks. The maps of the Scottish Survey (2*s.* 6*d.* each) cover individually a much larger area than those of England, and the work on Sheet 93 must have often seemed monotonous. The glacial and other superficial deposits are shown by stippling over the colour-printing used for "solid" rocks, and we no longer have the anomaly of peat and alluvium represented in colour and boulder-clay and glacial gravel omitted altogether. Fresh-water alluvia, however, still receive a separate colour. The contributions by J. S. Flett contain, as usual, much original matter. A riebeckite-

gneiss is described (p. 91) from Carn Chuinneag, containing ægirine and albite, and albite-gneisses occur near it, with streaks of magnetite and cassiterite. Scyelite, the remarkable biotite-hornblende-peridotite, occurs at Carn Cas nan Gabhar, two and a half miles north of the head of Loch Morie. Its exposures are almost too small to appear upon the map. Both the foliations in the great mass of igneous "augen gneiss" (why not "eye-gneiss"?) of Carn Chuinneag are attributed to pressure-metamorphism (p. 55).

In glacial times the ice moved from west to east across this area, Ben Wyvis forming an obstacle that was not completely overtopped. Ice, however, descended from it in the general easterly direction. The fluvio-glacial terraces of Glen Glass, east of the mountain, are finely illustrated in plate viii. (Fig. 1).

G. Barrow and E. H. Cunningham Craig, in Memoir 65 (*2s. 6d.*), describe a varied district centring in the granite mass of Balmoral Forest. The accompanying map, with its bands of quartzite and amphibole-schists folded with the Caledonian trend, shows clearly how the main granites are of later date than the earth-movements that made the Highlands. There remains some difference of opinion as to the extent to which these granites are responsible for the development of the contact-silicates present in the adjacent schists, and also (p. 26) as to the succession in the schists themselves. The remarkable boulder-bed, representing so continuous a horizon of erosion, is accepted by both authors as being near the summit of the series.

The same authors, with L. W. Hinxman, have explored the adjacent region of Upper Strathspey and the Forest of Atholl (Memoir and Sheet 64, *2s.* and *2s. 6d.* respectively). The huge granite domes of the Cairngorm Mountains lie in the north-east of the map, and the central high-road from the Grampians descends through Kingussie on the north-west. Glen Tilt, memorable for the researches of Hutton, Playfair, and Macculloch, between 1785 and 1816, on the contact of granite and limestone, occupies the south-east corner. Here, then, is a country full of inspiration for the geologist. The phenomena of river-capture are naturally interesting on the Grampian watershed; the case of the Feshie (p. 7) is notable, where it draws off the head-waters of the eastward-running Geldie Burn. On the map it appears that a preliminary capture was made of the Eidart, descending from the Cairngorm range, and that the increased flow enabled the stream to reverse the drainage at the east end of Sròn na Ban-righ. Is it, however, quite right to suggest, as is done in the memoir, that the upper part of the Feshie, at 1800 ft. above the sea, has "practically reached the base-level of erosion"?

The glacial features, including the formation of hanging valleys and dry gaps, are described in chapter ix.

In conclusion, we note that a new geological language is developing in the north. Are we to accept "calc-flintas," "hornfelses," and "kamiform"? After all, we have absorbed "taluses" and "volcanoes." G. A. J. C.

ORNITHOLOGICAL NOTES.

A PAPER on the Plumage Bill in relation to the British Empire was read by Mr. James Buckland at a meeting of the Royal Colonial Institute on June 13. This Bill proposes to forbid the sale, hire, or exchange of the plumage or skin of any species of wild bird inhabiting, during the whole or part of the year, any region of the British Empire or Protectorates, outside the United Kingdom. Ostriches, game-birds, domestic pigeons and poultry, are excepted from the operation of the Bill, as well as skins for museums. The effect of the measure would be, by prohibiting importation, to cut off a large proportion of the plumage supplies that now reach the London market. Mr. Buckland argues that the protection of wild birds throughout the British Empire would be of immense value to agriculture and forestry, in tending to keep down injurious insects, and that the wealth thus gained would enormously overbalance the loss necessarily sustained by the comparatively small number of merchants interested in the feather trade.

The proceedings at the annual meeting of the Royal Society for the Protection of Birds, presided over by Earl Curzon of Kedleston, covered practically all the subjects and objects in which the society interests itself. Foremost among these was the plume trade carried on in order that women may decorate their hats with the plumage of the most beautiful birds in the world. Despite what has been done in some countries beyond the seas to stop this trade, it seems to flourish here exceedingly—humming-birds and birds of paradise being sold by the tens of thousands—and we seem as yet far off getting the only law which will stop the destruction, viz. a law to prohibit the wearing by women of feathers of this description. Another important subject which came before the meeting was the protection of migrating birds from the dangers they incur at lighthouses through being attracted by the brilliant lights, and flying round until they become exhausted and fall to the ground, the gallery, or the sea. To prevent this it is proposed to fit up round the lights an apparatus, newly invented, on which the birds can perch and rest. This has been tried with good result on the Frisian coast. Funds for this special purpose are required by the society, and a considerable sum has been raised. Other subjects treated of by the speakers included sanctuaries for birds, nesting boxes, reserves for wild birds, the pole-trap in Norway, and the watchers' fund, which enabled the society to see that protective legislation was carried out. The society has more than twenty watchers spread over the country from Shetland to Cornwall. This society issues quarterly its very interesting publication, called *Bird Notes and News*, and the sixth number of vol. v. contains much that concerns the bird protector. The frontispiece gives a view of St. Catherine's Lighthouse, which has now been fitted with racks and perches for the use of migrating birds, as before mentioned. There are two short articles on the plume trade from which much may be learned.

A serious falling-off in the supply of guano from the islands off the coast of Peru induced the Peruvian Government to enlist the services of Dr. H. O. Forbes, the well-known naturalist, with a view to the suggestion of remedial measures. Dr. Forbes, who reached Peru at the commencement of 1912, but was unable to get to work until late in that year, has recently returned to this country, and an account of his experiences and investigations appeared in *The Times* of July 25. The guano-islands form a chain of more than 1000 miles in length, commencing with the Lobos Islands in the north to a point off Mollendo in the south. In the breeding season they are the resort of countless thousands of gannets, cormorants, pelicans, and other sea-birds, the two most important species from a commercial point of view being Bougainville's cormorant (*Phalacrocorax bougainvillei*) and the pelican known as *Pelecanus thagus*. Each of these voracious birds consumes from 8 to 10 lb. of fish *per diem*, and the production of guano from the whole assemblage is consequently enormous. Dr. Forbes succeeded in calculating the product of each pair of birds and their offspring in a season, from which he was enabled to form an estimate of the

amount for a period of, say, four years. "From that estimate he divided up the whole of the guano-archipelago into zones. He made certain practical suggestions for the protection of the birds with a view to allowing them to deposit and to have a rigorous close-season, and also a period of rest in each of four years. Only one zone would be worked every year, thus leaving a period for recovery." A remarkable event occurred just before Dr. Forbes's visit, almost the whole of the birds having deserted the islands in November, 1911, and not returning until February or March, 1912, leaving their young to perish from starvation. An unusually severe earthquake shock is considered by Dr. Forbes to have been the probable cause of the exodus, and he surmises that the birds may have betaken themselves northwards to the Galapagos Islands.

The supreme importance of birds to the agriculturist, as being in the main the only effective check on most of the insects by which crops are ravaged, is perhaps more fully and more generally recognised in the United States than in this country. Evidence of popular interest in this matter among our American cousins is afforded by the first article in the June number of *The National Geographic Magazine*, which is a reprint of a "Farmers' Bulletin," issued some years ago by the Agricultural Department, containing an account of fifty species of birds commonly frequenting American farms and orchards. In its new guise the article contains a coloured illustration, printed in the text, of each of these fifty species. Although small, the figures are beautifully executed, and form a striking instance of journalistic achievement.

In an illustrated article on national bird-reservations in the United States, published in the May number of *The American Museum Journal*, Prof. T. S. Palmer points out that, in addition to protected breeding places, refuges have been established in the west for birds while on passage. A reservation of this type "comprises merely a narrow strip of land bordering the reservoir, and is set aside to afford the birds a resting place on their journeys north and south. Some of these reservations were created before construction work was completed and before there was any water to attract the birds, in order to afford protection as soon as the reservoirs were filled and the birds began to visit them."

In an article on the velocities of migratory birds in the July number of *The Zoologist* Mr. F. J. Stubbs disputes the belief that migrants prefer to fly in the teeth of the wind, and likewise that they do so in order to escape the inconvenience of the wind ruffling their plumage by blowing obliquely through it from behind. The fact that head-winds undoubtedly bring most migrants has been a main argument in support of the former belief, but it is urged that such winds stop migration, and that birds flying under these conditions are really retarded. The "feather-ruffling" theory, on the other hand, is stated to be based on a misinterpretation of the fact that such birds as lapwings constantly stand head-to-wind in rough weather, and that if they happen to turn ruffling of their feathers ensues. For the author's arguments in support of his views, our readers must be referred to the article itself.

In an account of a recent visit to Phillip Island, published in *The Victorian Naturalist* for June, Mr. J. Gabriel states that sixty species of birds were identified, of which sixteen are sea or shore species, leaving forty-four as residents on the island, an excess of eight over a previous record. Protection, it is urged, is sorely needed for the mutton-bird and the little penguin, the numbers of which are rapidly diminishing owing to incessant persecution.

BLOOD-PARASITES.[1]

YOU will remember that Mephistopheles, when he insists upon the bond with Faust being signed with blood, says, "Blut ist ein ganz besondrer Saft" ("Blood is a quite special kind of juice"). Goethe would probably not have used the word "Saft" had he been writing "Faust" to-day instead of in 1808, for at that time the cellular elements of the blood—although they had been seen and described by Leeuwenhoek in 1686—were believed to be optical illusions, even by so distinguished a person as the professor of medicine of that time at the Sorbonne. The incredulity of scientific men as to what they see is proverbial and astounding, fortunately; but it is probably because science is really quite sure of nothing that it is always advancing.

I have the privilege this evening of trying to show you the barest outlines of our present knowledge of the parasitology of the blood. It is a subject of great practical and economic importance, as many grave diseases of man and beast are caused by these parasites, which, on account of their minuteness, enormous numbers, and very complex life-histories, are very difficult to eradicate or to deal with practically. On this account there is a good deal of the enthusiasm of the market-place mixed up with this subject, which, although a new one, has advanced with great rapidity, and has revolutionised pathology, and medicine so far as possible. From our point of view it began in 1880 with the discovery by Laveran, in the military hospital of Constantine, of the parasite which causes malaria. This caused the protozoa, to which order most of these parasites belong, to oust bacteria from the proud position they then occupied of being the cause of all the ills we have to bear, and to reign in their stead; not an altogether desirable change; for when you have seen what I shall show you, you will agree with me that sufficient unto life is the evil thereof. It has had all the disadvantages of a new subject, and since that time floods of work have been poured into journals, annals, proceedings, &c., some of it of the best, with much of it that is indifferent, temporary, and bad; so that at times it seems as if this branch of science were in danger of being smothered in the dust of its own workshop, or drowned in the waters of its own activity. We do not, nowadays, keep our ideas and scraps of work to ourselves until they are either established, or, as is more likely, dissipated, so we have a huge mass of what is called "literature," filled with many trivial, fragmentary, and doubtful generalisations, many of which we have with pain and trouble to sweep into the dustbin: nature's blessed mortmain law taking too long to act. You remember Carlyle complained—to use a mild term—of Poggendorff's *Annalen*, and I feel sure that, if he had had to study blood-parasites now, he would have said that it was a much over be-Poggendorffed subject. Blood-parasites are afflicted, too, with terrible names, and with large numbers of them; some have as many as ten or even fifteen different names, perhaps on the Socratic principle, that naming saves so much thinking. And they are in Latin, too, so that the terminology of this subject is a perfect museum of long Latin and hybrid-Latin names. The terminology generally of our later biology is, as one has said, "the Scylla's cave which men of science are preparing for themselves, to be able to pounce out upon us from it, and into which we cannot enter." This will be my excuse if I should use words you do not understand.

I will just remind you of the structure of the blood, that it consists of an extraordinarily complex fluid—

[1] Abstract of a discourse delivered at the Royal Institution on Friday, May 2, by Mr. H. G. Plimmer, F.R.S.

the plasma—which holds in suspension living cellular bodies, called cells or corpuscles. These are of two kinds, red and white corpuscles. The red are by far the more numerous, and in man there are about 5,000,000 of them to a cubic millimetre of blood, but this number varies enormously under the influence of parasites. To these red corpuscles is due the red colour of the blood, and they are the carriers of oxygen, acquired by the aëration of the blood in the lungs, to the tissues. We breathe in order that they may breathe, for we only care about oxygen in so far as they care about it.

The other kind of corpuscles are the white, or leucocytes, and of these in health there are about 7500 per cubic millimetre. A few years ago it was enough to know that there were red and white corpuscles, but now we have to know more. Through the work of Ehrlich we know that there are at least five different kinds of leucocytes in normal blood, which I will just indicate to you.

(1) Lymphocytes.—These are the smallest cells, and contain a relatively very large nucleus.

(2) Large Mononuclears.—These are large, and are called macrophages, as they possess the power of being able to absorb and digest parasites and other foreign bodies.

(3) Polynuclears.—These are characterised by the irregular, moniliform aspect of their nucleus, and they are called microphages for the same reason that the large mononuclears are called macrophages. Both of these are also called generally, phagocytes, on account of their power of ingesting and digesting foreign bodies.

(4) Eosinophiles.—These are characterised by a bilobed nucleus, and by granulations which colour deeply with eosin and other acid colours.

(5) Labrocytes or Mastzellen.—These are rare, and are characterised by large granulations which stain with basic colours.

In parasitic diseases these corpuscles are profoundly modified and altered, numerically and morphologically, and other new elements may make their appearance in the blood.

The blood is essentially the same in all animals, but it varies within certain limits. For instance, the red corpuscles are not of the same size and shape in every animal, and in birds and fishes they are nucleated; in us they are only nucleated in fœtal life and in disease. The mononuclear and polynuclear leucocytes are really separate organisms living in us, and they have qualities which it is very difficult to call anything else but consciousness; so that it is a subtle distinction to draw the line between the parasites—which these leucocytes are, in a way—which are part of us, and those that are not. When the balance of power is well preserved amongst our leucocytes, when they are working well together, then all is well with us; if we are ill, it is because they are quarrelling with themselves or with an invader, and we send for Sir Almroth Wright to pacify or chastise them with his vaccines.

So that, as Darwin said: "An organic being is a microcosm, a little universe, formed of a host of self-propagating organisms, inconceivably minute and numerous as the stars in heaven"—as we ourselves are but parts of life at large.

The three main functions of the blood are: that it is a means of respiration, a means of nutrition, and a defence against invading organisms.

And now to these latter. A blood-parasite proper is a living being, vegetable or animal, passing part or the whole of its existence in the blood of another living being, upon which it lives, this being obligatory and necessary to its life-cycle.

It was in 1841 that the first blood-parasite was seen by Valentin in the blood of a fish, and two years later Gruby gave the name trypanosoma to an organism he found in the blood of a frog. But since Laveran's discovery of the malarial parasite in 1880, we have learnt to differentiate many other parasites as causal agents of such diseases as I shall mention later in connection with the various parasites. But we know as yet dangerously little about most of them, so that we have strenuously to resist the temptation to make our account of them sound too harmonious, before we have found half the notes of the chord we are trying to play. We speak, as it were, with authorised uncertainty, and there are parts of our science which, after all, are only expressions for our ignorance of our own ignorance. These parasites have a very complicated life-history; part of their life-cycle is passed in the blood of man or beast, and part in various parts of the body of some blood-sucking invertebrate, such as a fly, mosquito, or tick, which transfers the parasite to another animal whilst feeding from him. It was thought formerly that blood-parasites would be a restricted order, but the work of recent years has shown that they have an enormous distribution both geographically and as regards their hosts. For instance, during the last five years I have had the opportunity of examining all the animals (in the large sense of the word) which have died in the Zoological Gardens. I have examined the blood of more than 8000 animals, coming from all parts of the world, and I have found parasites in the blood of 587 of them, that is in about 7 per cent., and in 295 species of animals I have found them for the first time. I mention this just to give you some numerical idea of their occurrence and distribution.

It will be better to take first those parasites which live in the plasma, and then those that live in the corpuscles, rather than to attempt to take them in their, at present rather uncertain, biological order; and I will begin at the bottom, biologically speaking, that is with the bacteria which are plants. These only require mention, since they do not live in the blood as parasites proper, but only as accidental parasites—that is, parasitism is not necessary to their life-cycle; they get into the blood in the later, or in certain, stages of certain diseases.

An example is the blood of a Senegal turtle-dove which died in twenty-six hours from fowl cholera. This bacillus was discovered by Pasteur, and is interesting, as it was his work upon it which led to his discovery of the attentuation of a virus, and of its transformation thereby into a protective vaccine.

The first parasites proper I shall mention are the Spirochetes. These have at present rather an insecure position in our idea of nature; they were formerly classed close to the bacteria, but now they are placed tentatively among animals, and they are not yet quite sure of their place. But they, nevertheless, although insecure of their place in the books, produce grave diseases, such as relapsing fever, tick fever of man, the spirochetoses of horses, oxen, and birds, syphilis, and yaws. They, with the exception of the last two, are carried by, and developed in, ticks and bugs; and in tick fever the parasite is also found in the nymph form of the tick, and this is one of the rare instances of heredity of a parasite.

The spirochete of relapsing fever in man was discovered by Obermeier in 1868, and he died from inoculating himself with the blood of a patient with the disease. He was one of the first scientific martyrs: he established our knowledge of the cause of this disease at the expense of his own life.

We will now take a long jump to the Filariæ. These are nematode worms, the embryo forms of which live in the blood; the parent forms, being too large to get through the capillaries, live in many

other parts of the body. The larval form lives in the body of some invertebrate—in a few known cases in a mosquito, or in a crustacean. The microfilariæ were discovered by Demarquay in 1863. Many of them show a remarkable periodicity, some appearing in the blood at an exact hour at night, and some in the day, for which phenomenon there is at present no satisfactory explanation.

Some are short, and some long, and some are encapsuled, others not. Filariæ cause various diseases, probably elephantiasis, and certainly enormous varicosities of the lymphatics, chyluria, chylous dropsy, Calabar swelling, and certain tumours.

We now come to the trypanosomes. They are flagellated organisms, which are the cause of many deadly diseases in men and animals, such as sleeping sickness, nagana (or tsetse-fly disease), surra, mal-de-caderas, dourine, and others. They are transferred from animal to animal by biting flies, fleas, lice, and leeches, in which the sexual part of their life-cycle takes place. The first one was seen in the blood of a frog by Gluge in 1842.

A type example is *T. lewisi* in the blood of a rat. This was discovered by Lewis in 1878, and is found in about 25–29 per cent. of wild rats. Some die, but most recover and become immune; it is a very specific parasite, and cannot be transferred to any other kind of animal.

The *T. brucei*, causing nagana or tsetse-fly disease, probably exists in the wild game of South Africa, much as the *T. lewisi* does in the wild rats, but when it is carried by the tsetse-fly to domesticated animals it kills them one and all in enormous numbers.

The *T. gambiense*, which causes sleeping sickness, was first seen by Dutton in 1902, and is carried by another species of tsetse-fly.

Nature attempts to fight against these invaders by phagocytosis. The parasites, however, multiply so rapidly that this method of attack is not very effectual; it can only be so in very early infections, and probably it then often is, that is, before the parasite has had time to start dividing. At the present time the question of trypanosomosis amongst man and animals is, for many countries which have colonies, of the greatest economic importance, so that a great deal of work has been done in the attempt to find a cure. A great many drugs, new and old, have been tried, and some good has been done. The first drug which was found to be of service was arsenic, first in simple and then in complex combination, and the subcommittee of the Royal Society, formed for the purpose of supervising experiments in this direction, suggested the trial of antimony in these diseases, on account of its near chemical relationship to arsenic.

This has given better results than arsenic, and a commission is at present at work in Africa, in the Lado district, trying its effects on a large scale. We found that the salts of antimony were too rapidly eliminated from the body to be successful in the larger animals and man, and so we devised a very finely divided form of the metal itself which we put directly into the circulation, and this has given, so far, the best results. The leucocytes eat it up and transform it slowly into some soluble form, taking, in a horse, for instance, four days to dispose of one dose, and the effect of this is much more profound and lasting than that of the salts. But some trypanosomes always escape, since one dose is never sufficient for cure. In rats with nagana, in which the trypanosomes by the fifth and sixth day may number 3,000,000 per cubic millimetre of blood, the minimum number of doses for cure has been found to be four, and with this dosage it is possible to cure 100 per cent. of rats. So there is still some hope.

It is interesting in this connection to remember what Bacon, whose death, you know, was due to an experiment he undertook to prove the preservative action of intense cold upon animal bodies, says, "Laying aside therefore all fantastic notions concerning them, I fully believe, that if something could be infused in very small portions into the whole substance of blood . . . it would stop not only all putrefaction, but arefaction likewise, and be very effectual in prolonging life." His vision was prophetic!

The bird trypanosomes are very much larger than the mammalian variety, are very dense, and move much more slowly.

An example of an organism very closely allied to the trypanosomes which is found only in fishes' blood is the trypanoplasma. It has two flagella, and the micronucleus is very large. This organism is probably transferred by leeches, but very little is yet known of it.

There are other flagellated organisms which may appear in the blood and live there as accidental parasites. There is a kind of inflammation of the intestines in reptiles (in the large sense) which causes the mucosa of the intestine to become permeable, so that some of the organisms which live in the intestine are able to get into the blood and live there. The only mention of these organisms in the blood is by Danilewsky, who in 1889 found hexamitus in the blood of a frog and tortoise. When in the blood they appear to excite a general œdema and ascites. I have found them now in nine cases. These are interesting as showing the power of adaptation to new surroundings possessed by these parasites.

I now come to the intracellular parasites.

Schaudinn thought that the bird trypanosomes had an intracellular stage, and if this were so they would form a bridge between the extra-cellular parasites, of which I have shown you types, and the intracellular parasites we are about to consider. But Schaudinn seemed, with his very brilliant attainments, to want a little more ballast of medical earth-knowledge. His work on this point has not been confirmed, and he was probably misled by a double, or even treble infection, so that we must think of these intracellular parasites as quite distinct from the others.

I will take first the *Plasmodium praecox*, the cause of the malaria in birds, as this parasite is of great historical interest; for it was Ross's work on this organism and his discovery of the rest of its life-cycle in the mosquito, which enabled him—on account of the great likeness between this and the parasite causing human malaria—to deduce from the one the etiology of the other, which was confirmed by Grassi and others. The *Plasmodium praecox* is, in many stages, so like human malaria that it can only be differentiated by the presence of the oval nucleus of the bird's red corpuscles. The life-cycle is very complex, part taking place in the blood of the bird, and another part (sexual reproduction) in the body of a mosquito. This parasite was first seen by Grassi in 1890; it is very widely distributed, and is very deadly to birds.

Human malaria has been known for centuries. Varro, who knew a good deal about what we should now call hygiene, more than a century B.C., thought that malarial fevers were due to invisible animals, which entered the body with the air in breathing, and Vitruvius, Columellus, and Paladius were of the same opinion. Now we know that the mosquito is again the carrier, and that the sexual part of the parasite's cycle takes place in it, but whether the mosquito alone can account for all the phenomena of malaria is not yet quite certain.

There are three varieties of malaria in man—the tertian, quartan, and quotidian: in the tertian the cycle of the parasite in the body takes forty-eight hours, and in quartan seventy-two hours, and in pernicious

malaria the fever is very irregular, but continuous. Whether there are three different parasites, or only one, which is altered according to its environment of host, climate, &c., is still apparently uncertain. Laveran and Metchnikoff believe in the specific unity of the parasite, whereas some observers want as many as five different species.

Just as in human malaria the pernicious form is distinguished by the elongated form of its gametes, so in birds there is a parasite which is distinguished, in the same way, from *Plasmodium praecox* by its very elongated gametes. This parasite is called *Haemoproteus danilewski*. Its development is unknown; it begins as a tiny, irregular body in the red corpuscles of the bird, then it grows in the long axis of the cell and turns round the end of the nucleus. It is possible in these parasites to follow the process of impregnation, which normally takes place in some insect. By taking the blood when full of the long, fully-grown gametocytes, and keeping it for a time outside the body, this process can be followed.

First of all, the gametocytes escape from the blood-corpuscles and roll themselves up into a ball. Some of these remain quiet—the females, curiously, the macrogametocytes—whilst in the microgametocytes active movements are seen; then tailed processes are seen projecting from its surface, which at last get free and wander about in the blood, this constituting the origin of the microgametes from the microgametocyte. They then find a macrogamete, and penetrate into it and fertilise it. This fertilised macrogamete then alters its shape and becomes an oökinete, with the remains attached containing the pigment. It may enter a red corpuscle, but it usually breaks up, because it finds it is not in the stomach of the insect it intended to be in, but between two pieces of glass.

From Hæmoproteus it is easy to pass to a rare and undetermined parasite of the blood of birds called a Leucocytozoon. It occurs in the blood in the form of a long, spindle-shaped, unpigmented body. Very little is known of it except that it is found in its sexual forms. The earliest observers of this parasite —Danilewsky and Ziemann—believed the host-cell to be a leucocyte (hence the name), but Laveran has shown that it is a red corpuscle.

We now come to a group of parasites of great practical importance, the Babesias, formerly called Piroplasma, which are the cause of Texas fever or red-water fever, malignant jaundice, East Coast fever, and biliary fever amongst domestic animals. We know, again, little that is certain concerning this group, except that they are unpigmented parasites of the red corpuscles, and are carried by ticks. They are the most destructive to the blood of any we know. In an ox, I have seen the red corpuscles decrease from 8,000,000—the normal—to 56,000 per cubic millimetre in two days.

Another important group, the Leishmania, is still uncertain of its exact position. In the body they occur as small bodies with a nucleus and micronucleus, but when cultivated on artificial media they become flagellated organisms of herpetotomas type. It is not quite certain what insect plays the part of carrier, but the different varieties of this group cause the diseases known as Kala Azar or tropical splenomegaly, Oriental sore, Delhi boil, Biskra boil, &c., and also infantile splenic anæmia.

The last class are the Hæmogregarines. These are parasites of the red corpuscles of reptiles principally, but they have been described in mammals and birds. We only know certain stages of the greater part of them; they are large, sausage-shaped bodies, not pigmented, and they are supposed to be carried by leeches, ticks, lice, and fleas. They generally have a capsule. In some instances the host-cell is enormously enlarged and entirely dehæmoglobinised, but in most cases the host-cell is not enlarged.

I have now taken you over some examples of all the known types of blood-parasites, but, at best, the picture in your minds must be like that of a landscape taken from a railway carriage at full speed; and the result, I fear, only a kind of clarified confusion, but it will be something if I have succeeded in making it transparent at the edges. What must have struck you most is the smallness of our exact knowledge of many of these extraordinary organisms and the gaps that there are even in this. But the incitement to future work lies in this fact, for

"Things won are done, joy's soul lies in the doing."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AT University College, Reading, Mr. S. B. McLaren, assistant lecturer in mathematics at Birmingham University, has been appointed professor of mathematics, and Mr. R. C. McLean lecturer in botany.

AN article dealing with the number of students at German universities during the session 1912–13 is contributed by Prof. Rudolf Tombo, junior, of Columbia University, to the issue of *Science* for July 18. The total number of matriculated students was 58,844, and, including auditors, the total reached 64,590. Of the matriculated students 3213 were women, of whom 904 attended the University of Berlin. Of the male matriculated students 26,988 were studying philosophy in the various universities. The largest number of matriculated students, namely 9806, was enrolled at Berlin. The Universities of Munich and Leipzig had 6759 and 5351 students respectively, and Bonn 4179. There were sixteen other universities with from one to three thousand matriculated students. The largest enrolment of foreign students was found at Berlin, where there were 1605, while Leipzig, Munich, Halle, Heidelberg, and Königsberg had numbers from 784 in the first to 244 in the last-mentioned case. Altogether there were 5193 matriculated foreigners enrolled at the German universities; of these 4648 were from Europe, 338 from America, 184 from Asia, twenty-two from Africa, and one from Australia. Of the European countries, Russia had the largest number of students, 2840, Austria had 900, Switzerland 340, and Great Britain 145.

THE following announcements relating to the Imperial College of Science and Technology, South Kensington, have reached us:—Mr. Otto Beit has announced his intention to found three fellowships for scientific research to be held at the college. Mr. Beit's intention in founding these fellowships is to foster only the highest research. The fellowships will be limited to Europeans, men or women, who have graduated at universities in the British Islands, Colonies, and Dominions, or are recognised by the trustees to be of the same standing. The annual value of each fellowship is not to exceed 150*l*.—Prof. S. M. Dixon, professor of civil engineering at the University of Birmingham, has been appointed to the new chair in civil engineering in the City and Guilds (Engineering) College. The department in the City and Guilds (Engineering) College which has hitherto covered the subjects of civil and mechanical engineering will next session be divided into two departments, one dealing with mechanical engineering and motive power, under Prof. Dalby, and the other with civil engineering, including theory of structures, hydraulics and hydraulic machinery, ferro-concrete construction, docks, water supply, and surveying, under Prof.

Dixon.—Prof. H. C. H. Carpenter, professor of metallurgy in the Victoria University of Manchester, has been appointed to the chair of metallurgy in the Royal School of Mines. Mr. S. J. Truscott has been appointed assistant professor of mining. These changes form part of a complete scheme of staff and curriculum reorganisation in the Royal School of Mines now being carried out. The work of the school will be transferred in October to the commodious pile of buildings now approaching completion in Prince Consort Road, South Kensington.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, July 21.—M. F. Guyon in the chair.—B. **Baillaud,** as president of the Bureau des Longitudes, presented the results obtained by the French committee charged with the execution of the preliminary operations relating to the measurement by wireless telegraphy of the difference of longitude between Paris and Washington, made under the direction of MM. Renaud and Bourgeois. The preliminary results include the determination of the time of transmission of the signals between the Eiffel Tower and Arlington (6175 kilometres), 0·0315 second, and the differences of longitude and colatitudes observed by the observers attached to the French Navy and Army independently. The signals emitted by Paris were received at Arlington with a sufficient intensity to be registered photographically.—J. **Boussinesq**: A new demonstration of the formula of surface potential energy in perfect liquids.—Armand **Gautier** and P. **Clausmann**: A remarkable condition of the attack of quartz by gaseous hydrofluoric acid. It had been noticed in some work on the determination of fluorine that quartz was scarcely attacked by quantities of hydrofluoric acid a hundred times greater than the amount giving a good etching on glass. It has now been found that the position of the surface of quartz under attack by the acid with respect to the axis of the crystal causes large variation in the amount of corrosion produced. Taking the attack of glass as 1000, that of fused quartz is about 100; quartz cut parallel to the axis is 11, cut perpendicular to the axis about 1.—A. **Haller**: The production of tetra-alkyl derivaties of the α or 1-methyl*cyclo*hexanone.—G. **Gouy**: The conditions of equilibrium of the solar atmosphere with respect to the repulsive force of radiation.—Magnus de **Sparre** was elected a correspondant of the academy for the section of mechanics in the place of M. Bazin, elected non-resident member.—René **Baillaud**: A new method of determining the horizontal flexure of meridian instruments.—M. **Fessenkoff**: Photometric observations on the zodiacal light.—F. S. **Zarlatti**: Some singular integral equations.—J. A. Le **Bel**: The catathermic radiation.—V. **Schaffers**: Electrical conduction in cylindrical fields under atmospheric pressure.—MM. **Massol** and **Faucon**: Absorption of the ultra-violet radiations by some organic colouring matters in aqueous solution.—H. **Gaudechon**: The relation between the thermal effect accompanying the immersion of dry powders in liquids and the aptitude of the latter to form associated molecules. Dried clay, starch, silica, and charcoal on addition to water or various organic liquids give off a certain amount of heat. This has been determined, and it is shown that with normal, non-associated liquids the temperature rise is very small; with associated liquids the heat evolution is greater.—Gabriel **Bertrand** and G. **Weisweiller**: The composition of coffee extract: the presence of pyridine. Amongst the products of coffee infusion to which the aroma is due pyridine has been found, and in a proportion greater than any other volatile constituent. The possibility of this base playing an appreciable part in the physiological action of coffee is discussed.—A. **Damiens**: Study of the action of water on the carbides of the rare earths. The carbides of cerium, lanthanum, neodymium, praseodymium, and samarium were studied, the hydrocarbons being analysed by the method recently described by Lebeau and Damiens. The primary reaction between the water and carbide is—

$$C_2M + 3H_2O = M(OH)_3 + C_2H_2 + H_2.$$

Ethylene and ethane are formed by the interaction of some of the hydrogen and acetylene, but no trace of methane is found.—J. **Clarens**: The spontaneous transformation of hypochlorites into chlorates and of hypobromites into bromates.—A. **Mailhe**: The catalytic preparation of the ketones with oxide of iron. At temperatures between 430° and 490° C. in presence of oxide of iron vapours of the fatty acids are catalytically converted into ketones, carbon dioxide and hydrogen being simultaneously evolved. Mixtures of benzoic acid with fatty acids give good yields of the mixed ketones. The worst yields were obtained with *iso*valeric and *iso*butyric acids.—H. **Giran**: Researches on sulphuric acid and sulphuric anhydride.—Paul **Lebeau** and Marius **Picon**: The action of sodammonium on phenylacetylene and styrolene. The reaction differs from that recently proved for acetylenic hydrocarbons of the fatty series, phenylacetylene giving ethylbenzene by reduction.—Jacques **Bardet**: The spectrographic study of French mineral waters. The salts from fifty-four springs have been examined using the arc spectra. Lead was found in all the samples, silver and tin in most of them. Germanium and gallium were found in a considerable number, and amongst other elements not usually mentioned as constituents of mineral waters were molybdenum, copper, antimony, cobalt, chromium, mercury, nickel, gold, thallium, vanadium, and tungsten.—M. **Gard**: The sexual elements in the vine.—Marcel **Delassus**: The influence of the partial suppression of the food reserves of the seed on the anatomy of the plant. Removal of part of the reserves of the seed results in development on a reduced scale, the differentiation of the tissues is retarded, and the number of fibro-ligneous bundles of the stem is diminished.—**Audebeau** Bey: The permeability of Egyptian soils.—J. **Winter**: The total volume of the gastric juice secreted during digestion.—G. **Bourguignon** and H. **Laugier**: The apparent differences of polar action and localisation of the stimulation on closing the circuit in Thomsen's disease.—Miromond de **Laroquette**: A new method for discovering foreign bodies in the tissues. The apparatus described is simple to use, and permits of the discovery of the exact position of the foreign body in less than one hour.—M. **Gerber**: The identity between the rennet, casease, and trypsin of one and the same latex. The existence of two types of proteolytic plant ferments.—Pierre **Thomas** and Mme. Sophie **Kolodziejska**: The proteid substances of yeast and their products of hydrolysis.—H. **Bierry** and Mlle. F. **Coupin**: *Sterigmatocystis nigra* and lactose.

NEW SOUTH WALES.

Linnean Society, May 28.—Mr. W. S. Dun, president, in the chair.—Dr. A. Jefferis **Turner**: Studies on Australian Micro-Lepidoptera. This contribution is intended to be a supplement to Mr. Meyrick's revisional paper on the Plutellidæ (Proceedings of the Linnean Society of New South Wales, 1907, p. 47). Additional localities for known species are given, and a number of species are described as new.—R. J. **Tillyard**: Some descriptions of new forms of Australian Odonata. This paper adds four new species, three new subspecies, and the hitherto unknown

female of *Diphlebia hybridoïdes*, Tillyard, to the list of Australian Odonata.—H. **Maiden** and E. **Betche**: Notes from the Botanic Gardens, Sydney. No. 18. Seven new species are proposed. Notes on proposed new varieties, plants new for New South Wales, and plants with interesting new localities are given.—Mr. **Tillyard**: Study of zoo-geographical distribution by means of specific contours. In this method, instead of attempting to subdivide the recognised zoo-geographical regions into distinctly marked-off sub-regions and lower divisions, it is proposed to study the various groups of plants or animals occurring over the whole region, by constructing "specific contours" by the following rules:—(1) The group selected must be a *natural* group, *i.e.* a genus, tribe, or family which forms a homogeneous whole, and not merely a group separated off for convenience of classification. (2) The records available must be sufficiently numerous to give the *general form of the contour*, but absolute accuracy is neither attainable (without infinite labour) nor necessary. (3) Each species of the selected group is reckoned as a unit. On the map of the region under study, against each locality which has been "worked," the number of units occurring there is to be put down. Then contour lines, in the form of free curves, are to be drawn so that all localities having an equal number of units shall be between any two successive contour lines.

BOOKS RECEIVED.

Department of Applied Statistics, University College, University of London. Drapers' Company Research Memoirs. Biometric Series VIII.:—A Monograph on Albinism in Man. By K. Pearson, E. Nettleship, and C. H. Usher. Part ii., Text. Pp. 265–524. Part ii., Atlas. Plates a.–w. and a.a.–n.n. (London: Dulau and Co., Ltd.) Text and Atlas, 30*s.* net.

Smithsonian Institution. U.S. National Museum. Bulletin 81:—Synopsis of the Rotatoria. By H. K. Harring. Pp. 226. (Washington: Government Printing Office.)

Memoirs of the Geological Survey of India. Vol. xli.:—The Coalfields of India. By the late Prof. V. Ball. Entirely revised and largely rewritten by R. R. Simpson. Pp. 147+xliv+20 plates+map. (Calcutta: Geological Survey of India; London: Kegan Paul and Co., Ltd.) 5 rupees, or 6*s.* 8*d.*

Transactions of the Royal Society of Edinburgh. Vol. xlix. Part 1. Session 1912–13. Vol. xlviii. Part 3. Session 1912–13. Vol. xlviii. Part 4. Session 1912–13. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 7*s.* 6*d.*, 31*s.*, and 16*s.* 8*d.* respectively.

The Standard of Value. By W. L. Jordan. Eighth edition. Pp. vi+287. (London: Simpkin and Co., Ltd.) 7*s.* 6*d.* net.

Practical Physics for Secondary Schools. By N. H. Black and Dr. H. N. Davis. Pp. viii+487. (London: Macmillan and Co., Ltd.) 5*s.* 6*d.* net.

British Pharmaceutical Conference. A Presidential Survey. 1863 to 1913. Pp. 96. (London: *The Chemist and Druggist.*)

On the Circulation of Energy and Matter. By E. M. Darken. Pp. 27. (Wellington, N.Z.: P.O. Box 266.)

Report on Scottish Ornithology in 1912, including Migration. By L. J. Rintoul and E. V. Baxter. Pp. 96. (Edinburgh: Oliver and Boyd.)

The National Physical Laboratory. Report for the Year 1912. Pp. 123. (Teddington: W. F. Parrott.)

The National Physical Laboratory. Collected Researches. Vol. ix., 1913. Pp. iv+245+plates. Vol x., 1913. Pp. iv+253+plates. (Teddington: National Physical Laboratory.)

Merck's Reagenzien-Verzeichnis. Dritte Auflage. Pp. 446. (Berlin: J. Springer; London: E. Merck.) 6*s.* 6*d.*

Organic Chemistry for Advanced Students. Vol. ii. By Prof. J. B. Cohen. Pp. vii+427. (London: E. Arnold.) 16*s.* net.

Die chemische Verwandtschaft und ihre Beziehungen zu den übrigen Energieformen. By Dr. Max Speter. Pp. 134. (Leipzig: P. Reclam, jun.) 2 marks.

Phonetic Spelling: a Proposed Universal Alphabet for the Rendering of English, French, German, and all other Forms of Speech. By Sir H. Johnston. Pp. 92. (Cambridge University Press.) 3*s.* 6*d.* net.

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