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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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For further particulars apply to the DEAN of the Medical School, St. Bartholomew's Hospital, London, E.C.

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For other Official Advertisements see pages clxxxviii *and* ii *of Supplement.*

THURSDAY, AUGUST 12, 1915.

THE PROBLEMS OF SCIENCE.

Problems of Science. By Prof. F. Enriques. Authorised Translation by K. Royce. Pp. xvi + 392. (Chicago and London: The Open Court Publishing Co., 1914.) Price 10*s.* net.

BESIDES two introductory chapters of a more or less metaphysical kind, this work contains four others dealing respectively with logic, geometry, mechanics, and the extension of mechanics; the last concluding with a section on the phenomena of life. This range of subjects is so great that, as might be expected, the treatment of them is unequal; but the fact that they are all discussed by a mathematician is significant, and for at least two of the main topics (geometry and physics) the author's special knowledge is of great value.

Naturally, a reader will be inclined to attach most weight to the section on geometry; in some respects he will be right. In this domain Prof. Enriques is a leading authority, and as he is treating of a subject with which he is thoroughly familiar, the result is very lucid and informing. We have a valuable historical account of the development of geometrical concepts, culminating with projective geometry in its modern form, and the different non-Euclidean theories, including the non-Archimedean geometry of Veronese; a good discussion of postulates; and a certain amount of psychological criticism, which is of a more controversial kind. One remark may be noticed as being (in English, at any rate) rather misleading. Before discussing Veronese's geometry, the author says:—"In the preceding examples the postulates that correspond to the various geometries express different physical hypotheses." As it stands, this is incorrect; any geometry, *as such,* is independent of physics altogether. What is probably meant is that each of the three Archimedean geometries is conceivably admissible as the "real" geometry most suitable for the physicist to assume in constructing his hypotheses. For instance, certain observations might make it simpler to assume a Riemann geometry than to modify the laws of motion. There is, on the other hand, no possibility of detecting by observation the existence of a non-Archimedean space, and there does not seem to be any possible development of physics which would naturally require the assumption of such a space.

To us the most interesting part of the book is that which deals with time. The author makes (like Bergson) a distinction between psychological and physical time which is likely to be really valuable, if used with the proper reservations; and he makes several useful remarks which illustrate the difference between a mathematician and an unmathematical metaphysician. For instance, it is pointed out that "the notion of before and after does not furnish any criterion for comparing two intervals of time which have not a common beginning (or end)"—or, we may add, are derived from a succession A, B, C, D, which involves that BC<AD. For instance, yesterday and to-day together are longer than to-day; but from this we cannot infer anything about the length of to-day as compared with that of yesterday. The importance of having a clear concept of time has been recently emphasised by the theory of relativity (discussed pp. 349–63), and hypotheses in elasticity and thermodynamics where the influence of "heredity" is assumed (pp. 316–17).

The sections on physics are very interesting, and, so far as we can judge, give a sound and clear view of its main principles, as at present understood. The author's general attitude is stated on p. 366 in a passage too long to print here. Briefly, it is that in any physical science we form a set of concepts and hypotheses by abstraction from a set of experiments; we thus have a provisional "scheme of relations" which we test by more refined experiments. The latter may refute one or more of our hypotheses; as a matter of fact, the more usual result nowadays, at least in physics, is to suggest corrections or modifications in our formulæ, by which they become more concordant with the results of observation. This summary, of course, does not do justice to the author; it is in the way he shows historically how these tendencies have been at work that one great merit of his work consists. In this respect he may be compared with Mach, by whom he has evidently been much influenced.

The section on biology might well have been omitted; the time has not come for making any such general statements about the principles of biology as we can make about those of mathematics and physics. We are glad to find, however, that on p. 201 he does protest (all too mildly) against some of the absurdities of the experimental psychologists, when they wander from their proper sphere. That Wundt, for instance, should attempt "to derive the planary structure of intuitive space from the fact that the arrangement of the bones is such as to favour rectilinear movement" is one of the most extraordinary examples of begging the question we have ever seen. As Prof. Enriques points out, the arrangement of the bones is *not* in favour of

rectilinear movement; but apart from this, the use of the word "rectilinear" here is a *petitio principii* of the grossest description. How can we say anything about the adaptation of the bones to rectilinear movement until we have the concept of what rectilinear motion is?

This leads us to the consideration of the more metaphysical parts of the book. Frankly, we disagree with the author on one or two fundamental points. He protests against the absolute as an illusion—even against what we may call the special absolute; we believe, on the other hand, with Bradley, that in a certain sense the absolute does "precede," or is involved by, the relative. At the same time, we may fully admit that concepts are formed by a psychological process, and that there is no *realisation* of an absolute, in the same sort of way that we cannot realise the arithmetical continuum as we can the numbers 2 and 3. Again, the author just touches on cases of illusion, insanity, and complete hallucinations; saying of the latter that "fortunately they seem quite rare." Doubtless this is fortunate, in one sense; but to ignore them without attempting to give a philosophical explanation of them is merely a confession of failure. However, we must agree to differ on metaphysics for the present, and be thankful that so much has been done recently to clear away fallacies and quibbles, and bring the real problems of philosophy into view.

The translation reads well on the whole, and we have only found one misprint of importance: on p. 321 "vertical" should be "vortical." On p. 17 the account of Russell's "vicious circle" analysis is not clear; whether this is the fault of the author or that of the translator we cannot say. What Russell has pointed out is that we are talking nonsense when we ascribe to a class of classes a defining quality which characterises its members: for instance, to speak of "the number of all numbers" is as nonsensical as to say "the animal comprising all animals." Similarly, there is no "class of all classes," and this is the most important example of the theorem. G. B. M.

PHYSICAL CHEMISTRY OF MOLECULES.

Molecular Association. By Dr. W. E. S. Turner. Pp. viii + 170. (London: Longmans, Green and Co., 1915.) Price 5*s.* net.

THE progress of chemical theory has been connected in an intimate way with the study of the complexity of molecules. By the introduction of Avogadro's hypothesis the determination of molecular complexity in gases was reduced to a comparatively simple problem. The development of the osmotic theory of solutions provided a theoretical basis for the interpretation of the results obtained in the investigation of the vapour pressures and freezing points of solutions. In so far as dilute solutions are concerned, the problem of molecular complexity is partially solved by the application of osmotic methods, although the question of the association of solute and solvent in the same molecule does not lend itself to attack in this way. When we pass from dilute to concentrated solutions or liquid mixtures, the problem acquires an entirely different character. For such mixtures there is no general guiding and reconciling principle such as is afforded by the hypothesis of Avogadro. The same difficulty confronts us when we deal with pure liquids. The methods available for the investigation of the molecular condition of pure liquid substances are entirely empirical, and the value to be attached to the various methods which have been proposed is at present largely a matter of personal opinion.

It is with the dependence of the complexity of the molecule on the nature of the constituent atoms, and on the forces which act on it, in so far as these forces are modified by changes in temperature, concentration, state of aggregation, and nature of the solvent, that the author's subject-matter is concerned. One chapter is devoted to the molecular complexity of gases, two to the complexity of dissolved substances, and three to that of pure liquids.

The molecular condition of pure liquids has attracted a great deal of attention in recent years, and the literature of the subject has attained to such dimensions that a summary and critical survey of the methods involved is particularly opportune. Molecular association has been the theme of the author's own work for many years, and it is therefore quite intelligible that the monograph is not a mere compilation of facts and hypotheses, but represents an extensive, well-ordered, and closely reasoned discussion of the salient features of the subject.

In an appendix, which runs to forty-four pages, the author gives a tabular record of the results of the investigation of the molecular complexity of dissolved substances. As a table of reference this should be found extremely useful, and its compilation adds materially to the value of the work.

Comprehensive as the monograph appears to be, there are certain noteworthy omissions. For instance, the reviewer has looked in vain for any reference to the determination of the molecular complexity of dissolved substances by means of the lowering of transition temperatures. Such investigations afford information relative to the molecular condition of substances in concentrated salt solutions. Although limited in their appli-

second this information is used to suggest methods applicable to the special needs of American farmers. In 1913 the German farmer could borrow from his mutual credit association at 3½ per cent., while his confrère in the Western States was paying from 6 to 10 per cent. for similar accommodation. The difference in the value of money in the two continents was, of course, partly responsible for this—a difference which the present enormous waste of capital in Europe will certainly reduce—but the advantages of the old-world farmer were chiefly due to his superior organisation.

For the provision of personal or short-time credit, the combination of farmers into co-operative credit societies is recommended. Seventeen States have already passed laws to facilitate the formation of such societies, but the scattered population on the large farms of the West renders the Raiffeisen type of credit bank, so successful in Europe, much more difficult to organise in America. As regards long-time loans to the landowning farmer, the State should grant these at reasonable rates of interest, and on the amortisation plan of repayment, by which equal payments over the period covered by the loan both meets the interest and extinguishes the capital debt. The author has set out a mass of facts and figures with great clearness, and has further provided a very complete bibliography of the subject.

The Statesman's Year Book. Edited by Dr. J. Scott Keltie, assisted by Dr. M. Epstein. Fifty-second annual publication. Revised. Pp. lxxxiv+1536. (London: Macmillan and Co., Ltd., 1915.) Price 10*s.* 6*d.* net.

THE editors of the "Statesman's Year-Book," gravely incommoded as they have been by the effects of the war, have met the situation successfully. The statistics given for enemy countries and Belgium are for the most part of no more than historical interest, but they have been revised to the latest dates possible, and will be of value in the future for purposes of comparison. Special revision is stated to have been applied to the sections on Turkey, China, Greece, Spain, and the Panama Canal zone. The accounts of Chinese government and administration are very clear so far as they go, and the statistical tables for this country have been decidedly improved. To the introductory tables some pages have been added specifically dealing with the war. The dates of nineteen separate declarations of war between July 28, 1914, and May 23, 1915, are furnished. The list of principal events of the war might well have been fuller, but there is a useful catalogue of the principal official and unofficial war publications.

The coloured maps are all pertinent to the war—an ethnographical map of Central Europe, an historical map of Prussia, and a map illustrating the three partitions of Poland (1772, 1793, and 1795), which is not very easy to follow. A map of the "World Colonial Powers concerned in War" is merely a map of the dominions of all the great European colonising Powers, including the Dutch. Attention has clearly been paid to the bibliographies, many of which are substantially more valuable than formerly; perhaps the selection of works other than those quite recently published is still open in some instances to further revision.

Lessons and Experiments on Scientific Hygiene and Temperance for Elementary School Children. By Helen Coomber. Pp. xx+163. (London: Macmillan and Co., Ltd., 1914.) Price 1*s.* net.

MANY people have an idea that it is impossible to learn physiology without the complex paraphernalia of the modern laboratory. Some go to the other extreme, and imagine it is possible to become acquainted with the subject from books alone. Both are obviously wrong, and Miss Coomber's manual will show how easy it is to teach the principles of elementary hygiene (applied physiology) with quite simple materials, such as a few bottles, a spirit lamp, a chemical reagent or two, and material such as any butcher can furnish. Whilst thoroughly agreeing with the underlying idea of the book—that such teaching, to be effective, must be practical—one is a little doubtful whether the system of question and answer, which is adopted throughout, though most suggestive to the teacher, is really the best for the learner. Some little summary of the main conclusions in each section should follow (or precede) the catechism and practical exercises. Indeed, the authoress oftens feels this herself, for some of the answers are prodigiously lengthy. Experience will, however, show whether some short connected accounts will be advisable in future editions. Any competent teacher could quite well supply the want if it is found necessary, and perhaps Miss Coomber thinks that this is the duty of the actual teacher rather than that of the writer of the present admirable little guide.

W. D. H.

Making the Most of Life. By Prof. M. V. O'Shea and J. H. Kellogg. Pp. ix+298. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 3*s.* 6*d.*

THIS is another of the many elementary manuals on physiology and hygiene which are being so prolifically produced in the United States. It is written clearly and to the point, and without any undue use of technical terms. How to live healthily and long is the ambition of most of us; this makes all the more astonishing the colossal ignorance which prevails, even amongst otherwise well-educated people, of the most elementary rules of health. One cannot praise sufficiently a nation which seeks to make knowledge on such a vital question part of the education of every citizen. Useful lessons are drawn from the lives of such men as Gladstone, Tolstoi, Cornaro, and others; but the most important section of the book appears to us to be that devoted to the history of our microscopic foes, and the means to combat their attacks upon us. W. D. H.

LETTERS TO THE EDITOR.

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

The Principle of Similitude.

DR. RIABOUCHINSKY directs attention concisely in NATURE (July 29, p. 591) to an important point, which must have arrested the notice of readers of Lord Rayleigh's weighty exposition and illustration of the scope of the method of dimensions, as an instrument of precision in the analysis of physical problems. The example under consideration was the cooling of a hot wire by a stream of air passing across it. The point is that temperature, although in ultimate analysis it must be expressible in terms of the three fundamental dynamical entities—mass, space, and time—can yet be in that problem considered *effectively* as a fourth independent entity, thus vastly increasing the information derivable from comparison of dimensions. In the formal analysis of mere diffusion or conduction this is clearly valid, for the dynamical aspect of temperature is not involved.

In so far as thermodynamic considerations, such as work of expansion, etc., are of secondary importance in the analysis of the convection from a hot wire (as is the case so long as only an adhering surface layer of the gas need be taken as operative [1]), the same principle will apply approximately there. But in a problem the content of which is mainly thermodynamic, the relations will be far more complex. In fact there is nothing transcendental about dimensions; the ultimate principle is precisely expressible (in Newton's terminology) as one of *similitude*, exact or approximate, to be tested by the rule that mere change in the magnitudes of the ordered scheme of units of measurement that is employed must not affect sensibly the forms of the equations that are the adequate expression of the underlying relations of the problem.

J. L.

Cambridge, July 31.

THE question raised by Dr. Riabouchinsky (NATURE, July 29, p. 591) belongs rather to the logic than to the use of the principle of similitude, with which I was mainly concerned (NATURE, March 18, p. 66). It would be well worthy of further discussion. The conclusion that I gave follows on the basis of the usual Fourier equations for conduction of heat, in which heat and temperature are regarded as *sui generis*. It would indeed be a paradox if the further knowledge of the nature of heat afforded by molecular theory put us in a worse position than before in dealing with a particular problem. The solution would seem to be that the Fourier equations embody something as to the nature of heat and temperature which is ignored in the alternative argument of Dr. Riabouchinsky.

August 2. RAYLEIGH.

The Probable Error of the Amplitudes in a Fourier Series obtained from a Given Set of Observations.

To express a periodic variation by one or more terms of a Fourier series is such a common and convenient method that it is of importance to know the extent to which the constants are trustworthy. This is particularly the case when the quantity is subject to a large casual and therefore non-periodic variation as well.

Suppose there are n evenly spaced observations, $y_0, y_1, y_2, \ldots y_{n-1}$, then confining attention to one term only, y may be expressed by the relation $y = a \sin(x - \alpha)$. This may be written

$$y = p \sin x + q \sin\left(x + \frac{\pi}{2}\right)$$

and the amplitude a is given by $a = \sqrt{p^2 + q^2}$.

The standard error of a therefore depends on that of p and q. To obtain p we write—

$$p = y_0 \sin 0 + y_1 \sin \frac{2\pi}{n} + y_2 \sin \frac{4\pi}{n} + \ldots + y_{n-1} \sin \frac{n-1}{n} 2\pi$$

whence, if σ is the standard error of the y's, it is easy to prove that $\sigma\sqrt{2}/\sqrt{n}$ is the standard error of the p or q. This is also the standard error for any higher order term depending on the n observations.

From the way in which p and q are obtained it is obvious they may be positive or negative; the sign depends, in fact, upon the origin chosen, and their mean value obtained from many samples would be zero. But even in the case of there being no period at all, and the y's being purely casual, it is very improbable that both p and q should be zero. In this special case the amplitude a is really zero, but it is almost certain, since it equals $\sqrt{p^2 + q^2}$, not to be given as zero. Its mean square is plainly equal to twice the mean square of p or q, but this is not the square of the standard error, because it is not taken about the mean value.

To ascertain the general magnitude of the error the following plan has been adopted. From a sort of roulette board of 100 compartments, 500 pairs of numbers have been taken, the numbers on the board being arranged to have a standard deviation of 10, and a distribution as nearly normal as the limit of 100 numbers permits. From these pairs, representing the p and q of the sine curve, 500 amplitudes have been found. The result gives a mean amplitude of 12·5, a standard deviation of 6·5, and a distribution such that 4 per cent. exceed the value 25.

Similar results from 500 other pairs, but with a genuine sine curve of amplitude 10 superadded, give a mean amplitude of 16·5, a standard deviation of 8·0, and a distribution such that 8 per cent. are below 5, and 5 per cent. above 30.

From theoretical considerations it is apparent that as the periodic part of the variation becomes large compared with the casual part, the mean amplitude will still exceed, but will approximate to, the genuine amplitude, and the standard error will approximate towards that of p or q.

Suppose, then, that we have a set of n well-distributed observations, and that nothing is known about them in regard to their periodic variation. Let their standard deviation be σ. Now let the first three terms of the Fourier series be found in the usual way, and let the amplitudes be a_1, a_2, and a_3, the question that arises is, to what extent do a_1, a_2, and a_3 represent genuine periodic variations? The standard deviation σ may be due entirely to the periodic variations, or may be purely casual. In the former case it is easily proved that $\sigma = \sqrt{a_1^2 + a_2^2 + a_3^2}/\sqrt{2}$, and if this relationship is approximately satisfied, the larger amplitudes may be accepted as correct. But if the deviation σ of the observations is distinctly larger than that produced by the periodic part, the casual part of it will lead to error in the a_1, a_2, and a_3, and unless an amplitude when compared with $\sigma\sqrt{2}/\sqrt{n}$ is well outside the limits for the special values given above, it need not be significant.

[1] *Cf.* also L. V. King, on hot-wire anemometry, *Phil. Trans.*, A 214 (1914), p. 373.

It follows that the amplitude of any term in a sine curve deduced from only a moderate number of observations must be received with caution until an investigation of its probable error has been made, and this remark refers especially to the second and higher terms where the amplitudes are so often small.

W. H. DINES.

Benson Observatory, Wallingford, July 29.

ON THE CHARACTER OF THE "S" SOUND.

SOME two years ago I asked for suggestions as to the formation of an artificial hiss, and I remarked that the best I had then been able to do was by blowing through a rubber tube nipped at about half an inch from the open end with a screw clamp, but that the sound so obtained was perhaps more like an *f* than an *s*. "There is reason to think that the ear, at any rate of elderly people, tires rapidly to a maintained hiss. The pitch is of the order of 10,000 per second."[1] The last remark was founded upon experiments already briefly described[2] under the head "Pitch of Sibilants."

Doubtless this may vary over a considerable range. In my experiments the method was that of nodes and loops (*Phil. Mag.*, vol. vii., p. 149 (1879); Scientific Papers, I., p. 406), executed with a sensitive flame and sliding reflector. A hiss given by Mr. Enock, which to me seemed very high and not over audible, gave a wave-length (λ) equal to 25 mm., with good agreement on repetition. A hiss which I gave was graver and less definite, corresponding to $\lambda=32$ mm. The frequency would be of the order of 10,000 per second, more than 5 octaves above middle C.

Among the replies, publicly or privately given, with which I was favoured, was one from Prof. E. B. Titchener, of Cornell University,[3] who wrote:—

Lord Rayleigh's sound more like an *f* than an *s* is due, according to Köhler's observations, to a slightly too high pitch. A Galton whistle, set for a tone of 8400 v.d., will give a pure *s*.

It was partly in connection with this that I remarked later[4] that I doubted whether any pure tone gives the full impression of an *s*, having often experimented with bird-calls of about the right pitch. In my published papers I find references to wave-lengths 31·2 mm., 1·304 in. = 33·1 mm., 1·28 in. = 32·5 mm.[5] It is true that these are of a pitch too high for Köhler's optimum, which at ordinary temperatures corresponds to a wave-length of 40·6 mm., or 1·60 inches; but they agree pretty well with the pitch found for actual hisses in my observations with Enock.

Prof. Titchener has lately returned to the subject. In a communication to the American Philosophical Society[6] he writes:—

It occurred to me that the question might be put to the test of experiment. The sound of a Galton's whistle set for 8400 v.d. might be imitated by the mouth, and a series of observations might be taken upon material composed partly of the natural (mouth) sounds and partly of the artificial (whistle) tones. If a listening observer were unable to distinguish between the two stimuli, and if the mouth sound were shown, phonetically, to be a true hiss, then it would be proved that the whistle also gives an *s*, and Lord Rayleigh would be answered.

The experiment was more troublesome than I had anticipated; but I may say at once that it has been carried out, and with affirmative result.

A whistle of Edelmann's pattern (symmetrical, like a steam whistle) was used, actuated by a rubber bulb; and it appears clear that a practised operator was able to imitate the whistle so successfully that the observer could not say with any certainty which was which. More doubt may be felt as to whether the sound was really a fully developed hiss. Reliance seems to have been placed almost exclusively upon the position of the lips and tongue of the operator. I confess I should prefer the opinion of unsophisticated observers judging of the result simply by ear. The only evidence of this kind mentioned is in a footnote (p. 328): "Mr. Stephens' use of the word 'hiss' was spontaneous, not due to suggestion." I have noticed that sometimes a hiss passes momentarily into what may almost be described as a whistle, but I do not think this can be regarded as a normal *s*.

Since reading Prof. Titchener's paper I have made further experiments with results that I propose to describe. The pitch of the sounds was determined by the sensitive flame and sliding reflector method, which is abundantly sensitive for the purpose. The reflector is gradually drawn back from the burner, and the positions noted in which the flame is unaffected. This phase occurs when the burner occupies a *node* of the stationary waves. It is a place where there is no to and fro *motion*. The places of recovery are thus at distances from the reflector which are (odd or even) multiples of the half wave-length. The reflector was usually drawn back until there had been five recoveries, indicating that the distance from the burner was now $5\times\frac{1}{2}\lambda$, and this distance was then measured.

The first observations were upon a whistle on Edelmann's pattern of my own construction. The flame and reflector gave $\lambda=1{\cdot}7$ in., about a semi-tone flat on Köhler's optimum. As regards the character of the sound, it seemed to me and others to bear some resemblance to an *s*, but still to be lacking in something essential. I should say that since my own hearing for *s*'s is now distinctly bad, I have always confirmed my opinion by that of other listeners whose hearing is good. That there should be some resemblance to an *s* at a pitch which is certainly the predominant pitch of an *s* is not surprising; and it is difficult to describe exactly in what the deficiency consisted. My own impression was that the sound was too nearly a pure tone, and that if it had been quite a pure tone the resemblance to an *s* would have been less. In subsequent observations the pitch was raised through

[1] NATURE, vol. xci., p. 319, 1913.
[2] *Phil. Mag.*, vol. xvi., p. 235, 1908. Scientific Papers, V., p. 486.
[3] NATURE, vol. xci., p. 451, 1913.
[4] NATURE, vol. xci., p. 558, 1913.
[5] Scientific Papers, I., p. 407; II., p. 100.
[6] Proceedings, vol. liii., August—December, 1914, p. 323.

$\lambda = 1{\cdot}6$ in., but without modifying the above impressions.

Wishing to try other sources which I thought more likely to give pure tones, I fell back on bird-calls. A new one, with adjustable distance between the perforated plates, gave on different trials $\lambda = 1{\cdot}8$ in., $\lambda = 1{\cdot}6$ in. In neither case was the sound judged to be at all a proper *s*, though perhaps some resemblance remained. The effect was simply that of a high note, like the squeak of a bird or insect. Further trials on another day gave confirmatory results.

The next observations were made with the highest pipe from an organ, gradually raised in pitch by cutting away at the open end. There was some difficulty in getting quite high enough, but measures were taken giving $\lambda = 2{\cdot}2$ in., $\lambda = 1{\cdot}9$ in., and eventually $\lambda = 1{\cdot}6$ in. In no case was there more than the slightest suggestion of an *s*.

As I was not satisfied that at the highest pitch the organ-pipe was speaking properly, I made another from lead tube, which could be blown from an *adjustable* wind nozzle. Tuned to give $\lambda = 1{\cdot}6$ in., it sounded faint to my ear, and conveyed no *s*. Other observers, who heard it well, said it was no *s*.

In all these experiments the sounds were *maintained*, the various instruments being blown from a loaded bag, charged beforehand with a foot blower. In this respect they are not fully comparable with those of Prof. Titchener, whose whistle was actuated by squeezing a rubber bulb. However, I have also tried a glass tube, 10·4 in. long, supported at the middle and rubbed with a resined leather. This should be of the right pitch, but the squeak heard did not suggest an *s*. I ought perhaps to add that the thing did not work particularly well.

It will be seen that my conclusions differ a good deal from those of Prof. Titchener, but since these estimates depend upon individual judgment, perhaps not uninfluenced by prepossessions, they are not fully satisfactory. Further independent aural observations are desirable. I fear a record, or ocular observation, of vibrations at so high a pitch is hardly feasible.

I may perhaps be asked if a characteristic *s*, having a dominant pitch, is not a pure tone, what is it? I am disposed to think that the vibration is irregular. A fairly defined pitch does not necessitate regular sequences of more than a few (say 3–10) vibrations. What is the state of affairs in an organ-pipe which does not speak well, or in a violin string badly bowed? An example more amenable to observation is afforded by the procession of drops into which a liquid jet breaks up. If the jet is well protected from outside influences, the procession is irregular, and yet there is a dominant interval between consecutive drops, giving rise under suitable conditions to a sound having a dominant pitch. Vibrations of this sort deserve more attention than they have received. In the case of the *s* the pitch is so high that there would be opportunity for interruption so frequent that they would not be separately audible, and yet not so many as to preclude a fairly defined dominant pitch. I have an impression, too, that the *s* includes subordinate components decidedly graver than the dominant pitch.

Similar questions naturally arise over the character of the *sh*, *f*, and *th* sounds.

RAYLEIGH.

GAUGES.

INTERCHANGEABILITY forms the basis of manufacture wherever there are a large number of articles to be made, and the processes required in order to secure it are well understood. The system makes it possible to subdivide the manufacture of any part into many small processes, each effected by one worker, aided by machine or hand tools, who acquires great skill in his particular operation. The parts so made must be capable of being assembled with the minimum labour; in fact, assembling ought to consist merely of putting together parts selected at random from stocks of details, with the certainty that these will fit without any additional tool work on the part of the assembler. Each operation performed in the making of any part must give to that part definite dimensions within prearranged limits. The precise dimensions and limits are chosen with a view to securing running, push, driving, or shrinking fits, according as will be required in the assembling operations. Gauges by means of which the results of each operation may be tested thus become a necessity in the manufacture of interchangeable parts. These gauges are generally of the limit form. Very large numbers of these gauges are required in the production of munitions.

Suppose the operation to consist of boring a hole nominally 1 in. in diameter, and that the finished hole must not exceed 1·003, nor be less than 0·997 in. in diameter. The gauge employed would be cylindrical, having one end 1·003, and the other end 0·997 in. in diameter. If the smaller end can go into the hole, the hole is not less than 0·997 in. in diameter, and if the larger end cannot go in, the hole is not larger than 1·003 in. diameter. By use of a gauge of this kind, any workman of ordinary intelligence may produce work having a high degree of accuracy.

It is obvious that the gauges employed must be much more accurate in dimensions than the work which they are employed to check. Thus the gauge mentioned above would have its larger end probably within the limits 1·0031 and 1·0029, the variation permitted being one ten-thousandth inch above or below the rated size. Further, gauges must be made of very hard material in order to reduce wear, and must have well-finished surfaces. The hard steel used for this purpose is often of such quality as to require annealing once or twice before the necessary machining operations can be completed. After machining nearly to the finished size, the gauge is hardened, a process which generally warps the material.

To correct this, and to bring the gauge to the proper dimensions, grinding and lapping by machines or hand is required. It will thus be understood that the whole operation of gauge-making is one which requires great skill, and a special plant.

Many of the gauges used in engineering manufactures are made by firms who lay themselves out specially for this class of work; in other cases the manufacturing firms make their own gauges. The latter plan has nothing against it, provided that the whole of the parts required in the finished products of the firm are made in their own factory. This is a point of importance at the present time, when most engineering firms have been called into the making of munitions. It is clear that the produce of any one firm producing certain parts must agree, within the prescribed limits of accuracy, with that of any other firm making the same parts. Hence all must be supplied with gauges having like limits of accuracy.

It is well known, as has been pointed out by a correspondent in the *Morning Post*, that the firms of gauge-makers have not been able to keep pace with the demand, and that many firms have been hindered in the starting of the manufacture of munitions by delay in the supplying of gauges. It is very easy to say now that the emergency might have been foreseen earlier. A very useful suggestion was made at a recent meeting of the Institution of Mechanical Engineers to the effect that all gauges should be made and supplied from a central factory. It may not be altogether a dream to imagine such a factory under direct government control, as is the case in Woolwich Arsenal, and working in conjunction with the National Physical Laboratory in order that standards may be maintained. Such an institution would be of great benefit to engineering manufacture, quite apart from the present war conditions, and could be worked so as to secure the standardisation of dimensions in a similar way to that in which are maintained our standards of weights used in distributive trades.

The National Physical Laboratory has recently been carrying out a useful piece of work in determining the desirable manufacturing limits for B.A. screws. Gauges for testing screws present peculiar difficulties in manufacture, as will be realised from what has been said above. The "fit" of a screw having a V thread in a tapped hole depends chiefly upon the effective diameter of the threads (*i.e.*, the diameter measured between the sloping sides of the thread), on the pitch, and on the correctness of the angle of the V. The National Physical Laboratory has issued tables giving recommendations (some of them provisional) for B.A. threads Nos. 0, 1, 2, 3, 4, 5, 6. The scope and importance of the recommendations may be understood by examination of the accompanying table, which we have abstracted from a number of tables in the report.

TABLE FOR B.A. THREADS. NO. 0.

All dimensions are in millimetres.

—	Standard	Finished parts		Tools			Gauges				
		Limits for screws	Limits for nuts and tapped holes	Limits for taps	Limits for dies	Limits for taps to cut dies	Screwed plug *a*	Go in plug *c*	Not go in plug *d*	Go in ring *e*	Not go in ring *f*
Full diameter	6·000	5·933 6·000	6·067 6·200	6.133 6·167	6·033 6·067	6·000 6·033	5·993 6·000			6·000	5·933
Effective diameter ...	5·400	5·267 5·333	5·467 5·533	5·433 5·467	5·333 5·367	5·267 5·300	5·380 5·387				
Core diameter	4·800	4·600 4·733	4·800 4·867	4·733 4·767	4·633 4·667	4·567 4·600	4·767 4·773	4·800	4·867		
Pitch, over 10 threads	10·000	9·985 10·015	9·985 10·015	9·971 10·000	10·000 10·029	9·9855 10·0145	9·997 10·003				
Angle of V	47½	42½° 52½°	42½° 52½°	45½° 49½°	45½° 49½°	45½° 49½°	46½° 48½°				

The gauges recommended are (*a*) a screwed plug gauge; (*b*) a screwed ring gauge; (*c*) a plain cylindrical "go in" gauge; (*d*) a plain cylindrical "not go in" gauge; (*e*) a "go in" ring gauge; (*f*) a "not go in" ring gauge. Gauge (*b*) would be specified to have the same thread form as the plug gauge (*a*) and would be checked by its fit upon the latter. Gauge (*c*) is of standard nominal core diameter, and should fit in gauge (*b*); gauges (*c*) and (*d*) serve the purpose of testing the core diameters of units and tapped holes. Gauges (*e*) and (*f*) are for testing the full diameters of screws.

The results of the investigation are bound to be of service at the present juncture to instrument makers and others using B.A. threads. The National Physical Laboratory is prepared, pending an authoritative decision on the matter, to certify screws, etc., which fall within the suggested limits, as B.A. screws, taps, or gauges.

FAUNA ANTARCTICA.[1]

DR. BRUCE is to be congratulated on the publication of the fourth volume of the scientific results of the voyage of the *Scotia*. This stately publication contains no fewer than nineteen reports (all by British investigators) on the vertebrate animals collected by the expedition, and it seems to us well worthy of the generosity, notably on the part of Sir Thomas Glen Coats, which has made its publication possible. Many of the reports have appeared previously in the transactions of scientific societies, as is carefully noted in each case, but the utility of having all the papers together is obvious.

Beginning with the mammals, we find a report by Dr. Bruce on the dimensions and weights of the Antarctic seals captured by the *Scotia*, and the editor also contributes a series of fine photo-

FIG. 1.—*Leptonychotes weddelli* (Weddell Seal). From "Report on the Scientific Results of the Voyage of s.y. *Scotia*."

graphs of the Weddell seal, the sea-leopard, the crab-eater, the Ross seal, and the Patagonian sea-lion. Dr. R. N. Rudmose-Brown gives a very interesting account of the habits of four Antarctic seals (Weddell, crab-eater, sea-leopard, and Ross seal), and the value of his personal observations is increased by numerous beautiful photographs. Prof. David Hepburn deals with the brain, the abdominal viscera, the respiratory organs, and the urogenital system of a young male Weddell seal (*Leptonychotes weddelli*); Prof. Robert Thomson with the skeleton of the Ross seal (*Ommatophoca rossi*); and Dr. Harold Axel Haig with the structure (macroscopic and microscopic) of a fœtal sea-leopard, *Stenorhynchus leptonyx*) and with the minute structure of the central nervous system of the Weddell seal. Dr. Bruce gives data in regard to seven Antarctic whales, and also discusses an interesting piebald porpoise (probably *Lagenorhynchus cruciger*). Mr. Theodore E. Salvesen's graphic account of the southern whale fisheries has been recently reviewed in NATURE (vol. xciv., p. 678, February 18, 1915).

Turning to the birds, we find a masterly account of the birds of the South Orkney Islands, the Weddell and adjacent seas, and Gough Island, by Mr. Eagle Clarke, of the Royal Scottish Museum. The birds observed and collected by the *Scotia* at other places have been dealt with in a number of short papers by the late Lieut. Lewis N. G. Ramsay, a young zoologist of great promise, who was, alas! killed at Neuve Chapelle in March of this year. Dr. R. N. Rudmose-Brown gives a vivid picture of the habits of penguins. Profs. D. Waterston and A. Campbell Gaddes deal with some anatomical features of the Emperor penguin and with the development of Gentoo and Adelie penguins. The extraordinary curvature of the cervical region of the penguin's vertebral column is carefully discussed, and an interesting contrast is made between the development of the duck's wing and that of the penguin's paddle.

An important report on the Antarctic fishes comes from the skilful hands of Mr. C. Tate Regan, who describes seven new genera and twenty-one new species. The first of the new genera, Eugnathosaurus, is based on a remarkable head taken off Coats Land at a depth of 1410 fathoms. A collection of over a hundred species of Atlantic fishes is briefly dealt with by Mr. R. S. Clark (now acting as zoologist on Sir Ernest Shackleton's expedition), who also reports on half-a-dozen fresh-water fishes from Buenos Aires. Prof. W. A. Herdman describes the Tunicates, fifteen or sixteen species represented by about two hundred specimens. The only new species (*Fungulus antarcticus*) is a very remarkable form belonging to the deep-sea genus Fungulus, a single specimen of which was obtained by the *Challenger* in 1882, between the Cape of Good Hope and Kerguelen, from a depth of 1600 fathoms. Nearly 3000 miles away, but again in the far south and in very deep water (2485 fathoms), the *Scotia* species was obtained, and again but a single specimen. The limit of the Chordate sub-kingdom is found by many zoologists in the remarkable animals known as Pterobranchia, and the *Scotia* explorers were fortunate enough to secure numerous specimens of

[1] Scottish National Antarctic Expedition. Report on the Scientific Results of the Voyage of S.Y. *Scotia* during the Years 1902, 1903, and 1904, under the leadership of W. S. Bruce. Vol. iv., "Zoology." Parts ii-xx. Vertebrates. Pp. xi+505+62 plates+2 maps. (Edinburgh: The Scottish Oceanographical Laboratory, 1915.) Price £2 10s. net.

a very interesting new species of Cephalodiscus, of which a fine account has been given by Drs. S. F. Harmer and W. G. Ridewood, whose previous studies of these strange types are well known. Thus we come, in the meantime, to the end of a valuable series of contributions to the marine zoology of the far south, contributions which do great credit to the investigators at home and to Dr. Bruce and his fellow-workers on the *Scotia*. We are told in the preface that there is material for six more volumes, and we hope that these will see the light in brighter days. If they sustain the standard of what has been already published they will do well.

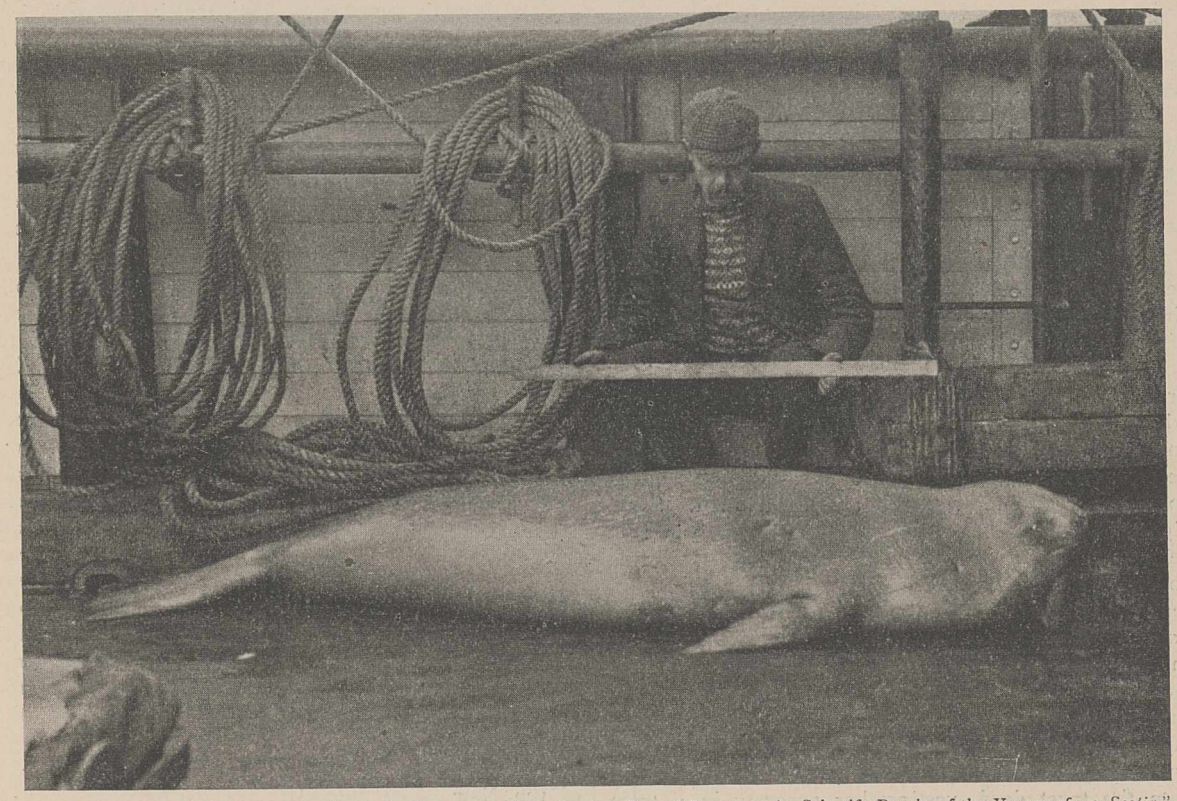

FIG. 2.—Ross Seal (*Ommatophoca rossi*) and Dr. Pirie on board the *Scotia*. From "Report on the Scientific Results of the Voyage of s.y. *Scotia*."

NOTES.

IT is stated in the *Pharmaceutical Journal* that, in consequence of the war, the meeting of the Australasian Association, which had been arranged to take place in Hobart in January next, has been postponed for a year, and that the Australasian Pharmaceutical Conference will not be held until January, 1917.

SIR A. SELBY-BIGGE (Permanent Secretary of the Board of Education since 1911) has been appointed special secretary to the committee of the Privy Council for the organisation and development of scientific and industrial research.

MR. F. W. HARBORD has been appointed honorary adviser in metallurgy to the Munitions Committee.

PROF. MELDOLA, writing as a member of the Advisory Council for the new Government scheme for the endowment of research, asks us to make it known that the article in the *Evening News* of August 2 dealing with this scheme was not written by him and that he does not identify himself with all the statements and opinions contained therein. A disclaimer was inserted in the same paper on August 5.

THE gold medal of the Company of Dyers has been awarded to Prof. A. G. Green, University of Leeds, and to Mr. W. Johnson, a research student of the University of Leeds, for research work in connection with the art of dyeing. The special research which was the occasion of the award was an investigation into the constitution of aniline black.

THE Weber-Parkes prize of the Royal College of Physicians for 1915 has been awarded to Dr. Noel Dean Bardswell.

THE Paris Academy of Medicine has accepted the legacy of Dr. M. Sigaut of 8,000 francs, the interest of which will be used to establish a prize to be known as the Dr. Max Sigaut prize. The prize will be awarded every two years for the best memoir on early diagnosis and the best treatment in cancer of the digestive tract.

THE Secretary of State for the Colonies has appointed a committee to consider and report upon the present condition and the prospects of the West African trade in palm kernels and other edible and oil-producing nuts and seeds and to make recommendations for the promotion, in the United Kingdom, of the industries dependent thereon. The committee as at present constituted is composed of Mr. Steel

Maitland (chairman), Sir G. Fiddes, Sir F. Lugard, Sir Hugh Clifford, Sir Owen Philipps, Mr. G. A. Moore, Mr. T. Walkden, Sir W. G. Watson, Bt., Mr. L. Couper, Prof. W. R. Dunstan, Mr. T. Middleton, Mr. T. Worthington, and Mr. T. Wiles. The secretary is Mr. J. E. W. Flood, of the Colonial Office.

THE death is announced of Dr. B. Fischer, Professor of Hygiene and Bacteriology in the University of Kiel, who recently succumbed to heart-failure near Ypres. In the early days of bacteriology he studied the action of antiseptics and disinfectants upon bacteria, and afterwards made important contributions on the phosphorescent and chromogenic bacteria and on bacterial structure and classification. The latter formed the subject of a series of lectures, an English translation of which appeared under the title of "The Structure and Functions of the Bacteria," which has passed through two or three editions and forms an admirable introduction to the more botanical side of bacteriology.

THE death is announced of Madame Osterberg, the head of the Swedish physical training movement in England. In 1880 she was appointed superintendent of the physical training department of the London School Board. In 1885 she started at Hampstead the first college in this country for teaching Swedish drill, which in 1895 was moved to Dartford Heath. The college was enlarged several times, the curriculum becoming more scientific, and a laboratory was added some years ago for research and experiment. Some eighteen months ago Madame Osterberg desired to relinquish the active direction of the work of the college. In so doing she wished, in the national interest, to secure the continuation of the work which had been so successfully developed. With this purpose in view she offered to transfer the college to the Government. For reasons in no way connected with the college it was found impracticable to accept the offer, and Madame Osterberg was advised to create a trust. Almost her last act before her death was to sign the trust deed, vesting her property in a trust with the object of carrying on the college in the national interest on its existing lines.

WE regret to note the death of Major A. M. Downie, of the 5th Highland Light Infantry. Major Downie was wounded on July 12 during operations in the Gallipoli Peninsula, and died on July 23. He was well known in engineering circles in Glasgow; he was educated at Allan Glen's School and at Glasgow University, where he took the degree of B.Sc. in engineering. At a comparatively early age he was appointed managing director of Messrs. D. Stewart and Co., Ltd., where his attainments proved of great service in developing the specialities of the firm—sugar machinery.

ACCORDING to a German wireless message, the death has just occurred, at Lichterfelde, Berlin, at the age of sixty-nine years, of Dr. Richard Kiepert, the cartographer.

WE regret to record the death of Rear-Admiral Benjamin Franklin Isherwood, who was engineer-in-chief of the United States Navy during the American Civil War. A short account of his career is given in *Engineering*. He was trained at the Albany Academy, and his early practical work was connected with railway construction. He was one of the first members of the Engineer Corps of the United States Navy, and saw service in the Mexican War in 1846 in the *Princeton*, the first screw-propelled vessel of the United States Navy. He was appointed engineer-in-chief of the navy in 1861. On his retirement he took up his residence in New York and devoted his energies to scientific research and literary work.

THE annual congress of the British Archæological Association will be held in the Isle of Wight from August 18–21 inclusive. On the evening of the opening day the president, Mr. C. E. Keyser, will deliver his presidential address at Ryde. On August 19 a joint meeting will be held with the Hampshire Field Club and Archæological Society, and arrangements have been made for visits to various places of interest on that day and on the concluding days of the meeting.

THE autumn meeting of the Institute of Metals will be held in the rooms of the Chemical Society on September 17. The following papers may be expected to be communicated:—The corrosion of gun-metal, Dr. C. H. Desch; metallic crystal twinning by direct mechanical strain, Prof. C. A. Edwards; notes on the copper-rich kalchoids, Profs. Brinton and S. L. Hoyt; the constitution of brasses containing small percentages of tin, Dr. O. F. Hudson and R. H. Jones; (*a*) structural changes in industrial brasses, (*b*) hardness of copper-zinc alloys, Dr. D. Meneghini; specifications for alloys for high-speed superheat steam turbine blading, W. B. Parker; the physical properties of metals as functions of each other, Dr. A. H. Stuart; detection of internal blow-holes in metal castings by means of X-rays, C. H. Tonamy; a thermostat for moderate and high temperatures, J. L. Haughton and D. Hanson.

IT is intended to celebrate the twentieth anniversary of the New York Botanical Garden in Bronx Park during the week beginning on September 6 next. In addition to meetings in the garden itself, there are to be visits to Staten Island for the study of the coastal flora, to the pine barrens of New Jersey, and to the Brooklyn Botanical Garden.

THE general programme of the ninety-seventh annual meeting of the Société Helvétique des Sciences naturelles to be held at Geneva on September 12–15 has now been issued. It will be remembered that this year is also the centenary of the foundation of the society. On September 13 the president, Prof. Amé Pictet, will deliver the opening address, and a lecture will be given by Prof. A. Heim, of Zurich, on new light in the investigation of the Jura Mountains. On September 14 the sectional meetings will take place, and on the concluding day the following lectures have been arranged:—Prof. P. L. Mercanton, of Lausanne, on the results of forty years' measurements of the Rhone glacier; Dr. Fritz Garasin, of Bale, on an archipelago in the Pacific Ocean: the Loyalty Islands; and Dr. E. Rübel, of Zurich, on the international plant geography excursion through North America. The presi-

dents of the various sections at this year's meeting are:—Mathematics and astronomy, Prof. H. Fehr; physics and geophysics, Prof. C. E. Guye; geography and mineralogy, Prof. Ch. Sarasin; chemistry, Dr. F. Reverdin; botany, Dr. J. Briquet; zoology, Dr. M. Bedot; entomology, Dr. Arnold Pictet; anthropology and ethnography, Dr. Eugène Pittard.

STUDENTS of the mythology of primitive races have hitherto mainly dealt with the problem from the point of view of folklore and philosophy. Many tabulations of the incidents out of which the legends have been built up have been made, but these have been as a rule merely mechanical. It shows the liberal definition of scientific research in the Geological Survey of Canada that it has published, as Museum Bulletin No. 16, an elaborate disquisition by Mr. Paul Radin on the literary aspects of North American mythology. When once we admit that in dealing with primitive mythology we are discussing literature in the true sense of the word, it becomes inevitable to apply to it the same methods of analysis and criticism that we apply to any modern literature, paying due regard to the personality of the author or author-*raconteur*, his literary and stylistic peculiarities. The author of this paper deals specially with the theories of Ehrenreich and other German writers, who argue that there must be a single original and correct version of every myth. The essay is interesting and serves to modify in some degree current views of the methods by which this body of legend was constructed.

IN *Man* for August, the Hon. J. Abercromby describes the few remaining examples of plastic art from the Grand Canary. There is a little difficulty about some of the specimens, as a collection from Mexico seems to have been mixed up with local articles in the Museum of Las Palmas. One specimen, perhaps the image of a goddess, seems to be of the steatopygous type, and another, showing an abnormal development of the biceps, may represent a wrestler. The steatopygous type cannot be Mexican, as this feature is believed to be absent in art from that country. As steatopygy prevailed among the Berber-speaking tribes of North Africa and the Sahara, and shows itself in some early figurines from the Ægean, it is possible that it may have extended to the Grand Canary. The examples illustrated are exceedingly rude, but they are interesting as examples of a very primitive school of art.

IN *Folk-lore* for June, Mr. W. J. Perry discusses Myths of Origin and the Home of the Dead in Indonesia. He arrives at the conclusion that the land of the dead, when situated on earth, is usually in the direction of the land whence the people who believe in it suppose themselves to have come. If the journey of the spirit be over water, a canoe for its use is generally provided, or in some cases the corpse may be actually conveyed to the homeland. When the home of the dead is a mountain, it implies that the tribe traces its origin to a mountain, and tree-disposal is often accompanied by a myth of origin from some kind of tree. Interment, he suggests, implies an origin from the earth, and the use of stone sepulchres implies a myth of origin from stones. These conclusions may be supported by the evidence from Indonesia, but they will not be accepted as of general application, and a treatment of the subject from the comparative point of view is much to be desired.

IN Memoir No. 75 of the Department of Mines, Canada, Mr. F. G. Speck contributes an account of the decorative art of the Indian tribes of Connecticut. Much work has recently been done among the eastern Algonkin tribes, many specimens of their art industries have been collected, and information has been procured from several aged Indians of the Mohegan and Niantic tribes of eastern Connecticut. The artistic capacity of these people is chiefly shown in painting on baskets, while decorative wood carving on household utensils and sometimes upon implements was common, but bead-work was only of secondary importance. This monograph is therefore specially devoted to basketry, and the materials, implements, and designs are fully described. Some of this work is highly ingenious and beautiful, and the memoir may prove useful to the authorities of some of our technical schools.

PROF. W. H. THOMPSON, who occupies the chair of physiology at Trinity College, Dublin, has published a little pamphlet on "Food Values," the proceeds of the sale of which will be devoted to the Dublin University Voluntary Aid Detachment Hospital. It deals primarily with the food supplies in Ireland, but may be applied, so far as its chief data are concerned, to the food supply of any nation. In these days, when economy is so urgent, its appearance is very timely. It deals in clear language which "he who runs may read" with the fundamental principles of diet. Mere weight is no criterion of the energy value of any food. The amount of water must be deducted, and many of the most expensive foods contain most water. After this the chemical constitution of the remainder (proteins, fats, carbohydrates, salts) must be considered, and, finally, the amount of each of the constituents which is digestible. The latter factor is much influenced by the method of cooking adopted. All these points are considered, and a number of useful illustrations help to elucidate the text. Emphasis is put upon the substitution of the cheaper forms of the more highly nutritious vegetable foods for those of animal origin. It is here that cooking (the weak point in many British households) is all-important. The bad or insufficient cooking of meaty foods does not profoundly affect their digestibility, although it influences their appetising quality, a by no means unimportant matter; but a badly cooked vegetable diet is not only destitute of the latter quality, but is very largely incapable of being digested. We are glad to see that a number of useful recipes are given, which enhance the practical value of this useful pamphlet.

THE economic resources of German South-West Africa form the subject of an article in the Bulletin of the Imperial Institute, vol. xiii., No. 2, just issued.

The value of the article is enhanced by a useful map showing the railways, rivers, diamondiferous areas, etc., and an account of the geology, meteorology, mineral resources, and agricultural conditions of the country is given. Diamonds were discovered in 1908, and the value of the output in 1912 was 1,520,704*l*. Gold, marble, and various other economic minerals of importance are found. As regards agriculture, stock-raising has received considerable attention, and in the middle districts and south, where irrigation is possible, a good many crops are grown. Tobacco-growing has been encouraged at the Government station Okahandja, and cotton of good quality has been grown experimentally. Grapes, peaches, apricots, etc., have also been successfully grown, and various dry-country trees are being grown at the forest stations.

UNDER the title of "The Wonderland of California," Mr. Herman Whitaker, in the July issue of the *National Geographic Magazine*, deals with some of the magnificent scenery of the peninsula. The paper is, as usual, illustrated by a splendid collection of photographs, among which those of the entrance of the Golden Gate, the magnificent trees in the State Redwood Park near Boulder Creek, the Bridal Veil waterfalls on Merced River, the views of the Yosemite Valley, and of the mighty granite peak known as El Capitan, are particularly impressive. Now that the Continent is likely to be barred for some time to come, travellers in search of the beautiful may well direct their attention to the country described in this pleasant paper.

INASMUCH as the wheat-producing capabilities of the non-belligerent nations is now a matter of the most vital importance, it is disconcerting to find that the Hessian fly, during the past season, has inflicted immense damage to the wheat crop of the United States, millions of bushels having been ruined. What is more, unless strenuous efforts are immediately made, the devastation will assume far more alarming proportions during the coming year. To avert this, if possible, the United States Department of Agriculture has just issued a leaflet, which cannot be too widely read by British farmers, for this country is by no means immune to attacks from this insidious parasite. The farmers over the vast area now infected are exhorted to act on the advice ignored by them, in spite of repeated warnings, during 1914. It is once more pointed out that this pest can be practically exterminated by adopting the simple precaution of delaying the autumn wheat-sowing until after the adult flies emerging from the "flax-seed" or larval cases adhering to the straw of the summer wheat have perished, which they must do soon after assuming the adult stage. They will thus die without leaving offspring, since they will find no nidus for their eggs. Wherever possible, all stubbles are to burned, and where this is not possible they should be deeply ploughed in and the ground rolled. Further, rotation of crops should be adopted whenever possible. Where good seed-wheat is sown on generous ground, a mild attack of this fly may even prove beneficial, since the early developing larvæ destroy the first shoots and cause the plant to "tiller." Maps showing the best average dates for sowing, according to latitude, and diagrams illustrating the life-history of the fly, add immensely to the value of this leaflet.

FROM the *Kew Bulletin* we learn that the new laboratory for the exclusive investigation of problems in plant pathology is now in use. The laboratory has been formed by the alteration of two Georgian cottages facing Kew Green, and contains several research rooms and a large library. The cottages were formerly houses in the occupation of Ladies of the Bedchamber when the Court was in residence at Kew, and the plaster ceilings in some of the rooms are of considerable beauty. Until now, much of the Board of Agriculture's pathological work has been carried out at Kew in the Jodrell Laboratory, but owing to the increasing importance of the work, the establishment of a separate institute with its own staff of plant pathologists has become an imperative necessity. The attention of the staff will be devoted primarily to the investigation of diseases caused by fungi, both at home and in our Colonies, and special research in connection with important problems in plant pathology will also be undertaken. Mr. A. D. Cotton, assistant in the herbarium, has been promoted to a first-class assistantship in connection with the new laboratory, and Mr. W. B. Brierley, of Manchester University, has also been appointed a first-class assistant. A temporary assistant and a preparer comprise the staff up to the present. A portion of the laboratory is being used temporarily by the entomologist of the Board of Agriculture, so that opportunity is also afforded for the investigation of plant diseases caused by insects.

OWING to the high price of wheat flour, attempts are being made in the West Indies to replace part of the imported flour by locally prepared products. An analysis of a sample of banana flour from Jamaica is given in the current number of the Bulletin of the Imperial Institute (vol. xiii., No. 2). Compared with wheat flour or maize meal, it was found to have a lower nutritive value, owing to the much smaller percentage of proteins. The meal has rather a pronounced aroma, but as a partial substitute for wheat flour or maize meal it may prove useful locally.

IN the *Indian Forest Records*, vol. v., part vi., of May, 1915, Mr. R. S. Hole describes a new species of forest grass from Burma under the name *Spodiopogon lacei*. The paper is illustrated by excellent photographs of the grass and drawings of the details of the structure of the spikelets and flowers, the number of the spikelets in the raceme and of flowers in each spikelet being important features in the genus. In this species the racemes consist of three to nine spikelets, and are usually two-flowered.

THE flowers of Milton form the subject of the first instalment of a paper, by the veteran Canon Ellacombe, in the *Gardener's Chronicle* for July 17. It will be remembered that he has already written on the flowers of Chaucer, Spenser, and Gower, and the

NATURE.

The number for **last week (Aug. 5)** contained :—

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present paper is of equal value to its predecessors. Milton had not the knowledge of plants possessed by the other three poets, but the Canon's notes are full of interest. Milton's amaranth still remains a puzzle, but as he places it in Paradise, further earthly research seems useless.

IN the current number (vol. xiii., No. 2) of the Imperial Institute Bulletin, Prof. J. B. Harrison and Mr. C. K. Bancroft contribute a paper on "The Field and Forest Resources of British Guiana." Some 55,770,000 acres of land are estimated to be open for beneficial occupation, some 9,000,000 of which are easily accessible. Rice is a product which may be grown over large areas, and the success which has attended its culture shows that the colony might well become the granary of the West Indies in this particular grain. Forestry development is limited by difficulties of transportation, but of timber there is abundance and of good quality. Balata, which occurs all over the colony, is one of the most important forest trees, and greenheart is perhaps the best known of all the timbers of British Guiana.

AT the monthly general meeting of the Zoological Society of London, held July 21, special attention was directed to the hatching, in the menagerie, of a white-browed wood swallow and two white storks. Since the total number of visitors to the Gardens between January 1 and June 30 shows a decrease of 120,993, it would seem that the war has, during this period, seriously crippled the Society; but matters are, happily, not so bad as this statement, in itself, would seem to show, for the receipts for admission at the gates, as compared with the corresponding period for the last ten years, show a deficiency of no more than 404*l.*, which may well be made up during the next few months.

THE investigation of another egg of Ornithorhynchus, described in the current number of the *Quarterly Journal of Microscopical Science* (vol. lxi., part i.), has afforded Profs. Wilson and Hill an opportunity of revising their views on the subject of the so-called primitive or archenteric knot. This structure was supposed to mark the position of the blastopore, but to come into relation with the primitive streak only secondarily, originally lying outside the embryonic shield. Both Keibel and Assheton criticised this interpretation, and suggested that the supposed archenteric knot in the younger stages of Ornithorhynchus might in reality be the yolk-navel. This view is definitely accepted by Profs. Wilson and Hill, who state that they feel with Assheton that "another stumbling-block has been removed from the path of the student of mammalian embryology."

THE way in which animals learn by the method of so-called trial and error has now been rendered fairly comprehensible by a considerable body of experimental work, largely conducted in the psychological laboratories of the United States. In a recent "Behavior Monograph" (No. 10) of the well-known series edited by Prof. J. B. Watson, Mr. J. L. Ulrich discusses the distribution of effort in learning in the white rat. The chief questions to which he seeks an answer are these: Given three "problems" to be practically solved by behaviour which has to be learnt, what in each several case is the optimum distribution of trials; once in three days, once a day, or thrice a day? The answer seems to be that once in three days gives the minimum number of trials before the lesson is completely learnt, but that with three trials a day the lesson is learnt in a shorter period of time. It seems, too, that when three modes of behaviour are learned abreast, trials in each being made on the same day, infrequent practice, say one trial in each *per diem*, is advantageous, and that under these conditions a much larger number of trials is required for the solution of each of the problems than is required when the modes of behaviour are learnt one at a time. Physiological interpretation is tentatively suggested.

IN a series of three papers published by the Edinburgh and East of Scotland College of Agriculture, Dr. J. P. M'Gowan discusses the epidemiology and pathology of three important animal diseases, swine-fever, louping-ill of sheep, and chicken-cholera. Louping-ill he considers to be caused by the *Bacillus bipolaris septicus ovium*; the disease is divisible into several varieties, and a "pseudo-louping-ill" is also known. Swine-fever is generally considered to be caused by a "filter-passer," but the view is expressed that the evidence for this being the case is far from complete. Chicken-cholera is caused by the *Bacillus pullorum*, but there are probably several varieties of this organism, and "white diarrhœa" of poultry and "white scour" of lambs are probably caused by similar micro-organisms.

IN an article on the production of X-ray bulbs in France (*La Nature*, July 10) it is pointed out that the statement that suitable French glass was not available at the outbreak of war was inaccurate. Since 1904 Appert Bros. have made suitable glass, and that though glass blowers preferred Thuringen glass, it was on grounds of economy only, and the Clichy factory was able to supply similar glass when the stocks became exhausted. From analyses of German glass by M. Matignon it was found possible to imitate it, and glass even more transparent to X-rays is now made. Pilon's modification of the Coolidge tube is described, showing how satisfactory cooling of the antikathode is obtained. The 1915 model gives a steady discharge even for such long periods as 1 hour 20 minutes, with perfect control of the character of discharge.

La Nature for July 10 also contains a very interesting article on the torpedo. Reference is made to the early history of the torpedo; to Whitehead's early pattern of a speed of only 6 knots, and capable of covering a distance of 600 metres. The great progress made to the present torpedo, with a speed of 45 knots and 10,000 metres range, carrying a charge of 150 kilos. of high explosive, is a notable achievement. An excellent description is given of the manner in which the difficulties of control of immersion and direction have been overcome by means of the hydro-

static balance and gyroscope. As is well known, compressed air (at 150 kilos. per square centimetre) is used for the engines. On expansion it is very materially cooled, and a reference is made to a modern arrangement for re-heating the air by injection of an alcohol or petrol spray, together with a fine spray of water—a method which leads to a great increase in speed and run of the torpedo. The article deals further with the interesting experimental station of the Schneider firm—the *Batterie des Maures*—situated in the roads of Hyères.

IN a recent article (NATURE, August 5) on modern methods for the preparation of hydrogen for balloons and dirigibles, the difficulties attendant on the use and transport of acid for the well-known methods of generation from zinc or iron were mentioned. One of the greatest troubles arising from the use of gas prepared by these reactions has been due to impurities in the gas. An article in *La Nature* (July 10) deals specially with this method of preparation and the purification of the gas. Among the impurities are hydrogen arsenide, antimonide, and selenide, all poisonous gases, and which led to the death of two employees and serious illness of three others engaged at the Chalais-Meudon Aerodrome in 1900. Sulphuretted hydrogen, formed by reduction in the generators, has a very deleterious action on the varnish of the fabric, which, containing lead, is attacked, forming the sulphide, and further, by the action of moist air, on the tissue itself. Exposed metal in dirigibles is also subject to its attack. Other impurities are water vapour, carbon dioxide, and gaseous hydrocarbons, which seriously diminish the lifting power of the gas. Purification entails first washing the gas to remove acid spray, passage through a special purifier containing a moist mixture of iron sulphate and lime on sawdust, and finally through soda. The iron purifying material which has absorbed the sulphuretted hydrogen is regenerated by exposure on grids to the air. The cost of purification is stated to be 1·5 to 2 centimes per cubic metre.

AN investigation by Messrs. G. K. Burgess and P. D. Merica, of the Bureau of Standards, a preliminary account of which appears in the *Journal of the Washington Academy of Sciences* for July 19, appears to provide a complete explanation of the mysterious failure of tin fusible boiler plugs. It will be remembered that these plugs are inserted in the crowns of boiler furnaces or flues and that their function is to give warning of overheating of the boiler by their melting and admitting steam to the fires. It was found that the tin of plugs which had failed had been converted in service into SnO_2, which melts at 1600° C. This oxidation was finally traced to the presence of zinc in the tin to the extent of 0·3 per cent. Plugs with this amount of impurity, when heated to 190° C. for 500 hours, develop a cellular structure, the walls of the cells consisting of oxidised zinc, to which oxidised tin is added with time, and the unoxidised tin is enclosed in the cells. Even when the tin is melted the cell walls may be strong enough to withstand the boiler pressure. The authors conclude that tin of at least 99·8 per cent. purity should be used for such boiler plugs.

THE July number of the Bulletin of the American Mathematical Society (xxi., 10) contains particulars of the courses in mathematics announced for the summer semester in six of the German universities. Excluding such general items as "colloquium" and "seminar," the statistics work out as follows:—Berlin, 13 courses by 8 lecturers; Bonn, 7 courses, 4 lecturers; Frankfurt, 7 courses, 4 lecturers; Göttingen, 13 courses, 9 lecturers; Leipzig, 9 courses, 4 lecturers; Munich, 11 courses, 8 lecturers. We also note the award of the Helmholtz medal of the Berlin Academy to Prof. M. Planck, and the celebration of the seventy-fifth birthday of Prof. F. Mertens, of Vienna, on November 7, 1914, and of the seventieth birthday of Prof. Georg Cantor, of Halle, on March 3, 1915. The lists of courses do not appear to differ to any substantial degree from those published in previous years, either in the number of courses or in the character of their subject-matter. To English readers they should afford some indication of the way our enemies are maintaining their higher scientific educational systems in war-time. By "lecturers" in the preceding list we mean professors in most cases, but include other members of the teaching staffs.

WE are asked by Messrs. Constable and Co., Ltd., to state that they are the English publishers of "Elementary Text-book of Economic Zoology and Entomology," by Profs. Kellogg and Doane, which was reviewed in the issue of NATURE for July 1 last.

OUR ASTRONOMICAL COLUMN.

ABSOLUTE SCALES OF PHOTOGRAPHIC AND PHOTOVISUAL MAGNITUDES.—A great piece of photometric work on which the 60-in. reflector of the Mount Wilson Observatory is engaged is the determination of absolute scales of photographic and photovisual magnitudes covering the whole range from brightest to faintest known stars. An account of the present position of the investigation has been communicated by F. A. Seares to the National Academy of Sciences (U.S.A.), vol. i., p. 307, 1915. The method employed involves the comparison of two series of images with a known variation of intensity between the exposures. The many practical difficulties have been successfully overcome at Mount Wilson by the use of wire gauze screens and circular diaphragms. The photographic scale for the intermediate stars (10–18 mags.) was first determined in two series of exposures, one set of eleven minutes and less, the other thirty to sixty minutes; numerous determinations were made. The average difference between the mean scales from the two series, derived from nine groups of stars between 10·6 and 16·8, is only 0·015 mag. The extension to the fainter objects was effected by plates which received two different exposures with the full aperture of 60 in., the longer exposures of four to five hours, the shorter approximately half an hour. The limiting photographic magnitude thus reached was about 20. The bright stars (brighter than 10 mag.) were photographed with screens or diaphragms interposed producing images comparable with those of stars between the tenth and fifteenth magnitude, obtained with the same exposure with unreduced aperture. The entire series of photographic magnitudes of 617 objects was reduced to the international zero point

by making the mean brightness of white (Ao) stars near the sixth magnitude equal to the mean of their visual magnitudes in Harvard Circular 170.

The photovisual scale was obtained in precisely the same manner, isochromatic plates being employed. Final photovisual magnitudes were obtained for 339 stars between magnitudes 2·1 and 17·5. About 300 stars are common to both lists, and for these colour indices are consequently available; for the bright stars this is small, or even negative, at the seventeenth photovisual magnitude the smallest value is 0·6 or 0·7. That the faint stars are all relatively red is thus confirmed.

METEOROLOGY OF THE SUN.—A lecture delivered before the Royal Meteorological Society last March by Prof. W. G. Duffield is reported in full in the Quarterly Journal of the Society. Whilst, of course, primarily adapted to the needs of meteorologists, it is too valuable an essay on the present position of solar research to be neglected by anyone interested in such work. The subject was divided into a number of sections; one of these, dealing with the pressure in the sun's atmosphere, has special interest in consequence of Prof. Duffield's own work on the effects of pressure on spectra. Electrical conditions in the sun's atmosphere are considered in another section, containing the interesting suggestion that the "facular masses" shown on spectroheliograms owe their luminosity to a continuous display of lightning between their several parts, or to a bombardment by negative electrons. Prof. Duffield also suggests that solar rotation is the cause of sun-spots and filaments, his theory being that the differential velocities of the various layers of the solar atmosphere set up vortices; these seen end-on are sun-spots, when floating lengthwise appear as filaments. Although neither of these ideas is entirely novel, yet both go a little further than their precursors.

The paper is illustrated by a number of useful diagrams, and contains reproductions of some fine spectroheliograms.

VARIABLE STARS.—Two papers dealing with investigations carried on at Princeton Observatory appear in the Proceedings of the American Philosophical Society, No. 216. In one of these Dr. Dugan (p. 54) gives some recent results obtained in the case of the eclipsing variables RT Persei and ε Draconis, both cases where the light curves have demonstrated ellipticity of figure, exchange of radiation, and possibly darkening at the limb. For RT Persei the shape of the light curve possibly indicates that the advancing side of the brighter component is brighter than the following. Some recent observations of the secondary minima show that the eclipses are now coming forty minutes earlier than the times predicted from the original elements derived from observations taken about seven years ago. Extending the period of observation by data from Harvard results in a reduction of the average period by one second. Using this shorter period the residuals reveal two periodic terms, the shorter of which closes in about 4000 eclipse periods, *i.e.* about nine years, and with a coefficient of five minutes. This is of the order of magnitude of that to be expected from the revolution of the line of apsides caused by the observed prolateness. Necessary additional observations are being undertaken. Similar results have been obtained for ε Draconis. In both stars the light at minimum is distinctly redder than before. In the other paper Mr. R. J. McDiarmid deals with the algol variables, TV, TW, TX Cassiopeiæ, and T Leonis Minoris. Secondary minima have been established in the light curves of TW Cass. and T Leo. Min. The light curve of TV Cass. indicates an increase of brightness between primary and secondary eclipse, and the light curve of TX Cass. affords evidence of darkening towards the limb.

SHORT PERIOD VARIABLE STARS.—Von G. Hornig (*Ast. Nach.*, No. 4808) publishes the results of numerous observations by Argelander's method of several bright variable stars of short period. The elements calculated from these observations, together with mean light curves, are given for the three Cepheid variables RT Aurigæ (74 obs.), η Aquilæ (190 obs.), δ Cephei (396 obs.), for the Geminid variable ζ Geminorum (171 obs.), and for the two stars of β Lyræ type, μ Herculis (208 obs.) and β Lyræ (327 obs.). Elements determined by Breson from observations of ζ Geminorum, η Aquilæ, δ Cephei, and β Lyræ, and by Lau in the case of δ Cephei and β Lyræ, are compared. It is stated that the lack of correspondence in the secondary maxima of light curves determined by different observers is due to their varied "colour-perception," as are also the minor differences of more or less pointed or flattened maxima.

THE MANCHESTER MEETING OF THE BRITISH ASSOCIATION.

AS already announced, the meeting will be opened on September 7 and close on September 11. The following are among the sectional arrangements:—In Section A there will be discussions on radio-active elements and the periodic law (opened by Prof. F. Soddy); spectral classification of stars and the order of stellar evolution (opened by Prof. A. Fowler); thermionic emission (opened by Prof. O. W. Richardson); and papers by Prof. W. H. Bragg and W. L. Bragg, on X-rays and crystal structure; G. H. Hardy, on prime numbers; and Prof. A. N. Whitehead, on time, space, and relativity.

In Section B there will be an exhibition and explanation of diagrams by Dr. Dalton, illustrating his atomic theory, an experimental paper by the Hon. R. J. Strutt on active nitrogen, a discussion on smoke prevention, experimental papers on combustion, a paper by Prof. W. J. Pope on liquid crystals (with experiments), and a discussion on homogeneous catalysis.

In Section C Dr. G. Hickling will give an account of the geology of Manchester and district; Prof. W. Boyd Dawkins, papers on the classification of the tertiary strata by means of the Eutherian mammals, and the geological evidence of the antiquity of man in Britain. There will be a joint discussion with Section E on the classification of land forms (opened by Dr. J. D. Falconer). Papers will be read by Dr. A. H. Cox and A. K. Wells on the Ordovician sequence in the Cader Idris district (Merioneth); Prof. T. G. Bonney, on the north-west region of Charnwood Forest; Dr. A. Vaughan, on the shift of the western shore-line in England and Wales during the Avonian period; Prof. W. G. Fearnsides, on a contour map of the Barnsley coal seam in Yorkshire. A discussion on radio-active problems in geology (opened by Sir E. Rutherford). Papers will be read by Prof. C. A. Edwards on twinning in metallic crystals; Prof. W. J. Sollas, on the restoration of certain fossils by serial sections; Dr. J. W. Evans, on the isolation in the directions image of a mineral in a rock-slice; Dr. G. Hickling, on the micro-structure of coal; D. M. S. Watson, on vertebrate life zones in the Permo-Trias; Dr. A. Wilmore, on the Carboniferous limestone zones of north-east Lancashire; H. Day, a brief criticism

of the fauna of the limestone beds at Freak Cliff and Peakshill, Castleton, Derbyshire; Dr. Jowett, a preliminary note on the glacial geology of the western slopes of the southern Pennines. It is intended to arrange, if possible, two or three afternoon geological excursions in the neighbourhood of Manchester. On Saturday there will be a whole-day field excursion to Edale and Castleton.

In Section D there will be the following communications :—A discussion on chromosomes and heredity (to be opened by Prof. E. W. MacBride), and a series of papers on material collected in or *en route* to Australia in connection with the visit of the association last year. Prof. Herdman will contribute notes on the plankton collected between Liverpool and Fremantle (*viâ* the Cape), Dr. J. H. Ashworth will give an account of larvæ of Lingula taken in the Red Sea and Indian Ocean, Prof. Dendy will give notes on his collecting in Australia, and Prof. Poulton will exhibit insects taken in Australia. Mr. Launcelot Harrison will give a paper on the relation of the phylogeny of the parasite to that of the host. He will advance the views that in the case of total obligate parasites, closely related parasites will be found to occur on phyletically connected hosts, and therefore the study of such parasites may give valuable indications as to the phylogeny of the host; for instance, the Mullophaga found on the New Zealand Apteryx indicate that this bird is a Ralline bird, and not a Ratite. Lieut.-Col. Lieper will give a demonstration upon his recent work on Bilharzia in Egypt, during the course of which he has been able to elucidate the life-history of this parasite of man. Other papers promised are :—Prof. F. J. Cole and N. B. Eales, materials for a graphic history of comparative anatomy; Prof. Hartog on the movements of chromosomes in cell-division; Prof. Hickson on the distribution of sea-pens; Dr. Dixey and Dr. Cameron on entomological subjects; Prof. Meek on the distribution of fish and (another paper) on the future of scientific literature in relation to the war; Dr. J. S. Thomson on the elasmobranch fore-brain; Dr. W. C. Mackenzie on the vermiform appendix in Monotremes and Marsupials; Dr. C. Powell White on the regeneration of the tail in lizards; F. W. Ash on secondary sex-characters.

The arrangements for Section E are :—Papers by A. R. Hinks on the map on the scale of 1 : 1,000,000; O. J. R. Howarth on geographical considerations arising out of the visit to Australia in 1914; Prof. J. W. Gregory on relations of the central lakes of Westralia; Dr. R. N. Rudmose Brown on the growth of cities in Australia; J. McFarlane on the Burrinjuck dam and the Yanco irrigation area; a joint discussion with Section C on the classification of land forms; a joint discussion with Section H on racial distribution in the Balkans (opened by Prof. G. Elliot Smith); papers by P. M. Roxby on north China and Korea; Dr. R. N. Rudmose Brown on Spitsbergen before the war; R. Curtis on the distribution of population in the district round Leek; T. Edwards on a rainfall map of Lancashire and Cheshire; Dr. F. Oswald on a recent visit to the Caucasus; J. Parry on lake movements as observed in Lake Vyrnwy, and one on afforestation, being continuation of the paper read at the Southport meeting in 1903.

Among the papers to be read in Section G are :—Prof. Asakawa and Prof. Petavel on an experimental investigation of the thermal efficiency of a gas engine; Prof. W. M. Thornton on the apparent specific heats in gaseous explosions; E. C. Mills on a unit gas-producer for steam boilers; A. A. Griffith on an investigation of the thermal conductivity of thin-air films; Prof. Batho on torsion stresses in framed structures and thin-walled prisms; A. Robertson on the strength of iron and steel struts; Dr. Eccles and A. J. Makower on electric oscillations in coupled circuits; Prof. G. W. O. Howe on the capacity of aerials of the umbrella type; Prof. Miles Walker on the eddy current losses in the end-plates of large turbo-generators; Prof. Walker will also describe some experiments to determine whether there exists mutual induction between masses; Prof. W. Morgan on the automobile and war; T. H. Brigg will describe a new method of attaching horses to vehicles.

In Section H the president's address will be followed by a discussion (to be opened by Prof. Elliot Smith) on the influence of ancient Egyptian civilisation on the world's culture; Prof. Flinders Petrie will deal with Egyptian jewelry, describing in particular the treasure of Lahun; Dr. Alan Gardiner will discuss the evidence pointing to a common parent for the Phenician, Greek, and Sabæan alphabets afforded by the inscriptions on strelæ, undecipherable as any form of Egyptian writing, discovered by Prof. Petrie at Sinai in 1905; Prof. Giuffrida-Ruggeri, of Naples, has forwarded a paper on the racial origins of the early Neolithic and copper-using peoples of Egypt, which will be presented and discussed by Prof. Elliot Smith, and Miss Margaret Murray, in a communication on royal marriage and matrilineal descent, and Mr. Hocart, in a paper on the quest for immortality, will be concerned largely with the Egyptian evidence. Racial distribution in the Balkans will form the subject of a discussion in joint session with Section E. Papers will be read by R. M. Dawkins on the Greek element in Asia Minor; and Dr. Rivers on analysis of ceremonial and descent in Ambrim. In physical anthropology Prof. Keith will present and discuss, at the request of the author, *une Application anthropologie à l'Art militaire*, by Prof. E. Manouvrier, of Paris, which deals with the desirability of classifying troops acording to certain anthropological characters; and Prof. Elliot Smith will exhibit the most ancient human remains from India. There will be a visit to the Roman fort at Ribchester, the exploration of which has been carried on under the auspices of Manchester University. The main features of the fort will be described by Prof. Haverfield, Prof. W. B. Anderson, who has been in charge of the excavations, and others.

In Section I it was hoped to have had a discussion on the physiological conditions necessary for the maximum efficiency of the factory worker, but the absence, owing to circumstances created by the war, of so many who could have spoken authoritatively on the subject has necessitated its deletion from the programme. Prof. B. Moore is giving a popular lecture during the meeting, in which he will have a good deal to say on the physiology of factory labour. Prof. Bayliss is to speak on the mode of action of urease; Dr. Edridge-Green on some fundamental facts of vision and colour vision; and Prof. B. Moore on the action of light on certain inorganic and organic substances. Some local contributions are kinematograph films by Dr. Graham Brown; the presence of copper in animal and vegetable tissues by Dr. C. Powell White; some laws of fat absorption, and the micro-chemical differentiation of tissue fats and lipoids, by Drs. Lamb and Holker. Dr. C. E. Lea is to give a demonstration of the detection of certain cardiac disorders by the electrocardiograph. Other contributors are Dr. Sarah M. Baker, on the liquid pressure theory of muscular contraction; Prof. W. H. Thompson on arginine and creatine formation, and on the effects of tetanisation on the creatinine and creatine of the muscles of the cat; Dr. John Tait on thrombokinase; Drs. Tait and Pringle on the elas-

ticity of the strophanthinised heart; and Prof. P. T. Herring on the effect of thyroidectomy on the adrenin-content of the suprarenals.

In Section K a lecture is to be given by W. Lawrence Balls on cotton, and the following papers will be read:—Prof. F. O. Bower on the evolution of some ferns, in particular the Dipterids and the allies of the common bracken; Dr. D. H. Scott on the fossil plants of the genus Heterangium; Dr. Marie C. Stopes on the fossils of the Aptian (Greensand) period, including some of the oldest flowering plants of this country showing internal structure; Prof. Osborn on the morphology of *Selaginella uliginosa*, and his wife on some Australian fossils belonging to the genus Zygopteris; Dr. Ellis on fossil bacteria and fossil fungi; Dr. Sarah M. Baker on a new hypothesis regarding the ascent of sap in plants; Dr. Marion Delf on the effect of temperature on the permeability of protoplasm to water; Miss Prankerd on Statoliths; Prof. W. B. Bottomley on the formation of auximones from nitrogenous organic substances; Prof. Julius MacLeod on the expression by measurements of specific characters with special reference to the mosses; Dr. J. C. Willis on the evolution of the flora of Ceylon.

In Section L the following discussions may be expected:—On methods and content of history as a subject of school study; on military training in schools; on education of women in relation to their careers; on education and industry.

In Section M papers will be read by Prof. J. Hendrick on composition and uses of seaweed; by Prof. W. Somerville on accumulation of fertility in grass land; by D. Macpherson on types of hill grazings, their economic value and importance; and discussions will take place on probable effects of the war on the future of British agriculture, and the economics of milk production.

THE STUDY OF HEREDITY.

THE popularity of problems of genetics as subjects for research and discussion is well illustrated by the May number of the *American Naturalist* (vol. xlix., No. 581), every paper in which bears on one or other of such problems. Of especial interest is Prof. Jacques Loeb's article on the nature of the conditions which determine or prevent the entrance of the spermatozoon into the egg. It is well-known that in normal fertilisation, the entrance of the spermatozoon is followed by the formation of a membrane around the egg, so that the entrance of other spermatozoa is prevented. But, as Prof. Loeb has already recorded in his work on "Artificial Parthenogenesis and Fertilisation," sea-urchin eggs the development of which has been started by treatment with hypertonic sea-water can be afterwards fertilised, a spermatozoon being capable of entering a blastomere—at least up to the stage of the eighth cleavage—and inducing "a distinct and clear membrane formation" around it. This shows that the entrance of a male cell is not necessarily prevented by "the changes underlying development." But eggs by treatment with butyric acid can be induced to form a membrane. If this membrane remain unbroken subsequent fertilisation becomes impossible, though parthenogenetic segmentation may begin; if, however, the membrane be ruptured by shaking, a spermatozoon can enter and the egg undergoes normal development. Hence it may be inferred that the physical condition of the surface of the egg—howsoever modified—is the immediate determinant of the admission or exclusion of a spermatozoon. This view is supported by Loeb's experiments in cross-fertilisation, which show that the sea-urchin (Strongylocentrotus) egg admits the sperm of an echinoderm of another class only in a hyper-alkaline solution. On the other hand, eggs cannot be fertilised by sperms of their own species in sea-water containing an excess of neutral chlorides. From all these facts Loeb is inclined to draw the conclusion that the tension of the surface of the egg may explain the engulfment or exclusion of the spermatozoon. But it is obvious that in the case of normal fertilisation this surface-condition is "induced from within the egg by changes caused by the entrance of the spermatozoon"—a deduction made by biologists long before the study of "experimental embryology" had become fashionable.

In the same number of the *American Naturalist* Dr. Raymond Pearl continues his studies in heredity with reference to questions of practical breeding with a paper on Mendelian inheritance of fecundity in the domestic fowl." Large egg-yield, especially during the winter months, is shown by experiment to depend upon the presence of two Mendelian factors in the germ-cells, so linked with sex-determining characters that the female is heterozygous. Thus is confirmed the belief of some poultry-fanciers that the father is of greater importance than the mother for the establishment of a "good laying strain." In the *Biological Bulletin* (vol. xxviii., No. 3) Dr. M. R. Curtis describes a Rhode Island red hen with the terminal part of her oviduct aborted. Consequently the eggs—which were produced in the normal way—passed out into the body cavity and their food materials were absorbed by the bird's tissues without disturbance of the metabolism.

A recent number of our British *Journal of Genetics* (vol. iv., No. 4) contains a noteworthy paper, by Dr. H. Drinkwater, on the inheritance of brachydactyly in human families. The observations on this condition made by Dr. W. C. Farabee in North America, and by Dr. Drinkwater in this country are summarised in Mr. Bateson's book, "Mendel's Principles of Heredity," and brachydactyly has become a classical example of a simple Mendelian dominant-character. Dr. Drinkwater now describes a second family in England, and proves it to be a branch of the American stock studied by Dr. Farabee. The most important feature of the present study is found in the very beautiful series of radiographs of the brachydactylous hands and feet. The second phalanx is not really absent, but remains in a rudimentary condition, and becomes usually united to the base of the terminal phalanx.

Colour phenomena in animal and plant inheritance naturally continue to attract the attention of experimenters. A short paper on the "English" rabbit, by Prof. W. E. Castle and P. B. Hadley (Proc. Nat. Acad. Sci., vol. i.) is worthy of note. The "standard" coat in these rabbits is white with black muzzle, ears, and spots on back and flanks. Breeding experiments have shown that this "standard" coloration is really a mark of hybridity, for when mated together such rabbits yield a progeny half of which are either without the back and flank black markings or with these greatly exaggerated. The present paper describes how a "standard English" buck was mated with "Belgian hare" does, and how one of his dark-coated sons from this cross was afterwards mated to the same does; the result was that this latter begot distinctly darker offspring than his father, the "modal grades" being respectively 2·0 and 3·25. "Yet the father," write the authors, "contained only a single dose (one gamete) of English pattern, and the son derived his English pattern exclusively from this same source. Hence the English unit-character had changed quantitatively in transmission from father to son. This seems to us conclusive evidence against the idea of unit-character constancy or gametic purity."

Dr. L. J. Cole's paper on the inheritance of colour in pigeons (Rhode Island Agric. Exp. Station, Bulletin 158) was summarised in NATURE last year (vol. xciv.,

p. 213). The same subject has now been further investigated by Mr. D. Lloyd-Jones (*Journ. Experimental Zoology*, vol. xviii., No. 3) in a microscopical and chemical study of the feather-pigments. Red colour is due to red-brown pigment-granules which are present in the intermediate cells of the epidermis as well as in special pigment-cells. This pigment, if very finely divided, produces yellow. Black pigment under various conditions produces black, dun, blue, or silver.

Pigeons serve also as the subject of an inquiry into "Sex Ratios" by Drs. L. J. Cole and W. F. Kirkpatrick (Rhode Island Agric. Exp. Station, Bulletin 162). The normal ratio calculated from a large number of broods is 105 males to 100 females, and the death-rate is especially high for the first three days after hatching and at the age of about a fortnight. It is well known that the pigeon's normal brood consists of two eggs. In the recorded cases there were 284 bisexual broods to 302 unisexual; of the latter 149 consisted of two males and 153 of two females—a result indicating almost perfect equality. The death-rate of males and females in the bisexual broods is essentially equal. "A comparison of the numbers of each sex hatched from first and from second eggs respectively shows no tendency for the former to produce exclusively males and the latter females, but more males than females are hatched from both." The authors conclude that "sex in pigeons is determined according to the laws of chance"—in Mendelian terminology the individuals of one sex are heterozygous, and those of the other homozygous as regards the sex-determining factors. G. H. C.

BIOMETRICS AND MAN.

IN part iv. of vol. x. of *Biometrika*, Mr. H. Waite publishes an interesting study, based on two thousand complete sets of finger-prints of adult males, part of a series in the biometric laboratory, University College, London. It appears that the various types of finger-print are not scattered at random over the fingers; certain types are more or less peculiar to certain fingers, and the appearance of one type is associated with that of another. In this respect certain fingers are more closely related to each other than to any third finger, and the distribution of this relationship is in general similar to that of the correlations of the bones of the same fingers. In the same number, Dr. Alice Lee discusses the influence of segregation on tuberculosis, a question to which much attention has been devoted of recent years. No method of measuring the extent of segregation is, however, found satisfactory, and the various methods used, for example, by Dr. Newsholme, lead, when examined by more stringent methods, to contradictory and inconclusive results. Whether there is any really substantial relation between the prevalence of phthisis and institutional segregation may remain an open question, but Dr. Lee is of opinion that no such relation has been demonstrated. Miss Elderton and Prof. Pearson similarly fail to find any evidence that isolation reduces the attack-rate from diphtheria; no appreciable influence on the attack-rate is found in certain data placed at their disposal by the medical officer of health for Coventry, though the death-rate may be lowered.

In the same journal Prof. Pearson, in collaboration with Miss Elderton, contributes an important memoir on further evidence of natural selection in man. The variate-difference correlation method is applied to the death-rates for males and for females in England and Wales from 1850 to 1908. The correlation between death-rates for successive years of life, over a long series of years, is high and positive. But the correlation of first differences is negative, and this negative correlation increases in intensity as higher and higher differences are taken, until fairly steady values are reached for the sixth differences, ranging round −0·7. Thus for males the correlation of sixth differences in the first and second years of life is −0·688, in the fourth and fifth years of life −0·695. For females the corresponding figures are −0·719 and −0·736. The correlations in each case are taken between death-rates of those born in the same year. At an interval of two years the partial correlations are negative but much lower; at three and four years' interval the signs are irregular and the results inconclusive. To assert the existence of selection and measure its intensity, the authors remind their readers, must be distinguished from advocacy of a high infantile mortality as a factor of racial efficiency.

We can only briefly direct attention to two articles by Mr. R. A. Fisher on the frequency distribution of the correlation coefficient in samples from an indefinitely large population, and on the distribution of standard derivations of small samples.

REPORTS ON MINING INDUSTRIES.

TWO reports issued by the Canadian Department of Mines ("Peat, Lignite, and Coal," by B. F. Haanel; "Report on the Non-Metallic Minerals Used in the Canadian Manufacturing Industries," by Howells Frechette; Ottawa, 1914) are further examples of the sedulous care with which the Canadian Government is endeavouring to foster the industry of mining in the Dominion. The report upon peat, lignite, and coal deals exclusively with the application of these fuels to the generation of power-gas and to the recovery of by-products, the latter being chiefly ammoniacal salts. An elaborate study has been made of the various methods of dealing with peat in Europe, although, for some reason not easy to understand, Russian practice appears not to have been included, in spite of the fact that conditions in Russia resemble more closely those in Canada than do any of the other countries investigated. The first part of the report is taken up with a discussion of the various methods of producing peat fuel; it is interesting to note that the author has devoted a good deal of attention to the well-known Ekenberg process of wet carbonisation, and that his conclusions are decidedly unfavourable to the process. He points out that the most recent report on the subject by Lassen shows "that in continuous operation on a large scale, a moisture content below 70 per cent. in the pressed cake cannot be counted on," and dismisses the subject with the following statement:—

"Although large funds have been placed at the disposal of various investigators in order to enable them to demonstrate the economic value of the process, and although a private company has conducted elaborate experiments on a large scale, involving the expenditure of a large amount of money, not one ton of peat fuel has been manufactured on a commercial scale by means of this process."

The author's opinion of the Brune and Horst process for pressing out the water is equally unfavourable, nor is he greatly impressed by the possibilities of any of the methods of artificial drying, and sums up in favour of air-dried peat. He shows that under normal Canadian conditions peat can be utilised to advantage for the production of gas provided that it contains not more than 40 per cent. of moisture and that it can be obtained at a cost not exceeding 1.50 dollars (6*s.* 3*d.*) per ton of peat containing 30 per cent. of moisture. He holds

that the recovery of ammonia is not likely to be profitable unless the nitrogen content exceeds 1½ per cent. calculated upon absolutely dry peat. Finally, he shows that under favourable conditions power can be generated from certain of these Canadian peat bogs at a cost equal to or below that at which it can be obtained by the utilisation of water-power. A little attention is also devoted to the question of the utilisation of the lignites of certain of the Western Provinces, where true bituminous coal is not obtainable locally, and it is shown that in certain circumstances it too can be employed profitably in the generation of gas.

The second report is intended to aid, not only the mining industry, but also the very large number of manufacturing industries that depend to a greater or lesser extent upon an adequate supply of raw materials in the shape of mineral products. The report deals with a very large number of miscellaneous minerals, of which asbestos, barytes, clay, lime, and sand are perhaps the most important, and it should be noted that such minerals as are used in Canadian manufactures but are not produced in Canada are referred to, as well as the minerals of domestic production. It is noteworthy that quite a considerable quantity of minerals is imported, although they could be produced in the Dominion, and one of the main objects of this report is to bring actual or possible producers and consumers into closer touch with one another. The object is an excellent one, and such reports as this should prove of the greatest value to both parties and should help towards that very desirable object, the industrial independence of this great Dominion.

The report of the Chief Inspector of Mines of the State of Mysore for the year 1913 has just been issued. Apart from the statistical portion, which shows that the value of the bullion produced during the year in question was 2,150,193*l*., a decrease of 0·37 per cent. from the previous year, the chief general interest in this report is to be found in a careful investigation of a shaft accident at the Mysore Gold Mine. It appears that the steel pin, which secured a driving clutch, that connected the engine shaft and the winding reel suddenly broke, allowing the cage, in which forty-two miners were travelling, to fall to the bottom of the shaft. An investigation was held into the cause of the fracture of this pin and into the reason why the powerful brake attached to the winding engine did not hold the reel, and the report of the committee of inquiry is now given. It cannot be said that the cause of the fracture is satisfactorily explained, but the insufficiency of the braking arrangements is very clearly demonstrated. Having regard to the fact that this brake is of the construction that is in general use on winding engines in all parts of the world, this report deserves the careful attention of all who have to do with winding from deep shafts by means of the powerful winding engines that are in general use in modern mines; in particular it may be noted that the brake appears to have complied fully with the provisions of our Coal Mines Act, and yet was found inadequate to prevent the very serious accident in question.

Another interesting section in this report deals with accidents due to "air blasts," which caused no fewer than thirty-one deaths during the year in question. These air-blasts consist in the sudden flying-off of huge masses of rock from the walls of stoped-out portions of the deposit, the action being extremely violent and suggesting that the rock is under some condition of great strain that suddenly relieves itself. The phenomenon is as yet but little understood, and all measures taken for combating this danger are still of a more or less tentative character.

TRYPANOSOMES CAUSING DISEASE IN MAN AND DOMESTIC ANIMALS IN CENTRAL AFRICA.[1]

THESE lectures are confined to a consideration of the trypanosomes causing disease in man and domestic animals in Central and Southern Africa. The conditions, however, which obtain on the east and west coasts of Africa between 20° N. and 30° S. latitude are much the same as those which are found in the central parts, and it is probable that the same trypanosome species are found throughout. So that in describing the species found in our own colonies it may be assumed that all the important pathological species found in Central Africa are being dealt with, although in other places they may be known by other names.

The central region—the tropical or equatorial—corresponds with the distribution of the tsetse-flies, and the trypanosomes causing disease in this region are carried from sick to healthy animals by various species of this genus of flies. In the north of Africa, outside the range of the tsetse-flies, two trypanosome diseases are found, one of the horse (dourine), and another of camels (surra), the former conveyed from sick to healthy horses by contagion, the latter almost certainly by large biting flies, the so-called horse-flies, or tabanidæ.

Classification of the African Trypanosomes.

The three characters mainly relied upon in this classification of trypanosomes are, in the first place, their morphology; secondly, their pathogenic action on animals; and, thirdly, their mode of development in the tsetse-flies. They may be divided into three groups, and these are set out in the following scheme:—

Group A. Trypanosoma Brucei Group.

1. *Trypanosoma brucei.*
2. *Trypanosoma gambiense.*
3. *Trypanosoma evansi.*
4. *Trypanosoma equiperdum.*

Group B. Trypanosoma Pecorum Group.

1. *Trypanosoma pecorum.*
2. *Trypanosoma simiae.*

Group C. Trypanosoma Vivax Group.

1. *Trypanosoma vivax.*
2. *Trypanosoma caprae.*
3. *Trypanosoma uniforme.*

These names probably represent most of the principal pathogenic trypanosomes discovered up to the present time in Africa. The northern species, *Trypanosoma evansi* and *T. equiperdum*, are placed in the first group, as they seem by morphology and their action on animals to belong there. Each group is distinguishable or separable by well-defined characters.

Group A. The Trypanosoma brucei Group.—The species forming this group (Fig. 1) are all more or less polymorphic, varying in size and shape from short and stumpy forms without free flagella to long and slender forms with free flagella. The cytoplasm contains numerous dark-staining granules. The micronucleus or kinetonucleus is small, and is situated as a rule some distance from the posterior extremity. The undulating membrane is well developed and thrown into bold folds.

[1] Abridged from the Croonian Lectures delivered before the Royal College of Physicians of London on June 17, 22, 24, and 29, by Sir David Bruce, C.B., F.R.S.

In regard to their action on animals, the members of this group may be said generally to affect many different species of animals—as, for example, man, horses, cattle, dogs, and most of the smaller experimental animals. The two Central African members of the group, *T. brucei* and *T. gambiense*, develop in the tsetse-flies in the same way. At first the development takes place in the intestine; afterwards the parasites pass into the salivary glands, by way probably of the proboscis, and there complete their development into infective forms. This is the only group in which the salivary glands are invaded. This group can be separated from the other groups by shape alone.

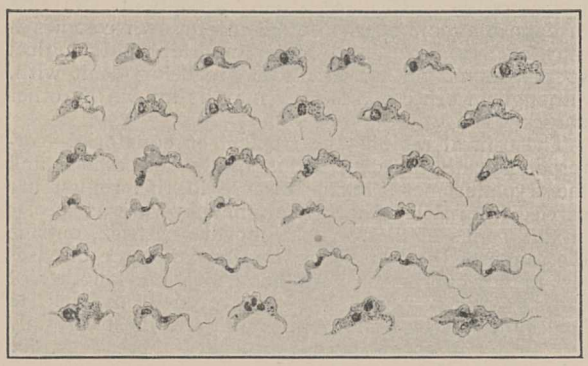

FIG. 1.—*Trypanosoma brucei* (Plimmer and Bradford) Zululand, 1913. ×about 700.

Group B. The Trypanosoma pecorum Group.—The trypanosomes are small and monomorphic. The cytoplasm is non-granular. The micronucleus is prominent, subterminal, and often seems to project beyond the margin. The undulating membrane is fairly well developed (Fig. 2).

The cycle of development in the tsetse-fly in Group B begins in the intestinal tract; afterwards the flagellates pass forward into the proboscis of the fly, and finally reach the salivary duct or hypopharynx, where they complete their development and become infective. The difference between Group A and Group B is that in the latter the salivary glands are never invaded. There are only two species at present included in this group—*T. pecorum* and *T. simiae*. The former gives rise to the most important trypanosome disease of cattle in Africa, while the latter is remarkable for the rapidity with which it kills the domestic pig.

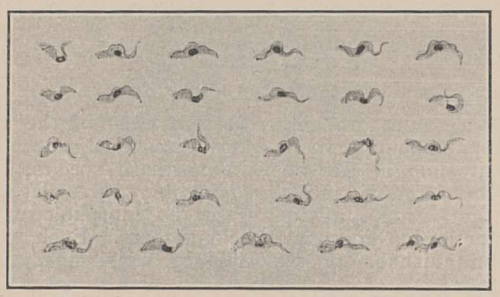

FIG. 2.—*Trypanosoma pecorum*. ×about 700.

Group C. The Trypanosoma vivax Group.—The species making up this group (Fig. 3) are monomorphic, and remarkable for the extreme rapidity of their movements. The posterior extremity is enlarged. The cytoplasm is clear and hyaline. The micronucleus is large and terminal, and the undulating membrane is little developed and simple. This species only affects horses, cattle, goats, and sheep. Monkeys, dogs, rabbits, guinea-pigs, and rats are refractory.

The cycle of development in Group C differs from that in Groups A and B in that it takes place at first only in the labial cavity of the proboscis, and later in the salivary duct or hypopharynx. No part of the cycle takes place in the intestinal tract or in the salivary glands.

These three groups are well marked, and it is fairly easy by microscopic examination alone to name what group a trypanosome belongs to, when seen in the blood of the vertebrate host or even in the tsetse-fly.

DESCRIPTION OF THE TSETSE-FLIES.

A description of *Glossina morsitans* and *Glossina palpalis* is given, with a figure illustrating the mouth parts of a tsetse-fly.

It is important to understand the structure of the proboscis, as this plays an important part in the development of Groups B and C. In the transverse section the parts are seen in position, the labrum and labium joined together form a tube through which the blood is drawn in the act of sucking, and known as the labial cavity; and the delicate terminal duct of the salivary glands or hypopharynx lying in the hollow of the labium, and opening near the tip of the proboscis. The salivary glands are long convoluted organs lying chiefly in the abdominal segment of the fly.

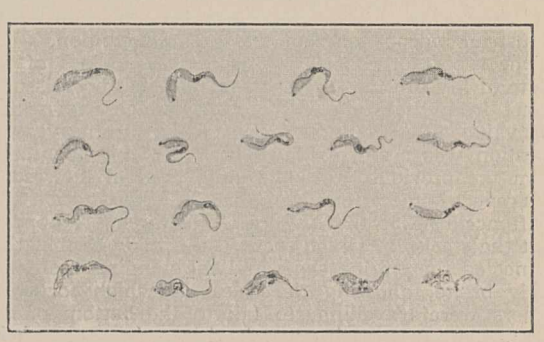

FIG. 3.—*Trypanosoma vivax* (Ziemann). ×about 700.

It was stated that probably all the tsetse-flies are capable of acting as carriers of all the pathogenic trypanosomes, at least in laboratory experiments. What makes one species of fly the especial carrier of a particular trypanosome is probably bound up in the natural history, the habits, and distribution of the fly.

It was shown that the two principal groups of tsetse-flies—the *G. morsitans* group and the *G. palpalis* group—differ from each other in well-marked characters, the former living in wild, unpopulated districts and trusting to the wild game for their food, the latter along rivers and lakes which are usually thickly populated, and trusting to man for a food supply, or in his absence living on the large reptiles, birds, and antelopes which frequent these places.

THE TRYPANOSOMES CAUSING DISEASE IN MAN AND DOMESTIC ANIMALS IN CENTRAL AFRICA.

Group A. Trypanosoma brucei Group.

(1) *T. brucei*, the Nagana Parasite.—This was the first pathogenic trypanosome discovered in Central or South Africa. It was found in Zululand in 1894 in the blood of native cattle suffering from Nagana. The parasite was sent in the living condition to the

Royal Society in 1896, and at that time found its way into many laboratories, and much of the earlier work on trypanosomes was founded on it. The parasite causing the Rhodesian and Nyasaland form of sleeping sickness, and which had been named *T. rhodesiense*, is considered to be identical with *T. brucei*. Various strains, Zululand, 1894 and 1913, Nyasaland and Uganda, are compared, and the conclusion come to that they are identical in morphology.

Susceptibility of Animals to *T. brucei*.

Many mammals, including man, horses, mules, donkeys, oxen, goats, sheep, monkeys, dogs, and many others, are attacked by this parasite. Birds and the cold-blooded vertebrates, such as crocodiles, lizards, and frogs, are quite unaffected by it. A single trypanosome seems to be just as efficacious in setting up infection as a million, and it does not seem to matter whether the kind of trypanosome injected is one of the long and slender forms or one of the short and stumpy.

Table I.—Giving (a) *the Average Duration in Days of the Disease in Various Strains of* T. brucei.

Strain	Man	Horse	Oxen	Goats and sheep	Monkeys	Dogs	Rabbits	Guinea-pigs	Rats
Human	90	—	134	42	26	34	28	67	30
Wild game	—	—	—	46	38	41	—	—	32
Wild *Glossina morsitans*	—	—	Recovered	54	38	29	47	81	26
Zululand, 1913	—	38	310	77	29	18	33	44	27
(b) *The Number of Animals Employed.*									
Human	?	—	1	?	20	25	7	15	21
Wild game	—	—	—	5	9	13	—	—	6
Wild *Glossina morsitans*	—	—	2	16	14	25	3	10	19
Zululand, 1913	—	3	1	7	8	17	8	10	23

Table I. gives the average duration in days of the disease caused by various strains of this trypanosome, also the number of animals employed. From this it will be seen that this disease runs a fairly rapid course in man, killing him as a rule in three or four months. This, as we shall see, is in marked contrast to the much more chronic course of the Congo sleeping sickness caused by *T. gambiense*. In horses, donkeys, and mules nagana runs its course on an average of thirty-eight days. No opportunity of studying the disease in horses occurred in Uganda or Nyasaland, as horses are very seldom seen in these countries. In the ox the disease is chronic and a certain proportion recover. In the other animals it may be said broadly that the disease runs a fairly similar course, and that little or no difference in the virulence is seen between the different strains.

Nagana is, as a rule, a fatal disease. With the exception of the oxen, almost all the other animals die. Out of 318 employed in these experiments only three recovered.

From its action on animals, then, just as from its morphology, it is apparent that *T. brucei* as it occurs in Zululand differs in no way from the Nyasaland strain called by Stephens and Fantham *T. rhodesiense*.

The Infectivity of Wild Tsetse-Flies (*G. morsitans*).

The tsetse-flies in Nyasaland were examined in order to find out how many of them were naturally infected. There were fifty-six experiments, and 10,081 tsetse-flies (*G. morsitans*) were employed. In the fifty-six experiments *T. brucei* was found twenty times (35·7 per cent.). Nine monkeys, fourteen dogs, and eleven goats were infected. This gives a proportion of 1 in 500, or 2 flies per 1000 caught in the sleeping sickness area, Nyasaland, infective with nagana. This is only allowing one infective fly to each series of flies fed on the experimental animals, and is therefore the irreducible minimum.

Trypanosomes Found in the Blood of Wild Animals Living in the Sleeping-sickness Area, Nyasaland.

When an animal was shot a small quantity of its blood was taken in a sterilised bottle containing citrate of potash to prevent coagulation. Smear preparations were made at the same time. As the animals were often shot thirty or forty miles away from the camp, a motor-cycle was used to get the blood up the hill as quickly as possible. When the blood arrived at the laboratory it was at once injected into a goat, a monkey, and a dog. In this way 180 specimens of blood of wild game living in the fly area were examined, and fifty-seven were found to harbour pathogenic trypanosomes (32 per cent.).

This is, however, probably much below the actual percentage. A wild animal is only examined once, and that often under unfavourable conditions. If it were possible to examine the same animal several times it is probable that many more would be found infected. The parasites come and go in the blood; one day they may be present, the next day absent. The big game live in the "Fly Country" among swarms of infected flies, and are constantly liable to infection and re-infection.

The following table (Table II.) represents the number of times *T. brucei* was found among the 180 wild animals examined, and the species of game which

Table II.—This Represents the Number of Times T. brucei *was Found Among the* 180 *Wild Animals Examined and the Species of Game which Harboured it.*

Species of animal	Number examined	Number infected with *T. brucei*	Species of animal	Number examined	Number infected with *T. brucei*
Eland ...	10	0	Duiker..	7	1
Sable ...	5	0	Buffalo..	9	0
Waterbuck	13	3	Lion ...	1	0
Koodoo ...	3	0	Hyæna..	3	0
Bushbuck...	10	0	Elephant	2	0
Hartebeeste	35	5	Warthog	33	1
Reedbuck...	19	3	Wild cat	3	0
Oribi ...	26	1	Porcupine	1	0

harboured it. From this it will be seen that fourteen animals among the 180 harboured the nagana parasite (7·8 per cent.), and that the waterbuck, hartebeeste, reedbuck, and duiker seem to be the most dangerous neighbours to man. Twenty-three per cent. of the waterbuck, 14 per cent. of the hartebeestes, 16 per cent. of the reedbuck, and 14 per cent. of the duiker had *T. brucei* in their blood. If, then, the contention that this parasite found in the wild game is the cause of Nyasaland sleeping-sickness be proved to be true, then it is abundantly obvious how dangerous these wild animals are to man; and it must be borne in mind that in this Nyasaland fly area *T. brucei* is only one of the pathogenic species of trypanosome found in the wild game. Other three species pathogenic to the domestic animals are also found, *T. pecorum*, *T. simiae*, and *T. caprae*; *T. pecorum* in 14·4 per cent., *T. simiae* 1·7 per cent., and *T. caprae* in 11·1 per cent. of the wild game examined. It is self-evident that these wild animals should not be allowed to live in "Fly Country," where they constitute a standing danger to the native inhabitants and the domestic animals. It would be as reasonable to allow mad dogs to live and be protected by law in our English towns and villages. Not only should all game laws

restricting their destruction in "Fly Country" be removed, but active measures should be taken for their early and complete blotting out. It must be strictly borne in mind that this only refers to wild animals living in "fly" areas. No pathogenic trypanosomes have up to the present been found by the Commission in the blood of animals living in fly-free areas.

(2) *T. gambiense*, the Parasite of Congo Sleeping-Sickness.—*T. gambiense* (Fig. 4) is very similar in size and shape to *T. brucei*, but it would appear to be possible to distinguish them by the presence of the blunt-ended, posterior-nucleated forms which are so common in the blood of animals infected by the nagana parasite and quite absent in animals infected by the other. But as these posterior-nucleated forms are absent or scarce in the blood of man, this method of diagnosis requires the inoculation of experimental animals and the study of many preparations of their blood. It would appear to be impossible at present to distinguish between the two species by the microscopical examination of preparations made from the blood of man alone.

Susceptibility of Animals to *T. gambiense*.

A marked difference exists between *T. gambiense* and *T. brucei* in regard to their virulence towards animals.

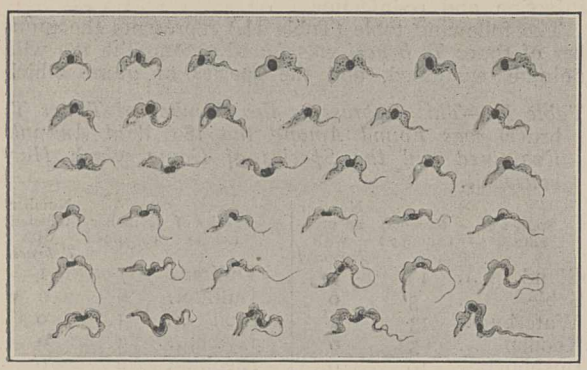

Fig. 4.—*Trypanosoma gambiense* (Dutton). Tanganyika, 1913. ×about 700.

It is almost impossible at first to give this disease to goats, monkeys, dogs, and guinea-pigs. The rat is the animal which is least refractory.

Table III.—*Showing the Average Duration in Days of the Disease caused by* T. gambiense, *Tanganyika, compared with that caused by* T. brucei, *Zululand.*

	Monkey	Dog	Guinea-pig	White rat
T. gambiense ...	159	96	264	137
T. brucei ...	26	34	67	30

The disease in animals caused by *T. gambiense* is thus much more chronic than that caused by *T. brucei*, and this character, combined with the morphology already described, affords the surest and safest means of separating these species.

G. palpalis the Carrier of *T. gambiense*. Infectivity of Wild *G. palpalis*.

In 1903 at Entebbe, the Government cantonment, the tsetse-flies had plenty of opportunity of becoming infected, since they were caught in the vicinity of the hut-tax labourers' camp. These men came in thousands to Entebbe to work for Government for one month in lieu of paying hut-tax. They lived in rudely-built grass huts near the lake shore, and on examination of their blood some 30 per cent. of them were found to harbour the parasite. In 1903, while these highly-infected labourers were living on the lake shore, the proportion of infective flies was found to be as high as 11·2 per 1000. The Government removed the hut-tax labourers from the vicinity of the lake, which became deserted, and a year afterwards the proportion of infected flies fell to 1·2 per 1000. When the Commission returned to Uganda in 1908 and took up camp at Mpumu at the north end of Lake Victoria we found the lake-shore flies in the vicinity still infective, although the population had been removed early that year. The examination of 7200 flies gave a proportion of 1·8 per 1000. But we had given the Government to understand that as soon as the natives were removed the flies would become harmless. It was therefore important to find out how long the lake-shore flies remained infective, and why they remained infective. For this purpose they were examined every year until 1912.

Table IV.—*Showing the Results of Yearly Examinations of wild* G. palpalis *from* 1903 *to* 1912 *inclusive.*

Year.	Locality	Number of flies examined.	Number of flies infective	Proportion of infective flies per 1000	Remarks.
1903	Entebbe.	?	?	11·2	—
1904	,,	?	?	1·2	—
1908	Mpumu.	7,200	11	1·8	1 in 654
1909	,,	18,691	7	0·4	1 in 2670
1910	,,	27,179	4	0·14	1 in 6795
1911	,,	23,899	1	0·04	1 in 23899
1912	,,	28,279	4	0·14	1 in 7070

From this it will be seen that although there had been a steady decrease in the proportion of infective flies, a few remained, and these showed no sign of disappearing. The mistake made by the Commission was first in believing that the transmission of the *T. gambiense* was mechanical, and that a fly lost its power of infection within three days after feeding on an infected animal; and, secondly, in believing that man was the sole reservoir of the virus. It was found that a fly may remain infective for several months, and that man is by no means the only source of the virus.

The Cycle of Development of *T. gambiense* in *G. palpalis*.

This prolonged infectivity which some flies possess is due to the fact that in these the trypanosomes do not die off, but proceed to further multiplication. It was shown that a very small proportion of flies which feed on an infected animal show this cycle of development. In one series of experiments, forty-two in number, only one fly in 212 (0·5 per cent.) became infective. An average of thirty-six days is required to complete the cycle. The long account given may be summarised as follows.

Trypanosomes taken into the alimentary canal of tsetse-flies retain their shape and infectivity for some eighteen hours. They then degenerate and lose their power of infection, and as a rule have disappeared altogether from the majority of the flies by the fifth or sixth day. In a small percentage of flies, male as well as female, the trypanosomes maintain their position, they continue to multiply, and in a short time swarm in the alimentary canal of the fly. These multiplication forms bear little or no resemblance to the original trypanosomes. After some twenty or thirty days the developing flagellates find their way into the salivary glands, resume their original blood form, and regain their infectivity.

THE RESERVOIR OF *T. gambiense* (CONGO SLEEPING-SICKNESS).

Besides man, who is probably the most important reservoir of the virus, native cattle and the antelope living on the lake-shore in Uganda were found to harbour the parasites in their blood.

The prophecy that the fly would become harmless shortly after the natives were removed from the lake shore has unfortunately proved wrong, and before the islands are repopulated some other measure will have to be taken to get rid of the fly danger.

GROUP B.—THE *T. pecorum* GROUP.

I.—*T. pecorum.*

The first of this small group, which only consists of two species, is *T. pecorum*. It is probably the most important trypanosome disease of domestic animals in Central Africa.

Morphology.

Fig. 2 shows the general appearance of the trypanosome. It is the smallest of all the African pathogenic trypanosomes, varying from 9 to 18 microns in length, with an average of 14 microns.

Animals Susceptible to T. pecorum.

In regard to the animals attacked by this trypanosome. This is essentially a disease of the herds: horses, donkeys, oxen, goats, sheep, and pigs, all fall victims.

TABLE V.—*The Average Duration of Life, in Days, of Various Animals Infected by* T. pecorum.

—	Donkey	Cattle	Goat	Pig	Monkey	Dog	Guinea-pig	White rat
Average duration in days	87?	121?	55	21	129	48	41	33
Number of animals employed ...	1	4	59	1	11	57	5	10

The Percentages of Recoveries in Various Animals from T. pecorum *Infection.*

Percentages	80	35	12	0	0	1	0	0
Number of animals employed ...	5	17	70	1	11	63	5	10

This trypanosome does not seem to be very fatal to horses, mules, or donkeys. In Nyasaland there was no opportunity of testing it on horses, but out of five donkeys four recovered. Two-thirds of the cattle, and seven-eighths of the goats, succumbed.

THE CARRIER OF *T. pecorum.*

The chief carrier of *T. pecorum* is *G. morsitans*. In Nyasaland, this parasite was the commonest of the trypanosomes with which *G. morsitans* was infected. There were fifty-six experiments, and 10,081 tsetse-flies (*G. morsitans*) were employed. In the fifty-six experiments *T. pecorum* was found forty-six times, more than twice as often as *T. brucei*. Nine monkeys, thirty-four dogs, and thirty-five goats were infected. This gives a proportion of 4·6 per 1000 flies infected with *T. pecorum.*

THE CYCLE OF DEVELOPMENT OF *T. pecorum* IN *G. morsitans.*

This trypanosome belongs to Group B, in which development takes place first in the gut and then passes forward into the labial cavity of the proboscis, and finally reaches the salivary duct or hypopharynx where the trypanosomes revert to the original blood form and become infective. There is no infection of the salivary glands.

THE TYPE OF TRYPANOSOMES FOUND IN THE INFECTED FLIES.

Fig. 5 represents the developmental forms of *T. pecorum* found in labial cavity of *G. morsitans*. The first seven figures represent early forms in the labial cavity. These were seen adhering singly by their flagella to the labrum.

The next group contains the ordinary forms found clinging by their flagellar ends to the labrum. It will be seen that they have assumed the crithidial stage, a stage which seems to be a *sine quâ non* in the final stages of the cycle of development of all the pathogenic trypanosomes, and the interpretation of which is still obscure. The small blood forms are from the hypopharynx of dead infective flies. They represent the final stage in the cycle of development and are the only infective forms. On the same figure are seen drawings of the labrum and hypopharynx of a fly infected with this trypanosome. While the labial cavity is seen to contain clusters of large ribbon-like trypanosomes, the hypopharynx is swarming with the

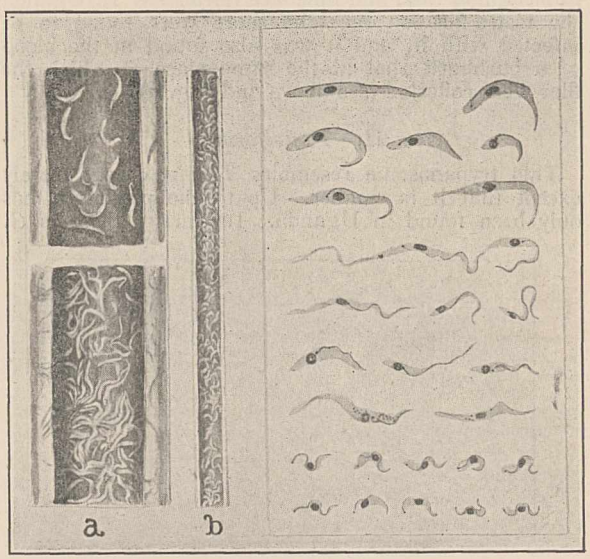

FIG. 5.—Developmental forms of *Trypanosoma pecorum* found in the labial cavity and hypopharynx of infected flies. *a*, Labrum. *b*, Hypopharynx.

small infective forms. From these drawings the ease and facility with which a tsetse-fly can infect an animal will be readily understood.

II.—*T. Simiae.*

This species of trypanosome is remarkable for the virulence it displays towards the monkey and the domestic pig, killing these animals in an incredibly short period of time, whereas it is harmless to oxen, antelope, dogs, and the smaller experimental animals. Curiously enough it affects goats and sheep, although oxen and antelope escape.

In the whole range of the trypanosome diseases of animals there is surely nothing so striking as the rapidly fatal action of *T. simiae* on the domestic pig. In nine experiments the average duration was only 5·3 days. This not from the time of the appearance of the trypanosome in the blood, but from the date of the infection. Further, this rapid action is not the result of an exaltation of virulence by numerous passages through the pig, but natural to the trypanosome.

Another interesting point in regard to this species is that, so far as is known, the warthog is the only

animal among the wild game which harbours it. It is probable that it will also be found in the blood of the bush-pig, but that has not been done yet.

GROUP C.—THE *T. vivax* GROUP.

The three species forming this group have a strong family resemblance, and but for size might almost be included in one species.

I.—*T. vivax.*

This is the cause of one of the most important cattle diseases in Uganda. We did not meet with it in Nyasaland, where its place seems to be taken by *T. caprae.* It is, however, widely distributed in Central Africa. It has been reported from Senegal and the Sudan in the north to Rhodesia in the south. It is easily recognised on account of its extreme activity during life, its characteristic morphology in stained specimens, and the fact that it only affects horses, cattle, goats, and sheep, while monkeys, dogs, rabbits, guinea-pigs, rats, and mice are refractory. In Uganda the tsetse-flies on the lake shore were found to be infected with it, and it was also found in the blood of a bushbuck shot at the same place at which the flies were collected (see above and Fig. 3).

II.—*T. uniforme.*

This trypanosome resembles *T. vivax* very closely except that it is smaller. Up to the present it has only been found in Uganda. Its carrier there is *G.*

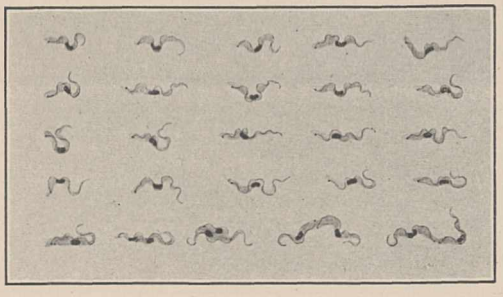

FIG. 6.—*Trypanosoma simiæ.* ×about 700.

palpalis, and its reservoir the wild game on the lake shore.

III.—*T. Caprae.*

This species has only been reported up to the present from Lake Tanganyika and Nyasaland. It, like the other two species belonging to this group, only affects cattle, sheep, and goats. Monkeys, dogs, and smaller experimental animals are immune.

CONCLUSION.

This concludes the Croonian Lectures on the trypanosomes causing disease in man and domestic animals in Central Africa. These lectures deal with but a small part of the subject, which has in the course of the last twenty years grown to huge proportions. Nothing has been said about medicinal treatment, and even measures of prevention have been left a good deal to the imagination. Taking a look back over the whole field the outstanding features may be said to be, first, that some order is beginning to reign in what was lately chaos in regard to the classification of the pathogenic trypanosomes. They may all now be referred to three groups and nine species.

In regard to the transference of the virus from sick to healthy animals by the fly, this has been made clearer and easier of comprehension by the discovery of the part which the salivary glands and hypopharynx play in the various modes of development which the trypanosomes undergo in the fly. It results that it would almost appear impossible for an infective fly to pierce even momentarily the skin of a healthy susceptible animal without causing infection.

Another important feature is the proof brought forward that *T. brucei* and *T. rhodesiense* are the same.

Finally, in regard to the prevention of these trypanosome diseases of man and domestic animals. We have seen that the wild game in the fly country is heavily infected. It is impossible to doubt that they are the reservoir and source of many of these diseases. There can be little doubt that if the wild game were driven out of the fly country trypanosome diseases such as those caused by *T. brucei* and *T. pecorum* would disappear.

In regard to the measures of prevention against the most important of all the trypanosome diseases—Congo sleeping-sickness—it has been shown by experience that the removal of the natives from the fly area is a simple and efficacious way of stopping an epidemic. In these sparsely inhabited countries, where spare land and food are easily obtained, there is, as a rule, no difficulty in effecting this migration. If it is desired to go a step further and render the sleeping-sickness area habitable, then clearing and cultivation must be resorted to. By these means, in all probability, *G. palpalis* will be driven away, and with it the disease.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. H. G. EARLE has been appointed to the chair of physiology in the University of Hong-kong.

DR. J. A. MENZIES has been appointed professor of physiology in the University of Durham College of Medicine, Newcastle-upon-Tyne.

IN the prospectus of the University College of North Wales a reference to "Aeroplane and Other Researches" occurs in the schemes of study of the department of applied mathematics. In view of the important part played by aeroplanes in the present war, we hope that Prof. Bryan will make every effort to enlist the services of his pupils in the solution of the many unsolved problems which he has enumerated, and that he will encourage them to take up this work in preference to studies of a more examinational character. We understand from Prof. Bryan that he would be glad to secure the assistance of students from other universities possessing the necessary training in applied mathematics who are able and willing to enter the college at Bangor for a post-graduate course of research in the subjects in question.

THE prospectus of the University courses in the Municipal School of Technology, Manchester, for the session 1915–16, which is now available, serves admirably to give the inquiring student an excellent idea of the resources and equipment of this great technical college. It will be remembered that a faculty of technology in the University of Manchester was established in 1905, with the principal of the School of Technology as dean of the faculty and with the heads of the mechanical and electrical engineering, applied chemistry, and architecture departments of the School of Technology as professors of the University.

The dean and these professors are members of the University Senate. The University courses provided by the school lead to the degrees of Bachelor and Master of Technical Science. These courses are controlled by the Senate of the University, through the board of the faculty of technology, which is composed of the heads of departments in the School of Technology together with certain other professors and lecturers in the University. A new characteristic of the present issue of the prospectus is the excellent summary running to some ten pages of approved courses which students proceeding to degrees in technical science, or certificates in technology, are recommended to follow. The account of the equipment of the laboratories, for which the school is justly renowned, gives particulars which serve as an index of the lavish and judicious expenditure incurred to make the college thoroughly complete and modern.

SOME of our universities have already taken steps to deal justly with the many young men who have broken their academical work by joining the Army. The subject is dealt with at length in *Engineering* for August 6. But few of these young men will be able again to take up the threads of their studies when peace is proclaimed. They will have been face to face with actualities of most serious import, and will never again be able to resume the docile and attentive attitude which befits the student. It is most earnestly to be hoped that before peace is declared the whole of the academic and professional bodies of this country will come to some definite decision as to what is to be their attitude to the young men who are faced with the possibility of their careers being broken irretrievably. The matter is not simple, as the claims both of the public and of the young men have to be considered; the former expect that diplomas shall not be given to men lacking in the necessary attainments; it would be outrageous to the latter if the future prizes in life were allotted to those who stayed at home. *Engineering* suggests that the kind of knowledge which might be expected reasonably from candidates who have served in the Army is that which an ordinary candidate has retained three years after taking his diploma. In that time all tricks for examination purposes have disappeared, leaving only that knowledge which the man felt was really necessary for his profession. We should like to add to the case which is presented very ably by our contemporary, that it is extremely desirable that all our universities and colleges come to a common understanding, so that there shall be equality of treatment for all the candidates on retiring from the Army.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, July 5.—Sir E. A. Schäfer, vice-president, in the chair.—Sir William **Turner**: A contribution to the craniology of the people of Scotland: Part ii., prehistoric, descriptive, and ethnographical. Judging from the size and general plan of the skull of the prehistoric inhabitants of Scotland, he found nothing to show that these very remote ancestors were not people of great brain-power.—W. **Evans**: Mallophaga and Ixodidæ, Ectoparasites of birds from the *Scotia* collections (Scottish National Antarctic Expedition). Interesting examples were recorded of the same species of parasite infesting closely allied species of birds.—Dr. J. R. **Milne**: Mathematical theory of the harmonic synthetiser: part ii. Nine years ago the author described an instrument for drawing the curve which is the sum of a number of simple harmonic curves. The apparatus makes use of Kelvin's summation wire and an approximate method of obtaining harmonic motions which was rejected by him as insufficiently accurate. It was shown, however, in the previous paper that if the various parts be properly proportioned, the error can be made very small. The more complete mathematical discussion in the present paper shows how it may be reduced to negligible dimensions.—Prof. C. R. **Marshall** and Miss Elizabeth **Gilchrist**: The interaction of methylene iodide and silver nitrate.—James W. **Munro**: The structure and life-history of *Bracon hylobii*, a study in parasitism. The *Hylobius abietis* was the most dangerous insect enemy to forestry in Scotland. One way of fighting it was by the breeding and setting free of a parasitic enemy. Such a parasite is *Bracon hylobii*.—Miss Augusta **Lamont**: The lateral sense organs of Elasmobranchs; the ampullary canals of the genus Raia.

NEW SOUTH WALES.

Linnean Society, May 26.—Mr. A. G. Hamilton, president, in the chair.—W. N. **Benson**: The geology and petrology of the great serpentine-belt of New South Wales. Part iv.—The dolerites, spilites, and keratophyres of the Nundle district. This paper is a detailed account of the Middle Devonian igneous rocks, which were briefly discussed in earlier parts of this series. It is shown that the rocks are intrusive, whenever clear evidence of their *mise-en-place* is obtainable, even though pillow-structure is well developed, a feature usually characteristic of flows. A remarkable series of magnetite-albite rocks have been discovered among the keratophyres. They find their closest analogy among the igneous rocks accompanying the iron-ores of Lapland.—Dr. A. J. **Turner**: Further notes on the Lepidoptera of Ebor Scrub, N.S.W. Two later visits in February, 1915, resulted in the acquisition of specimens of thirty-one species, of which only seven were obtained in 1914. Thirteen of the twenty-four additional species are known from other localities; nine are described as new; and two remain undetermined. Two species, previously undetermined, are described as new from more complete material.—F. H. **Taylor**: Contributions to a knowledge of Australian Culicidæ. No. II. Five species referable to the genera Stegomyia, Neomacleaya, Culicada, and Culex (two) are described as new. The males of two species, previously unknown, are also described.—Dr. R. **Greig-Smith**: A new gum-levan-forming Bacterium. The hitherto described bacteria capable of forming gum-levan from saccharose, are two in number. A third has been isolated from the tissues of a seedling of *Eucalyptus hemiphloia*. It differs from *Bac. levaniformans* in forming no spores; and from *Bac. eucalypti* in its power of fermenting dextrose, saccharose, and lactose, with production of acid and gas.—E. A. **Briggs**: Hydroids from New South Wales. *Sertularella longitheca*, Bale, var. *robusta*, Ritchie (fam. Sertularidæ), described from sterile specimens dredged off the coast of New South Wales, is now shown, from the examination of colonies bearing gonangia, not to be a variety of *S. longitheca*, but to be entitled to specific rank.—Dr. Th. **Mortensen**: Preliminary note on the remarkable, shortened development of an Australian sea-urchin (*Toxocidaris erythrogrammus*). The ova are large, opaque, and full of yolk, and float on the surface of the water. Cleavage is total and regular at first. The gastrula is free-swimming, the aboral end being turned upwards, and containing most of the yolk. The postoral processes are represented only by a rudimentary swelling, and there is no sign of a Pluteus-stage; nor, appar-

ently, is there any trace of a larval skeleton. The whole animal is ciliated, but the cilia are not collected into bands. The young sea-urchin develops on one side of the embryo, near the mouth. The aboral part serves as a food-reservoir, and becomes finally quite overgrown and enclosed within the urchin's body. The young animal may sink to the bottom or remain swimming at the surface.

BOOKS RECEIVED.

Revision Papers in Algebra. By W. G. Borchardt. Pp. vi+152+xxxix. (London: Rivingtons.) 2s.

Stories of Exploration and Discovery. By A. B. Archer. Pp. viii+198. (Cambridge; At the University Press.) 2s. 6d. net.

The North-West and North-East Passages, 1576–1611. Edited by P. F. Alexander. Pp. xix+211. (Cambridge: At the University Press.) 2s. 6d. net.

Post-Mortem Methods. By Prof. J. M. Beattie. Pp. viii+231. (Cambridge: At the University Press.) 10s. 6d. net.

The Study of Plants. By Dr. T. W. Woodhead. Pp. 440. (Oxford: At the Clarendon Press.) 5s. 6d.

Publications of West Hendon House Observatory, Sunderland. No. iv., Meteorological Observations chiefly at Sunderland. By T. W. Backhouse. Pp. v+188. (Sunderland: Hills and Co.)

The Sacred Chank of India. By J. Hornell. Pp. viii+181+18 plates. (Madras: Government Press.)

Experimental Harmonic Motion. By Dr. G. F. C. Searle. Pp. x+92. (Cambridge: At the University Press.) 4s. 6d. net.

Annals of the Cape Observatory. Vol. xii., part 1: Determination of the Mass of Jupiter and Elements of the Orbits of its Satellites, from Observations made with the Cape Heliometer. By Sir D. Gill and W. H. Finlay; reduced and discussed by Prof. W. de Sitter. Pp. 173. (Edinburgh: H.M.S.O.; London: Wyman and Sons, Ltd.) 6s.

Cape Astrographic Zones. Vol. ii.: Catalogue of Rectangular Co-ordinates and Diameters of Star Images, derived from Photographs taken at the Royal Observatory, Cape of Good Hope. Commenced under the direction of Sir D. Gill. Completed and prepared for press under the supervision of S. S. Hough. Zone—42°. Pp. xxxviii+499. (Edinburgh: H.M.S.O.; London: Wyman and Sons, Ltd.) 20s.

Results of Meridian Observations of Stars made at the Royal Observatory, Cape of Good Hope, in the years 1905 to 1908, under the direction of Sir D. Gill and S. S. Hough. Pp. 255+127. (Edinburgh: H.M.S.O.; London: Wyman and Sons, Ltd.) 30s.

Papers from the Department of Marine Biology of the Carnegie Institution of Washington. Vol. vii, pp. 128; Contributions to Embryology, Vol. i., No. 1, pp. 103 and 11 plates; Vol. ii., Nos. 2, 3, 4, 5, 6, pp. 5–108; The Permo-Carboniferous Red Beds of North America and their Vertebrate Fauna. By Prof. E. C. Case. Pp. iii+176+24 plates. (Washington: Carnegie Institution.)

Wireless Time Signals. Issued by the Paris Bureau of Longitudes. Authorised translation. Pp. vii+133. (London: E. and F. N. Spon, Ltd.) 3s. 6d. net.

Light and Colour Theories and their Relation to Light and Colour Standardisation. By J. W. Lovibond. Pp. xii+90+plates. London: E. and F. N. Spon, Ltd.) 6s. net.

Mineral Resources of Minas Geraes (Brazil). By A. F. Calvert. Pp. 100+127 plates. (London: E. and F. N. Spon, Ltd.) 6s. net.

The World's Supply of Potash. Pp. 47. (London: The Imperial Institute.) 1s.

Prof. Edward Forbes' Centenary, 1915. Pp. 45. (London: The Manx Society.) 1s.

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