THURSDAY, SEPTEMBER 14, 1905.

ASTRONOMY FOR TRAVELLERS.

Handbuch der geographischen Ortbestimmung für Geographen und Forschungsreisende. By Dr. Adolf Marcuse. Pp. x+342+2 charts; illustrated. (Brunswick: Friedrich Vieweg und Sohn, 1905.)

A SHORT preface by the author tells us that this book is designed, in the first place, to give assistance to geographers and explorers, to aid students of the mathematical sciences and pupils in the higher schools, and to serve as an introduction to those parts of astronomy which, since they are concerned with the determination of time and of position on the earth's surface, have an important influence on everyday life. One does not expect, therefore, a description or an explanation of the nicest details that lead to the greatest accuracy, but rather the exhibition of the general principles on which the determination of coordinates depends; and on the whole this ground is fairly well covered, both from a theoretical and practical point of view. But when an author poses as a teacher, we are apt to examine his book a little closely, to see if he has shown any sign of clearly apprehending the difficulties that learners and pupils encounter when attacking a new subject, and made any adequate effort to remove these difficulties. There is no evidence of any particular care in this direction, though, of course, it is no easy matter to detect beforehand where the pitfalls and misconceptions on the part of the pupil will arise, and points that seem to one teacher to demand a lengthened explanation or further illustration do not present themselves in the same way to the judgment of another expert.

But there is another test which may be more safely applied. Are any matters introduced which give needless complexity, or delay the continuous progress of the work? In this respect we think the author is not altogether blameless. For instance, the section on "probable error" and the solution of equations by the method of least squares seems on this ground out of place. The subject in the space given to it is not, and cannot be, treated exhaustively; it must leave but a very hazy notion in the student's mind, and the application of the theory is not wanted in the discussion of the rough results which are derived from the instruments that are employed. Similarly, what has a traveller dealing with approximate values of latitude and longitude to do with the small variations arising from the motion of the Pole? It seems a little inconsistent to suggest a degree of accuracy in the final results which cannot be realised with the particular means adopted.

If these are details into which it would have been better not to have entered, there are, on the other hand, omissions, or at least what appear to be omissions, to which some reference should have been made. Thus, by way of illustration, we may mention the absence of all reference to the sextant and artificial horizon in the portion of the book devoted to the description of instruments. The author is perhaps desirous that his book should not be confounded with the many treatises on nautical astronomy and the methods of reduction therein employed; but the sextant has as distinct a value in exploring new country as the chronometer, to which the author devotes a very satisfactory section. In the determination of longitude, the sextant applied to the measurement of lunar distances affords more trustworthy results than does the observation of Jupiter's satellites, on which the author would apparently rely. Occultations of stars by the moon, which is merely a particular case of the method of lunar distances, are referred to at considerable length. A numerical example of the application of the method is worked out in full, and in all the various methods of deriving the latitude and longitude detailed examples are furnished. This is a very satisfactory feature of the book, and we could have wished that the selection of examples had been more varied and had included the method of lunar distances.

If these omissions seem to us to be slight blemishes on an otherwise excellent book, it is with the greater pleasure that one can turn to the consideration of the sections which treat of matters of more novelty and originality. In the chapter devoted to instruments we meet with a "level-quadrant" (Libellenquadrant) with which we are unfamiliar, and though it appears to be distinctly inferior to the sextant, it may be of advantage in some situations. The peculiar feature of the instrument consists in the fact that the bubble of a level carried on a rotating arm is reflected into the field of view and made to do the same service as the reflection of the sun to the horizon by means of the ordinary arrangements found in the sextant. In the case of determining the position of a balloon when the earth may be invisible owing to clouds passing beneath the observer, such an arrangement can be used with effect. In the chapter on the determination of a balloon's course, the method is applied with very considerable success. The path of a balloon from Berlin to a point beyond Breslau, a complete run of about 400 kilometres, is worked out, and the average error appears to be about 16 kilometres. This would be a large error on board ship, but the conditions are not the same, nor is there the same necessity for accuracy. The aëronaut has simply to take care that he does not run out to sea; the navigating officer has to make a land fall. The calculations in this section have been materially shortened by the use of the so-called Mercator function, which, in the examples given, does away with the necessity of logarithmic tables, and suggests a method of working that seems to be well worth the little study that is necessary to master the application of it.

Lastly, we may mention an ingenious method of determining approximately geographical positions without the use of graduated instruments. Threads supporting a weight at the apex of a triangle so as to ensure verticality and to give steadiness can be hung on tent poles, and over these threads the transit of stars can be observed with the naked eye. Then, knowing the time, the latitude, longitude, and azimuth can be approximately derived; and when instruments have been injured or delayed, or are generally inaccessible, such methods are not to be despised. It would be an admirable exercise for anyone, whether he travels or not, to accustom himself to the use of such tools, and learn to what degree of accuracy he can rely on such devices.

THE EVOLUTION OF HUMAN SOCIETY.

La Sociologie génétique. By François Cosentini. Introduction by Maxime Kovalewsky. Pp. xviii +205. (Paris: F. Alcan, 1905.) Price 3.75 francs.

IN a short compass this book gives an excellent bird's-eye view of a very wide territory. It begins with a discussion of the data available for the study of the evolution of human society. Even animal associations are not neglected, but, naturally, more space is devoted to the beliefs and customs of savage tribes. Our author decides wisely with regard to primitive man that much is to be learnt thus. But he deprecates rash inferences. The ancestors of civilised man, there is reason to believe, never ceased to make progress. The savages of the present day have stagnated, and may, in some cases, have retrograded. Still, when the theories that suggest themselves to the investigator of savages and their ways are modified and corrected by the study of the institutions, the beliefs, the folk-lore of civilised peoples, it is probable that the risk of serious error is reduced to very small proportions.

M. Cosentini decides in favour of a polyphyletic origin of the human race, arguing partly from the reduced fertility observable when two widely different types interbreed. After a brief but interesting account of the Palæolithic and Neolithic ages, he deals with the origin of the family. Here, as elsewhere, he shows sound judgment in his treatment of the various rival theories. He refuses to regard the patriarchal family as primitive. The more primitive the community the less sign is there of patriarchal authority. On the other hand, it would be foolish to maintain that there was ever a time in which woman was absolutely predominant. This view is precluded by the fact that primitive man had to wage incessant war against wild beasts and almost incessant war against hostile tribes. But there is abundant evidence that there was a time when a man was known as his mother's son and not as his father's, when pedigrees were traced through the female line, and when women had much more power and influence than at a later period when the patriarchal system had been developed. When the tendency changed and the paterfamilias became an autocrat within his own household, civilisation made great progress.

The family has been the nucleus which has made the higher civilisation possible, a point which, perhaps, M. Cosentini does not sufficiently recognise. Our author is, no doubt, right in holding that the idea of the family grew out of the idea of private property. The wife was the property of her husband. In very many cases he had captured her as he had captured his cattle. But with regard to monogamy, M. Cosentini does not bring out the interesting fact that in northern climes, where it is most firmly rooted, it derives its strength mainly from the fact that one man's labour suffices for the feeding and clothing of only a small number of children. Even among animals we find the same thing. Where the work of both parents is required for the bringing up of the young, there the system of pairing is the rule. Where the young are precocious and are soon able to fend for themselves, polygamy arises.

On the remainder of the book want of space forbids us to comment at length. It deals with animism, myths, language, religion, morality, law, the origin of social classes, art, industry, and commerce. The style is clear; and throughout the book M. Cosentini proves himself a fair critic and a clear-headed thinker. F. W. H.

OUR BOOK SHELF.

Trees. By H. Marshall Ward. Vol. iii. Flowers and Inflorescences. Pp. xii+402. (Cambridge: The University Press, 1905.) Price 4*s.* 6*d.* net.

THE first two volumes of the above work have been previously noticed in these columns. The present volume, which deals with flowers, is, like the others, divided into two parts. Part i. deals with the flower in general. The author has been very successful in his treatment of this vast subject; he has brought together and arranged his facts in such a clear and simple manner that the beginner should have no difficulty in gaining a very comprehensive knowledge concerning the different kinds of inflorescences, the structure and development of flowers, as well as the meaning of their various forms and modifications. So far as possible technical terms have been carefully avoided, but at the same time it is quite impossible to treat a subject like this without using one or two terms which have a special meaning of their own which cannot be readily put into every-day language. Wherever such expressions are used their meaning is always carefully explained, and at the end of the book a useful glossary is given which will remove all mystery concerning these terms should any such exist.

The author has naturally confined himself to a critical examination of the flowers of trees and shrubs, and the student will find here an epitome of the natural system of classification, and when this epitome has been mastered he will be in a position to understand the structure and form of the flowers of cultivated and wild herbaceous plants as well.

Part ii. is more of the nature of a flora, *i.e.* the author has given in tabular form a general conspectus of woody plants and their flowers, by which means any given species may be easily diagnosed at flowering time.

It is a well known fact that the willows are almost, if not, the most difficult family to deal with as regards their identification. Apart from their tendency to hybridise with each other, the willows are diœcious, which renders their identification very difficult when only one kind of flower is available. The author has very ingeniously overcome this difficulty by giving a special table as an appendix wherein the separate characters of the male and female flowers are used for the purposes of diagnosis.

This volume, like the other two, is profusely illustrated. There is also a very useful and exhaustive index at the end of the book. While vol. i., "Buds and Twigs," is a book for the winter study of trees and shrubs, we have in vol. iii. a book which is specially adapted for use in summer.

A Laboratory Guide in Elementary Bacteriology. By Dr. William Dodge Frost. Third revised edition. Pp. xiii+395. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 7*s.* net.

THIS book is, as stated in the title, a guide for practical laboratory work in elementary bacteriology. The student is taken step by step through the various processes of cleaning and setting up apparatus, sterilisation, preparation of culture media, demonstration of gas production, and detection of certain chemical products, the result of microbial activity. The isolation and cultivation of bacteria, and staining methods, are then considered, and a few exercises are given on the physiological properties of micro-organisms, such, for example, as the influence of the reaction of the medium on growth, the effects of desiccation, &c. The student is next introduced to the systematic study of types, first of non-pathogenic and then of the chief pathogenic forms. In this, as well as in the preceding portions of the book, a heading only is given, and to the exercises and practical work, and pages are left blank for the student's own notes, subheadings indicating what he should observe and look for, the facts observed being entered up by the student himself. In addition, outline diagrams are given of culture tubes which are to be filled in with the students' own drawings. In this way the guide becomes a permanent note-book and record of the student's work. Finally, directions are given for the inoculation and *post-mortem* examination of animals, and a key index of the characters of the more important species concludes the volume. At the end of each section a reference is given to the principal manuals and text-books of bacteriology, such as Abbott's, Chester's, Eyre's, Hewlett's, Muir and Ritchie's, Sternberg's, &c., so that the student may read up the subject. So far as we have been able to observe, the directions given are clear and concise, the exercises judiciously chosen, and the book is singularly free from errors. That a third edition should have been called for is sufficient evidence of the need for such a book, and for those who desire and work from a laboratory guide, and to lighten the labour of full and complete note taking, it may be strongly recommended. R. T. HEWLETT.

Nature-study Lessons for Primary Grades. By L. B. McMurry. Pp. xi+191. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1905.) Price 2*s.* 6*d.* net.

DR. C. A. MCMURRY, who has written the introduction to this volume, is one of the chief recognised authorities in America on elementary scientific education, and, indeed, on elementary education in general, and since he has probably read the proofs and given a general approval to the text, the work may be regarded as being written by one having authority. The plan of the work is to take a series of animals and plants and to show how the lessons to be learnt from them may be taught to pupils of tender years, or rather how the pupils may be trained to find out the meaning of the lessons for themselves. Having gained the confidence and attracted the interest of the pupils, the first object of the teacher should be to endeavour to foster and develop their own powers of observation and of drawing simple conclusions from such observations; and for this purpose the method adopted in the volume seems admirably adapted. Although it is not expected that all teachers will select the same objects for their texts, or that they should all follow by any means the same method of instructing, there can be no doubt of the advantage of having a list of those objects which appear most suitable for the purpose, and also of the benefits which younger teachers may derive from a perusal of the manner in which a more experienced member of their body handles her subject.

While the book appears admirably adapted for its purpose so far as teaching in America is concerned, it seems to require a word of warning when put into the hands of British teachers, and we think it would have been well had a special note to this effect been inserted in the copies intended for sale in this country. For instance, the teaching suggested in the chapter headed "The Robin" will apply for the most part excellently well to the bird so designated in this country; but when the inexperienced teacher (who is unaware that the so-called American robin is not our own familiar red-breast) reads that robins lay blue eggs he, or she, will be apt to put the book aside with the remark that the author does not know her subject. Again, it would much have simplified matters had the English teacher been informed that the plants known in America as "Morning-Glory" include the one commonly called *Convolvulus major* in this country.

With these limitations (which refer only to its issue in this country), we have nothing but praise to bestow upon Dr. and Mrs. McMurry's efforts to establish elementary biological teaching upon a sensible and practical basis. R. L.

Einführung in die Vektoranalysis mit Anwendungen auf die mathematische Physik. By Dr. Richard Gans. Pp. ix+226. (Leipzig: Teubner, 1905.) Price 8 marks.

THIS well-written book gives the usual definitions of scalar and vector products, introduces the now familiar differential operators "div" and "rot" (or "curl"), and uses them skilfully in the simpler applications of the line, surface, and volume integrals, associated with the names of Green, Gauss, and Stokes. The necessity for vector analysis in electromagnetic work is becoming more generally recognised, and Dr. Gans deserves the thanks of all for his able presentation of the outlines of the method, which, nevertheless, is at its best a "Quaternionenstenographie," as C. Neumann felicitously nicknames it. One has only to compare the demonstrations here given, which are primarily Cartesian and are then transformed into the concise vector notation, with corresponding quaternion demonstrations, such as may be found in Joly's "Manual," to see plainly the analytical gulf which separates Hamilton's *calculus* from other vector analyses, which are essentially shorthand *notations.* The mathematical historian of the future will find much food for thought in the mental shortsightedness of many vector analysts who delight in the use of contraction symbols like *grad, rot, div,* but despise the Hamiltonian selective symbols V and S, which with the real ∇ give the whole theory in exquisite compactness and flexibility. On a folding sheet at the end Dr. Gans gives a table of eighteen transformation formulæ, which presumably must all be learned off by rote. There does not seem to be any resemblance among the formulæ (*h*), (*o*), (*q*), which give respectively the equivalents of $[\mathbf{A}[\mathbf{BC}]]$, rot rot $\mathbf{A}$, rot $[\mathbf{AB}]$. In the quaternion notation $V\mathbf{A}V\mathbf{BC}$, $V\nabla V\nabla\mathbf{A}$, $V\nabla V\mathbf{AB}$, they are seen to be of the same "form," and are, indeed, analytically amenable to the same treatment. This is but one illustration of the inferiority of the "Quaternionenstenographie" to the real quaternion analysis. Dr. Gans gives interesting applications in hydrodynamics and in Maxwell's electromagnetic theory, but is limited somewhat by the fact that in this introduction there is no account taken of the linear vector function or matrix.

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.]*

Observations of the Total Solar Eclipse in Tripoli, Barbary.

OUR eclipse took place in the midst of the fierce heat of the *Gibleh*, or Sahara sirocco; but an hour or two before totality the wind very fortunately changed, and brought skies of the highest possible optical transparency. There was no wind, and the conditions, except for the intense heat, which we momentarily feared would snap our great cameras, were the most nearly perfect imaginable at a sea-level station.

Unfortunately, on account of leaving home at very short notice, we brought no spectroscopic outfit, and our efforts were directed solely toward coronal photography with automatic and semi-automatic coronagraphs, and to exposure of plates for the slightly suspected intra-Mercurial planet. Other branches of our work related to coronal sketches, both with and without occulting discs, and to shadow band observations, both optically and photographically.

By the kindness of His Majesty's Government, represented by Mr. Alfred Dickson, Vice-Consul, the American expedition from Amherst College was permitted to establish its instruments on the terrace of the consulate, in the midst of the white city—in precisely the same spot occupied for the similar eclipse of 1900.

Many citizens of Tripoli took immediate and constant interest in our operations, and contributed very greatly to our success by their liberality in granting that service which only the chief of an expedition remote from home can fully appreciate. I am glad to mention especially Mr. W. F. Riley, Mr. W. H. Venables, Maris de Nunes Vais, the excellent photographer of the expedition, and Etim Bey, a Turkish gentleman resident in Tripoli, whose unique collection of photographic and mechanical appliances was frequently and helpfully drawn upon.

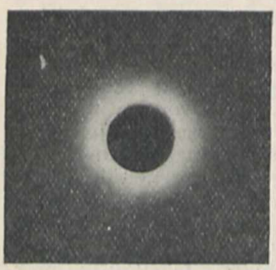


FIG. 1.—Total Solar Eclipse of August 30. Photographed at Tripoli.

The observations of shadow bands were conducted by parties organised by Mrs. Todd and Miss Todd, and will be reported to my friend Mr. Lawrence Rotch, of Blue Hill, at whose request they were made. These bands were seen as early as ten minutes before totality, and had many remarkable and pronounced peculiarities. They were wavering and narrow, moving swifter than one could walk, at right angles to the wind, their length with it, and waxing and waning five times during the eight minutes preceding totality.

The coronal sketches revealed nothing out of the ordinary. Extended rays beyond the occulting discs were looked for eagerly, but the disc (8 inches diameter at 35 feet distance) covered everything. The sky and general illumination were exceptionally bright. Totality as predicted was 3m. 9s. in duration; as observed 3m. 6s.

Our chief and largest instrument was a photographically corrected lens by Clacey, of 12 inches full aperture. To this was attached an orthochromatic screen for photographing Baily's beads, and a Burckhalter occulter as described by the writer four years ago in the *Monthly Notices*. Of the results obtained with this instrument I shall write elsewhere; about twenty exposures were made with it, and the beads are excellently shown in the accompanying photograph. The occulter was only in part successful.

Alongside it were the large Clark cameras, containing a pair of 3-inch lenses of 11 feet 4 inches focus, which took plates on which are a great number of stars, not yet fully examined. Owing to the unexpected brilliancy of the sky, the plates were exposed longer than would seem to have been wise. Everything to the eighth magnitude seems to have been caught, however.

A third instrument was a 3½-inch Goerz doublet of about 18 inches focus, from which I removed the back lens, increasing the focal length to 33½ inches. This was attached to one of the automatic movements used in my previous expeditions of 1896, 1900, and 1901. It was geared up to a rate of 265 photographs during the 189 seconds of totality, the exposure being about ¼ second for each. Most of these pictures are very good, and I enclose a print from one of them (Fig. 1), which does not, however, do the original negative justice. The corona was much less impressive, it strikes me, than other coronas I have seen—1878 and 1900 in clear skies, and 1887, 1889 (*b*), 1896, and 1901 in clouds; in fact, the shadow bands and Baily's beads seem to have been rather more interesting to the general observer than the corona itself.

DAVID TODD.

British Consulate, Tripoli, Barbary, August 31.

On the Class of Cubic Surfaces.

IN Salmon's "Geometry of Three Dimensions," the classes of the twenty-three different species of cubic surfaces are stated; but the process by which these results are obtained is not obvious. I therefore propose to indicate an easy method.

The class of a plane curve is equal to the number of tangents which can be drawn from a point not on the curve; hence the class of a curve is equal to the degree of its reciprocal polar. And since the line joining two points on a surface corresponds to the line of intersection of two tangent planes to the reciprocal surface, it is necessary, in order to make the theories of curves and surfaces correspond, to define the class m of a surface to be equal to the number of tangent planes which can be drawn through a given straight line. Let $(\alpha, \beta, \gamma, \delta)$ be quadriplanar coordinates referred to a tetrahedron of reference ABCD; then the equation of the tangent plane at any point (f, g, h, k) is

$$\alpha\frac{dF}{df} + \beta\frac{dF}{dg} + \gamma\frac{dF}{dh} + \delta\frac{dF}{dk} = 0 \qquad (1)$$

and if this plane passes through the line CD, we must have $dF/dh = 0$, $dF/dk = 0$. Hence the points of contact of the tangent planes which pass through CD are the points of intersection of the three surfaces

$$F = 0,\ dF/d\gamma = 0,\ dF/d\delta = 0 \qquad (2)$$

and their number is equal to $n(n-1)^2$, which is the value of m for an anautotomic surface. The elimination of (α, β) between (2) will furnish a binary quantic in (γ, δ) the degree of which is equal to the class of the surface.

It is obvious from geometrical considerations that a conic node must diminish the class by 2. The equation of a cubic having a binode B_3 is $\alpha\gamma\delta + u_3 = 0$, where u_3 is a ternary cubic in (β, γ, δ). Differentiating with respect to γ and δ, and then putting $\delta = \lambda\gamma$, we obtain

$$\left.\begin{array}{l} \lambda\alpha\gamma^2 + u'_3 = 0 \\ \lambda\alpha\gamma + du'_3/d\gamma = 0 \\ \alpha\gamma + du'_3/d\delta = 0 \end{array}\right\} \qquad (3)$$

where the accents denote what the quantities become when δ is put equal to $\lambda\gamma$ after differentiation. Equations (3) are those of the sections of the cubic and the polar quadrics of C and D by *any* plane through AB; and since they intersect in three coincident points at A, $m = 12 - 3 = 9$.

The equation of a cubic having a binode B_4 at A is

$$\alpha\gamma\delta + \beta^2 v_1 + \beta v_2 + v_3 = 0 \qquad (4)$$

where v_n is a *binary* quantic in (γ, δ). Let $v'_n = dv_n/d\gamma$, $v''_n = dv_n/d\delta$. Differentiating (4) with respect to γ and δ, and eliminating α, we obtain

$$\left.\begin{array}{l} \beta^2(v_1 - \gamma v'_1) + \beta(v_2 - \gamma v'_2) + v_3 - \gamma v'_3 = 0 \\ \beta^2(v_1 - \delta v''_1) + \beta(v_2 - \delta v''_2) + v_3 - \delta v''_3 = 0 \end{array}\right\} \qquad (5)$$

The eliminant of (5) is a binary octavic in (γ, δ); whence B_4 reduces the class by 4.

The classes of all the remaining species may be found by means of the eliminant of (5), or directly from their equations.

A. B. BASSET.

September 6.

Ben Nevis Observatory and the Argentine Republic.

NEWS has reached me here from the office of the Scottish National Antarctic Expedition in Edinburgh of the appointment of almost the whole of the Ben Nevis Observatory staff to the Argentine Meteorological Office, including the superintendent, Mr. Angus Rankin, who has been associated with the observatory for more than twenty years, Mr. Robert Macdougal, for many years assistant, and Mr. Bee.

It may be remembered that in March, 1903, the Scottish National Antarctic Expedition set up a first-class meteorological and magnetical station in the South Orkneys, at Scotia Bay, and that, after the wintering of the *Scotia*, I offered to hand over the station, including Omond House and Copeland Observatory, to the Argentine Government with eighteen months' provisions, as well as to give a passage on board the *Scotia* to Argentine men of science if the Republic would undertake to continue the work and relieve the party the following year. This was carried through by the energy of Mr. Walter G. Davis, director of the Argentine Meteorological Office, and Mr. Robert C. Mossman, the Scottish expedition's meteorologist, was asked to continue in charge. Now Mr. Mossman has returned after two years' valuable work in the Antarctic, and the station is being kept up a third year—the first time in the history of Antarctic exploration that scientific observations have been carried on in one place for more than two years.

But the Republic is not satisfied; it is to continue the work for still another year, and is even going to increase the number of Antarctic stations. Trained men were required, and since Mr. Mossman's return he has been in communication with Mr. Davis, with the result that these three gentlemen have been appointed to carry on this work, as well as Mr. W. R. Bruce, also of Ben Nevis Observatory, who arrived in Buenos Aires three weeks ago.

The Argentine Republic must be congratulated on its enlightened perspective; but surely while doing so we must hang our heads in shame, for, while our Government has discouraged scientific research, we find this rapidly rising Republic eager to encourage it.

WILLIAM S. BRUCE.

Eggishorn, Switzerland, September 8.

Properties of Photographic Plates Exposed to Light.

IN May, 1904, I exposed an ordinary sensitised ¼ plate (20th Century Rapid) to daylight. It was so placed that the light had to pass through a window before falling upon the plate. The day was cloudy and dull, without sun, and the time of exposure was from two to four p.m.

In the meantime I placed an unexposed plate in a box, and upon it a steel pair of scissors. Then taking the exposed plate I placed it above the unexposed plate with the scissors in between and in contact with the sensitised sides of both plates.

After closing the box and wrapping up to exclude light, I put it away for six weeks.

At the end of this period I developed (with MQ) the unexposed plate, and found, as I had hoped, a radiograph of the scissors; then developing the exposed plate it appeared, if anything, to be less dark than the unexposed plate, but without any image.

During 1904 I repeated the experiment several times, varying the time of exposure and letting the light pass through thicker glass, also developing at shorter intervals, the days in every case being cloudy as in the first case. With one slight exception, I failed to obtain any result.

This year I put down three other pairs under the same conditions as the first experiment of 1904, but, if anything, the day, though cloudy, was much brighter. With these I obtained three good results, one of which I unfortunately spoilt in developing.

At present I have five or six other pairs which will be ready for development in four or five weeks' time. In these cases the day was bright sunshine, so that perhaps better results may be expected. L. H. WINN.

Coombe College, Luton Road, Harpenden.

CAUSE AND PREVENTION OF DUST FROM AUTOMOBILES.

AT the present time by far the most serious problem which the automobilist has to face is the abatement of the "dust nuisance." A great deal of bad feeling has arisen against the motorist on account of the dust which he too frequently produces, and there is no doubt that there are very good grounds for the irritation which has arisen, more particularly in agricultural districts. Farming in this country, at the best of times, is not in a prosperous condition, and a farmer does not view with any kindly eye a further reduction in his produce through the effects of dust. Apart from that, however, dust may cause a great deal of personal discomfort to other users of the roads; but this phase of the question would, perhaps, not require very serious consideration were it not that dust of this nature is apt to carry disease, and to lower the health of the poorer part of our population living along the main thoroughfares. As such matters may lead to serious opposition to automobilism, and possibly to further legal restrictions, all tending to hamper a growing and very important industry in this country, it is becoming imperative to see what can be done to minimise a nuisance of this kind.

At present there are two distinct methods of tackling the problem. One is to treat the roads, or construct them, in some way so that they no longer give rise to dust. The other is to so alter the construction of the car that dust, if it exists, will not be raised to a serious extent. These two methods we will now consider.

(1) *Special Treatment of the Roads.*

Undoubtedly proper treatment of the roads, if something permanent and at the same time not costly could be devised, would be the most effective solution of the problem. If, for example, the surface could remain moist, there would obviously be no dust. But treatment with the ordinary watering-cart is very transient; moreover, it is destructive, for the water, as a rule, is used in excess. The use of a deliquescent substance, such as calcium chloride, naturally suggests itself. But in order to be effective the solution would have to be above a certain strength, and probably a little wet weather would remove so much of the deliquescent material that re-treatment would be necessary very soon.

A number of solutions are now on the market for the more or less temporary treatment of roads. Perhaps the best known is Westrumite, containing chiefly petroleum and ammonia, the product being completely miscible with water. It has been used extensively as a temporary measure. Experiments by the Scottish Automobile Club show that the effect remains for a considerable time. Three stretches of road, each about half a mile in length, comprising metalling in three different stages of wear, were selected. These were thoroughly cleaned and treated with a 10 per cent. solution of Westrumite. This was repeated after three days, and, as very heavy rain fell soon after, a solution of the same strength was applied a third time. The result appears to have been very satisfactory. Absolutely no dust was raised by vehicles of any description passing over the road for a very considerable time after the application, and even after three months the dust was nothing to speak of. On the metalling that had been worn the dust was found to be greater. The permanency of the result probably depends on the amount of traffic, as results elsewhere have not always been so satisfactory.

Other preparations of a similar character have been devised, such as Akonia and Dustroyd. The latter is a liquid manufactured from tar, and as it is not soluble in water it should have the advantage of greater permanence, being less affected by rain than are soluble preparations. It is said to give an asphaltic surface to the roads.

A more permanent style of treatment is by means of oil. So far this method has not received much attention in this country, but in America it is being tried on an extensive scale. This is the case at Los Angeles, Cal. The secretary of the Chamber of Commerce of that city gives the following details in a report on the subject:—

"For the past four or five years the use of oil on our roadways has been increasing rapidly, and is now considered the best method for laying the dust, as well as of making a serviceable roadway. It has been taken up by the different boards of supervisors in the surrounding counties as well as by the superintendent of streets in Los Angeles, and we have now in the neighbourhood 300 or 400 miles of oiled roads within a radius of 60 miles of the city. It has been found, when properly applied and the necessary attention given to it, that it forms a smooth durable surface; and in one case of a road with a 6 per cent. grade treated with oil, it was found after a heavy rainstorm the road had not cut or washed, but on a road in the same neighbourhood under the same conditions not treated with oil it became impassable.

"The process of preparation varies considerably according to the opinions and experience of the different workers, as well as with the different material of which the road bed is composed. Some officials have claimed that a very sandy road would not be benefited with oil, but by repeated experiment it has been found that by putting on a very heavy coat of oil the loose sand has taken it up, and by continual application a very fair road bed has been made out of what was almost impassable sand. In some instances sandy roads have been first crowned up with a heavier soil or with clay, making a firm foundation, and then treated with oil, thus making as good a road as in other sections where the land is heavier. In some localities, where oil has been used for some time and careful attention given to repairs and renewal, the roads have become as smooth and hard as asphalt pavements and without the disadvantage of dust. In preparing an ordinary road, in some instances the surface has been loosened by a machine carrying something in the nature of a rake, for the purpose of being able thereby to mix the oil with the surface dirt. In others where the soil is heavy and packed hard, it has been covered with oil and then a thin coating of light sand is sprinkled over this, which causes the whole to cement together, forming a hard surface. For roads of this nature, that is, with a hard surface, it has been found preferable in many cases to use a light gravity oil, which is absorbed readily by the earth. In cases of light or sandy soil, it is contended by many that the heavier oils carrying more asphalt in their composition are more desirable and more effectual for the purpose.

"It is a hard matter to give any definite figures as to the cost of treating the roads, for the reason that conditions differ and prices of material vary in the different localities; but from the figures given by some of our supervisors it seems that it takes from 75 to 250 barrels of oil per mile for the first treatment, according to the character of the soil. About one-third of the original amount is sufficient for the second year, and thereafter in constantly decreasing amounts. It is stated that the average cost, taking the first application and the later attention, should not exceed 20*l.* per year per mile. It is authoritatively claimed that treatment by oil is much less expensive, even at the outset, than the use of water in laying the dust, and at the same time is enduring."

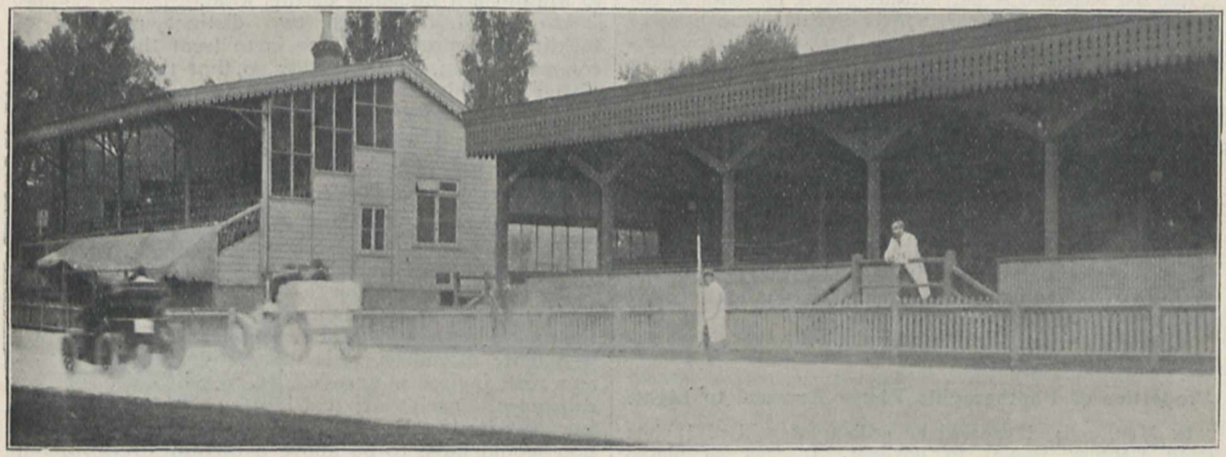


FIG. 1.—Test of a dustless car running over flour at the Crystal Palace. From the *Automobile Club Journal*.

Mr. Lyle Rathbone, in a paper read before the Liverpool Self-propelled Traffic Association this year, gives an account of experiments with oil carried out on the roads at Liverpool. The oils used were hot and cold creosote oil by itself, creosote oil mixed with small proportions of pitch, resin, or tallow respectively, hot coal tar, cheap waste oil from coal tar, common petroleum, and crude Texas petroleum. The general results do not appear to be anything like so permanent as those obtained in America referred to above. They were satisfactory as far as they went, the tendency being for the road surfaces to be preserved, to dry more quickly, and to be cleaner. No very conclusive result as to the best oil seems to have been reached. Creosote oil with resin gave the cleanest and best appearance, and ordinary petroleum was the least lasting. Heavy coal tar waste oil lasted longer than creosote, and was very much cheaper; a single coat kept the surface in good order for about three weeks, and two coats for about five weeks.

Experiments by the Scottish Automobile Club showed that crude oil was most effective. It was poured on to the cleaned road surface by means of cans, and brushed over so as to saturate the surface uniformly. In about twelve hours the surface was dry enough for traffic. The cost per mile of road of fair average width was about 20*l.*, which may seem costly, but the method has the great advantage that a single application is sufficient for a season, and against this cost must be set a saving in other ways. It is to be hoped that more extensive experiments will be carried out on these lines, for the results seem rather contradictory, and there are probably a good many factors to be observed.

In the methods so far referred to, attempts are made to improve the roads with their present mode of construction. But it would be more rational to use materials in road-making that would not give rise to dust; for example, with materials of a viscous nature. Tar very naturally suggests itself, and a good many experiments have been made either by mixing it with road materials or by applying it hot as a coating. Mr. Scott Montagu, in a paper recently read before the Automobile Club, gives several instances in which the tarring of roads has proved effective. It is perhaps a little early to say whether this treatment remains satisfactory under all conditions, or whether it may after a time give rise to unpleasant mud in wet weather under certain conditions.

In order to obtain a permanent result it seems necessary that the crust of the roadway should be really waterproof to a fair depth, so that dust-forming materials cannot work up. This result can only be obtained by combining the tar with the materials used in construction. It is useless, however, to tar such materials as granite or syenite, because the tar remains only on the outside, and as the material is worn the tar becomes ineffective. For that reason Mr. E. P. Hooley uses furnace slag, which is very porous, and produces a material which he has named "Tarmac." The slag is taken hot from the furnaces, broken, and thrown into tanks of tar. Upon cooling, the tar becomes absorbed, and the slag is thoroughly impregnated, so that if the pieces are broken further a tarred surface is still found. In other words, the material is such that it cannot give rise to dust. It is used in construction, like other materials, to a depth of several inches. The initial cost is rather heavier than for a macadam road, but this appears to be more than counterbalanced by the greater durability and the fact that a waterproof road is obtained free from dust and requiring much less cleaning than the usual macadam.

FIG. 2.—Test of a dusty car running over flour at the Crystal Palace. From the *Automobile Club Journal*.

(2) *Design of the Car.*

Although a permanently good road may be made by the use of such materials as Tarmac, and dusty roads may be cured temporarily by various means, yet such measures can be taken only over a small proportion of our roads owing to the cost. In towns and large villages the roads might be suitably treated; but the average motorist seeks the country, and the greater part of the routes which he wishes to traverse will not pay for any special treatment. It therefore becomes very important to modify the design of cars so that the dust raised may be reduced to a minimum, and also, if possible, to find some simple means of checking the dust in the case of cars already in use.

One of the simplest defects to remedy is the direction of the exhaust, which is sometimes pointed downwards. In such a case the dust raised by the exhaust alone may be considerable, and an improvement may be made very simply. It has even been proposed to use the exhaust, suitably directed, for laying the dust which is otherwise raised by the car; and M. Baudry de Saunier, editor of *La Vie Automobile,* vouches for the efficiency of the Feugère system, as it is called. The exhaust is discharged from a horizontal pipe taken across the back of the car, having a line of holes along its length. Thus a number of jets in the same plane is formed, and the pipe is so mounted that the angle at which these jets impinge on the roadway may be varied so as to be as effective as possible. Naturally, the less fluctuating the stream of exhaust gases the better for such a purpose, and the result is said to have been much more satisfactory on a four-cylinder than on a single-cylinder car. I have not had an opportunity of seeing this device in action.

Speaking generally, and leaving such special points as direction of exhaust out of account, it may be said that the dust is raised by the tyres, and is then scattered by the air currents produced by the body. In other words, if the body were moved along the road at its normal height, supported by other means than the wheels, very little dust would result. But it is equally true that if the wheels could be run without the body there would not be much cause for complaint as to dust. By *body* is here meant the whole structure, apart from the wheels, so that the term is more comprehensive than usual. The passage of a car body through the air necessarily creates a great deal of disturbance, and the extent to which the air near the ground is disturbed must depend to a great extent upon the shape of the body. The less the disturbance, the less will the dust be formed into a cloud.

In 1903, the Automobile Club tested the dust-raising qualities of a large number of cars. Each car was run at twenty miles per hour over a patch of flour on the cycle track at the Crystal Palace. The flour was kept at a definite thickness, and as each car passed it was photographed. These photographs gave a permanent record of the dust cloud raised by each car, enabling the committee to classify the cars in the order of merit. The records so obtained gave a great deal of useful information, and it was recognised that this method of testing was far more satisfactory than optical observations, because an observer has a good deal of difficulty in retaining a mental picture of what may be termed a standard car as regards dust.

In a paper read in 1903 before the Automobile Club, Colonel Crompton and Mr. Crawley came to the following conclusions, based on these experiments:—Hard tyres are better than soft; narrow tyres are better than broad; neither have a preponderating influence; flaring mud-guards are probably bad, especially if they come low down; cars which are low underneath are worse than cars a long way off the ground; but smoothness of bottom-shape and absence of forward coning are infinitely more important. There is strong evidence that it is desirable that the car should slope upwards towards the back. At the same time, the authors point out that "a low car is not necessarily a dusty one, nor is a high car necessarily dustless."

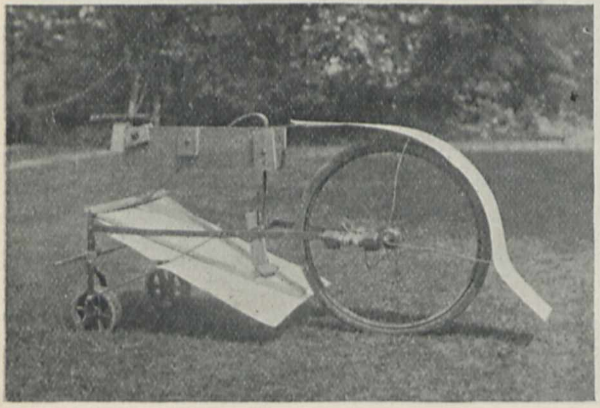


FIG. 3.—Experimental tricycle.

Figs. 1 and 2, which are reproductions of photographs taken during the Crystal Palace tests, show the great difference that already exists between different makes of car, the first being of a comparatively dustless car, and the second of a very dusty car, both running at twenty miles per hour, the pace being given by a "speed car" running alongside. It will be seen that it is possible to make cars comparatively dustless, though the means of doing so are not yet well understood.

In approaching the problem, it is necessary to give up all preconceived ideas, for the practical results by no means always agree with what would theoretically be expected. If a dusty car and a comparatively dustless car are examined and compared, it is often not at all easy to say why the one is more dusty than the other. People are apt to have the idea that comparatively small differences in the car body are important. Last year, however, the Automobile Club carried out a series of experiments on different shapes of body, and these showed that the dust raised did not depend to any great extent upon the shape, at least as regards small modifications of the upper structure. An irregular shape under the chassis is no doubt bad, and the transverse tool-box carried low down at the back of the car, which is frequently seen, is certainly harmful.

The investigation of the problem by means of a car is difficult, owing to the number of variables. For example, the experimental car may be a "medium" dust-raiser, and, if any modification is made, the effect may be masked to a considerable extent by other factors which we may not be able to control. Therefore it would be better, if possible, to study the problem with a much simpler apparatus, so that any one variable might be taken in turn without difficulty. In the hope of doing something in this way, I have recently carried out experiments on an elementary form of tricycle, which is shown in Fig. 3. This is drawn over a track laid with

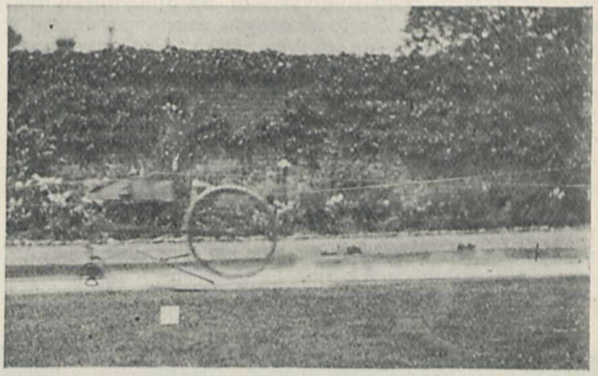


FIG. 4.—Dust thrown up by a tyre pumped hard.

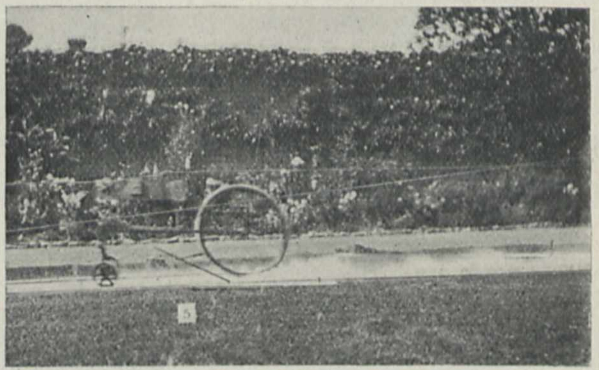


FIG. 5.—Dust thrown up by a very soft tyre.

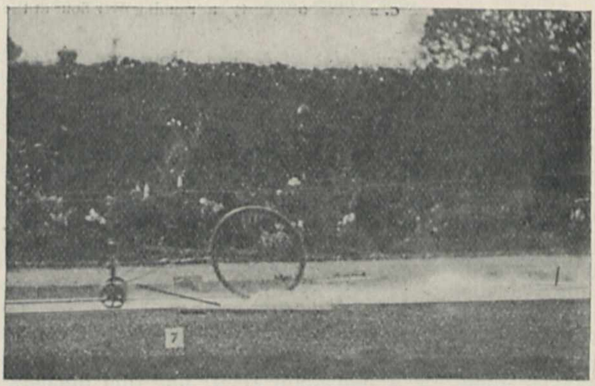
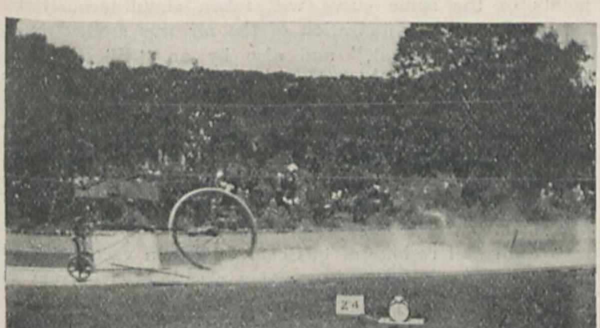


FIG. 6.—Dust thrown up by a very soft tyre loaded with 12 lbs.

flour at, say, fifteen to twenty miles per hour, and photographs are automatically taken to show how much dust is raised by the large wheel, which is an ordinary bicycle wheel. The flour is laid only along the centre of the track, so that the bicycle wheel is the only one that causes any disturbance. As the framework is of very simple construction, it may be regarded as causing no serious disturbance in the air, unless it is supplemented by some form of body. In the illustration it is shown provided with a mud-guard and an inclined plane; these, and any other "bodies," are easily made of cardboard, and a number of experiments can be carried out in a comparatively short time.

By stripping the frame, the action of the tyre alone, apart from any body, may be easily investigated in a way which is impossible with a car having four wheels with a conflicting set of mud-guards, or a body which will affect the back wheels quite differently from the front wheels. Thus Fig. 4 shows the dust thrown up by a tyre pumped hard, from



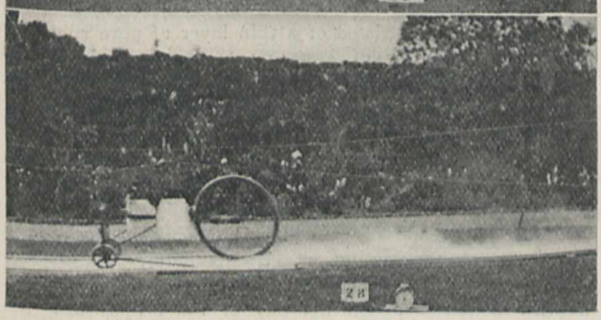


Fig. 7.—Dust cloud formed by a square box 3 inches off the ground.
Fig. 8.—Dust cloud formed by a square box 9 inches off the ground.

which it will be seen that the dust is only slight. In Fig. 5 the effect is shown of a very soft tyre, the dust being a good deal more. In both these photographs the tyre was unloaded, except for the proportion of the frame which it had to bear. But in Fig. 6 the effect is shown of a load of 12 lb. on the tyre, and it is seen that the dust raised is much increased.

Although, from the point of view of raising dust, the tyres may not be so important as the body, their action does seem to be important enough to warrant more careful investigation. They are capable, in themselves, of raising a good deal of dust, as is often to be seen in the case of bicycles. Very possibly dust is carried up by tyres through a kind of suction, and this may vary a good deal with the design. Now that there are so many different tyres, including non-skidding bands, on the market, there is likely to be a considerable difference in the various types as regards dust. In the photographs which are reproduced, the wheel is equivalent to the front wheels of a car, as there is no driving force on the tyre. In the case of wheels which are drivers, there will be a certain amount of slip of one kind or another, and the dust raised is likely to be greater; but, actually, there

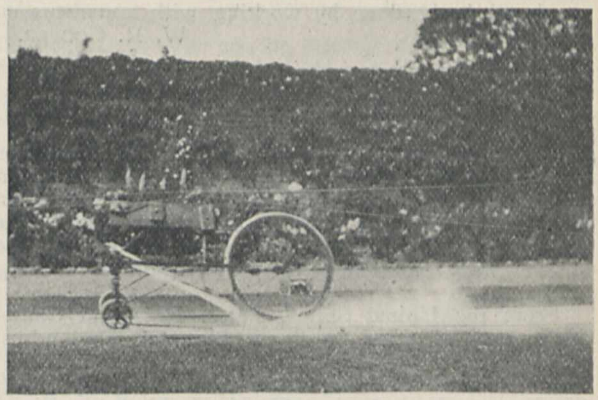


Fig. 9.—Effect of an inclined plane.

does not seem to be any very great difference between drivers and non-drivers—at least there is much less than would be expected.

As regards "bodies," Figs. 7 and 8 show the effect of allowing a square box, 18 inches long by 20 inches wide and 12 inches deep, to precede the wheel. In Fig. 7, which shows a large cloud of dust, the box is only 3 inches off the ground; but in Fig. 8 it is 9 inches above the ground. In the latter there is still a lot of disturbance, which fact is of interest, seeing that the bodies of certain cars are brought down to within about 6 inches of the ground. These illustrations and those following are comparable with Fig. 6, the tyre being loaded and soft, and the motion being always from right to left. In Fig. 9 is seen the effect of an inclined plane, so inclined that the air is severely thrown down on to the track. It is a little surprising to notice that the effect of the plane is not nearly so serious as that of the box seen in the two preceding illustrations, although the box and plane are about the same in width, and the plane, which is carried down to within about 4 inches of the ground, is of considerable length. It may be, therefore, that the inclination of the under surface of a car body is not of much importance after all. In Fig. 10 is shown the very marked disturbance caused by a vertical card, 12 inches square, fixed

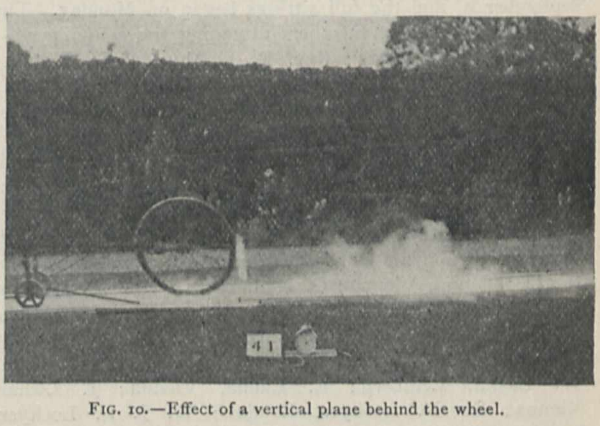


Fig. 10.—Effect of a vertical plane behind the wheel.

behind the wheel; this is akin to the tool-box which is often carried low down behind a car, and is generally recognised as having a bad effect.

In the present article it is impossible to go further into details. The apparatus as illustrated is rather crude and elementary, but I think enough has been said to justify the view that a good deal of useful work might be done by working with apparatus on these lines.

W. R. COOPER.

THE INTERNATIONAL UNION FOR COOPERATION IN SOLAR RESEARCH.

A CONFERENCE of the International Union for Cooperation in Solar Research will be held on September 27 at New College, Oxford, by invitation of the warden and fellows of the college. The following delegates of societies constituting the union have signified their intention of being present:—

From the United States, Profs. Hale and Campbell; from France, Messrs. Janssen, Deslandres, Fabry, Perot, and the Comte de la Baume Pluvinel; from Russia, M. Belopolski; from Germany, Prof. H. Kayser; from Holland, Prof. H. H. Julius; from Sweden, Prof. Knut Ångström; from Switzerland, Prof. A. Wolfer; from Austria, as representative of the International Association of Academies, Prof. Edmund Weiss. Great Britain will be represented by Profs. Turner, Schuster, and Fowler, Father Cortie, Mr. W. E. Wilson, Major Hills, Dr. W. J. S. Lockyer, and Dr. Halm. The subjects of discussion will include the following:—

The fixing of standards of wave-length in spectroscopic research, cooperation in the measurement of the intensity of solar radiation, cooperation in recording solar phenomena by means of photographs of the disc, spectroheliograph records and observations at the limb of the sun.

The foreign savants will be lodged at and entertained by New College. On Friday, September 29, the president of the Astronomical Society and Mrs. Maw will give a reception at their residence in London, and for the following day invitations to visit the observatories at Cambridge have been received from Sir Robert Ball and Mr. Newall. Prof. Schuster is acting as chairman of the executive committee which was appointed last year at the first conference of the union held at St. Louis.

NOTES.

THE meeting of the International Meteorological Conference at Innsbruck was opened on Saturday last, September 9, and the full sittings began on Monday. The following is a list of members attending the conference:—F. Åckerblom, Upsala; Rev. P. J. Algué, S.J., Manila; A. Angot, Paris; R. Assmann, Lindenberg bei Breskow; A. Belar, Laibach; W. v. Bezold, Berlin; B. Brunhes, Puy de Dôme; V. Carlheim-Gyllensköld, Stockholm; V. Conrad, Vienna; P. M. Dechevrens, Jersey; E. Durand-Gréville, Mentone; Sir John Eliot, London; F. Erk, Munich; E. van Everdingen, de Bilt; G. Fineman, Stockholm; Rev. P. L. Froc, S.J., Zi-ka-wei; V. Gama, Tacubaya Obs., Mexico; G. Greim, Darmstadt; J. Hann, Vienna; G. Hellmann, Berlin; E. Hepites, Bukarest; H. Hergesell, Strassburg; H. H. Hildebrandsson, Upsala; W. Kesslitz, Pola; N. v. Konkoly, Budapest; W. Köppen, Hamburg; A. Lancaster, Uccle; W. Láska, Lemberg; E. Lauda, Vienna; J. Liznar, Vienna; Sir N. Lockyer, London; W. J. S. Lockyer, London; J. H. Lyons, Cairo; E. Mazelle, Triest; H. Mohn, Christiania; A. Mohorovičić, Agram; L. Moore, Washington; M. Nedelkovitch, Belgrade; L. Palazzo, Rome; A. Paulsen, Copenhagen; J. M. Pernter, Vienna; F. C. A. Pockels, Heidelberg; P. Polis, Aachen; G. B. Rizzo, Messina; A. L. Rotch, Boston; P. v. Rudzki, Cracow; M. Rykatchew, Petersburg; A. Schmidt, Potsdam; A. Schmidt, Stuttgart; P. Schreiber, Dresden; Ch. Schultheiss, Karlsruhe; Rev. P. Th. Schwarz, Kremsmünster; W. N. Shaw, London; A. Silvado, Rio de Janeiro; R. F. Stupart, Toronto; L. Teisserenc de Bort, Trappes; W. Trabert, Innsbruck; J. Valentin, Vienna; J. Violle, Paris. The members of the Solar Commission are:—M. Angot, Sir John Eliot, Prof. Hann, Sir N. Lockyer (president), Dr. Lockyer, Captain Lyons, Prof. Pernter, Prof. Rizzo, Dr. Rotch, Dr. Shaw, M. Teisserenc de Bort, Dr. Konkoly.

THE Carnegie Institution, Washington, sent Profs. F. Elster and H. Geitel and Herr F. Harms to Palma to make observations of the electric conditions of the atmosphere during the recent solar eclipse. By means of a self-registering electrometer, the variation of atmospheric electricity was photographically recorded, and a series of points of the same curve was taken simultaneously by eye-readings. The ionisation of the air was studied by a "Zerstreuungsapparat," and also by an "Ebert's Föncounter." Besides these observations, exact measurements of the intensity of the solar radiation within the short wave-lengths were carried out, a peculiar kind of photometer having been prepared for this purpose. It is based upon the property possessed by clean surfaces of the alkaline metals of emitting kathode rays of a density proportional to the intensity of the incident light; by these rays the small residue of gas contained in a vacuum glass bulb is rendered conductive, and a circuit of a current is closed, the intensity of which may be read by means of a d'Arsonval galvanometer. In the apparatus alluded to the sensitive surface consisted of a thin layer of pure rubidium metal. An accuracy of ½ per cent. to 1 per cent. was easily obtained. By a blue Jena glass rays of long wave-length are absorbed before reaching the rubidium surface, so only the blue and violet, and partially the ultra-violet, region of the spectrum remains, and these are the radiations which may be supposed to have an ionising effect on the atmospheric air. The results, as well as the description of the apparatus, will be published in the reports of the Carnegie Institution. Unfortunately the observations, like all others in Spain, suffered from the bad weather conditions. On the day of the eclipse rain fell during the morning; consequently it cannot be considered as undisturbed with regard to atmospheric electricity. The measurements of the solar radiation were possible in a continuous series only from the first contact to the end of totality; the decrease of illumination, therefore, was determined in a satisfactory manner and without any gaps. On the other hand, clouds prevented any reading being taken during the increase of light after totality.

THE photographs of the total solar eclipse, taken by the Solar Physics Observatory Expedition at Palma, have proved to be better than was expected from the state of the sky during totality. A fine picture of the corona was secured with the long-focus mirror, but the clouds were too dense for successful tri-colour photographs to be obtained.

THE visit of the members of the British Association to the Victoria Falls on September 12 was made the occasion of the formal opening of the bridge over the falls, by Prof. G. H. Darwin, president of the association. In declaring the bridge open, Reuter's Agency reports Prof. Darwin to have remarked that the great enterprise of the Cape to Cairo Railway, of which the bridge is a part, had become possible by the influence of steam. He could not refrain from quoting the remarkable forecast written by his great grandfather, Erasmus Darwin, in 1785:—

> Soon shall they arm unconquered steam afar,
> Urge the slow barge and draw the flying car.

How little could the writer of these lines have foreseen that his great grandson would have the honour of declaring a railway bridge open in the heart of Equatorial Africa. Yet another interesting point was that this enterprise had rendered possible a purely scientific enterprise. He referred to the great survey of an arc of meridian which was due to the insight of Sir David Gill.

IT is announced that the Emperor of Austria has made Dr. Karl Toldt, professor of anatomy in the University of Vienna, a life member of the Austrian House of Lords.

THE Harben lectures will be delivered in the lecture room of the Royal Institute of Public Health on October 10, 12, and 17 by Prof. T. Oliver. The subject of the lectures will be some of the maladies caused by the air breathed in the home, the factory, and the mine, including a description of caisson disease or compressed air illness.

A TELEGRAM to the *New York Sun* from Honolulu states that the steamship *Sierra*, which arrived at New York on September 6 from Australia, reports that a volcanic eruption has occurred on the island of Savaii, the largest of the Samoan group.

THE Arctic expedition of the Duc d'Orléans arrived at Ostend on September 12 on board the *Belgica*. M. de Gerlache, the commander of the expedition, said that the duke and himself were delighted with the results attained. They had been able to follow the pack ice the whole way from Spitsbergen to Greenland. The expedition has brought back a number of cases containing collections of scientific value.

WE regret to have to record the death of Mr. H. R. Noble, a past student in physics at University College, London. Mr. Noble had shown the possession of great experimental ability in connection with various investigations published by the Royal Society, especially by his work on the question of the relative movement of ether and matter. He had gained an 1851 scholarship, and had gone to Giessen to work under Dr. Drude when failing health compelled him to relinquish this work. Mr. Noble was very popular amongst his fellow-students and teachers at University College, and the news of his early death will be received with great regret.

IT was stated recently by the *British Medical Journal* that a member of the Brazilian Chamber of Deputies had proposed that a prize of 400,000*l*. should be offered for the discovery of a certain method of stamping out consumption. It is now understood by our contemporary that the offer, which has been approved by the Brazilian Parliament, is larger in scope than was supposed, for it appears that the prize will be given to anyone, native or foreign, who shall discover a certain means of prevention or cure of syphilis, tuberculosis, or cancer. The Brazilian Minister of the Interior will, it is said, refer the proposal to a committee composed of a representative of the National Academy of Medicine, and four other members of kindred bodies in France, England, Germany, and Italy. The Brazilian Government will regulate the meetings of the committee.

THE Paris correspondent of the *Times* states that one of the most interesting features of the International Congress on Tuberculosis, to be held at the Grand Palais on October 2–7, will be a museum and international exhibition of tuberculosis. The Paris Municipal Council has agreed to retain a considerable part of the scientific objects in the exhibition for a permanent free museum similar to that established by the Berlin Municipality at Charlottenburg. The opening meeting of the congress will be presided over by the President of the Republic, and attended by numerous French and foreign delegates, including leading men of science. The congress will be divided into four sections, that of medical pathology being presided over by Prof. Bouchard, that of surgical pathology by Prof. Lannelongue, that of the preservation and assistance of infant life by Prof. Grancher, while that of the preservation and assistance of adult life and social hygiene will be under the joint presidency of Prof. Landouzy and Senator Paul Strauss. The acting president and vice-presidents of the congress are Dr. Hérard, of the Academy of Medicine, and Profs. Chauveau and Brouardel, of the Institut de France. Dr. C. Theodore Williams and Dr. H. T. Bulstrode have been appointed by the Government the British delegates to the congress.

A SEVERE earthquake disturbed a large part of Italy and Sicily on September 8, causing much damage and the loss of hundreds of lives. The region most affected was in the vicinity of Monteleone, Calabria. The shock caused damage so far as Sant Agata di Saro, Roggiano, and Gravigna (province of Cosenza) and Sicily in the south, and there was a sensible seismic movement in the north so far as the province of Palermo, Saserno, Basilicata, Puglia, Bari, and Lecce, and in the south over the whole eastern coast of Sicily. The following summary of Reuter's messages contains the essential facts relating to the disturbance:—*Reggio, Calabria, September* 8.—Very severe earthquake at 2.44 a.m. *September* 9.—Two undulating earthquake shocks of short duration felt at 2.8 p.m. *Catanzaro, Calabria, September* 8.—Violent shock of earthquake, lasting eighteen seconds, felt at 2.55 a.m. Several walls collapsed and cracks appeared in others. *Messina, September* 8.—Very severe shock occurred at 2.43 a.m., the direction of movement being from north to south. *Rome, September* 8.—Shock felt about 2.45 a.m., followed by other shocks during the day. Public clocks stopped. *September* 9, 2 p.m.—Slight shock registered by the instruments of the observatory at Rocca di Pappa. *Martirano.*—Many killed and injured. All the buildings collapsed. *Stefanaconi.*—Many houses destroyed, and about 100 people killed. *Piscopio.*—Every house in the village in ruins, and the dead number 50. *Monteleone.*—Many houses destroyed, and about 600 lives lost in the district. *Triparni.*—Totally destroyed, and 60 people killed. *San Gregorio.*—Sixty-five deaths. *Zammaro.*—Houses destroyed. *Zungri.*—Nearly every house wrecked, and many persons killed. *Cessaniti.*—Practically all the houses destroyed. *Bratico, Sanleo, St. Costantino,* and *Conidini* totally destroyed. *Catanzaro.*—All the villages in this province seriously damaged. Several entirely destroyed. About 450 killed and 1000 injured. *San Floro.*—Houses seriously damaged. *Daffina, Daffinillo,* and *Louzione, in the district of Tropea.*—Much damage done to houses. *Fesenza.*—Shock very severe, and extensive damage done. *Syracuse* and *Catania.*—Severe shocks felt. *Castellammare, Naples,* and *Florence.*—Slight shocks.

AN article in the *Hong Kong Daily Press* by Mr. W. Kingsmill discusses the position of Ophir. He argues that the situation of Ophir and the provenance of the gold of Ophir are two distinct questions, holding with Prof. Keane that the latter came from South Africa the ruined cities of which are engaging the attention of the British Association and, what is more to the purpose, of trained archæologists. The original Ophir, on the other hand, Mr. Kingsmill locates at the head of the Persian Gulf, which was reached by Solomon's fleets; he makes his argument depend to some extent on a second argument to prove that the head of the gulf is the site of the Garden of Eden—a theory not improbable in itself, but apparently unconnected with the question of Ophir and the source of Solomon's treasure or of that of the earliest civilisations. Mr. Kingsmill has no evidence to show that the Jews connected the Garden of Eden with the head of the Persian Gulf, even if the myth originally referred to that area, and it is by no means clear why the Jews should associate gold with Ophir when they were, in Mr. Kingsmill's opinion, drawing their supplies of that metal from South Africa; for no evidence is produced to show that they drew gold from Mr. Kingsmill's Ophir at any time, or yet that the head of the Persian Gulf was known, much less proverbial in pre-Solomonic times as a source of gold. Mr. Kingsmill holds that Ophir, Sheba, Sofala, Havilah, &c., are one and the same, but it is scarcely sufficient to urge in proof of this that York appears twenty times in the *Times* Atlas. Needless to say, the article was written without knowing Mr. Randall MacIver's results recently described.

THE issue of the *Electrician* for September 1 contains a note by Lieut. Evans, R.E., upon some experiments made with different methods of earth connection for wireless telegraphic installations. The experiments were made with an oscillator consisting of a square copper wire capacity, 17 feet square, suspended horizontally by insulators, 14 feet above the ground. From the centre of this area, a vertical wire led to one knob of a spark gap, the other knob being connected by a similar wire to an iron-wire netting 17 feet square, suspended horizontally 2 feet above the ground, also on insulators. The current flowing in the vertical wire was measured under various conditions as regards the earthing of the iron-wire netting, and it was found that any connection of the transmitter or of the receiver with the earth was objectionable, since it greatly reduced the current flowing in the vertical wire. The most desirable form for the oscillator was, in fact, proved to be that approaching closely to a symmetrical Hertz oscillator as described by Sir Oliver Lodge in his Patent Specification, No. 11,575, of 1897. In this specification, two capacity areas, connected by self-induction coils and the receiving transformer, are clearly indicated.

As is customary, the issues of the *Lancet* and the *British Medical Journal* for September 2 are students' and educational numbers dealing with the curriculum necessary for the student of medicine, the various medical schools, books, the portals of entry into the profession, &c. The guardian of a prospective student could not do better than consult these periodicals.

THE issue of *Biologisches Centralblatt* for August 15 contains an article by Mr. A. Issakowitsch on the causes of sexual determination in water-fleas of the daphnid group, and a second by Prof. J. Lebedensky on the embryonic development of the echinoderm *Pedicellina echinata*.

FISHES from Borneo, principally from the Baram district of Sarawak, form the subject of a paper by H. W. Fowler in the July issue of the *Proceedings of the Philadelphia Academy*. Several are described as new, notably a shark belonging to the "tope" group, referred to the genus Carcharinus as *C. tephroides*.

IN a recent issue of *Science* Mr. O. A. Peterson, of the Carnegie Museum, publishes a preliminary note on remains of a huge pig-like animal allied to Entelodon from the Loup-Fork beds of Nebraska, for which the name *Dinochoerus hollandi* is suggested. The chief grounds for generic separation of the new form appear to be the geological horizon and the immense proportions of the animal, of which the skull measures no less than thirty-five inches in length. It would be interesting to ascertain what relation this monster presents to the imperfectly known Tetraconodon of the Indian Siwaliks.

THE *Fortnightly Review* and the *Independent Review* for September each publish articles on the origin of life. In the former Mr. Burke gives an account of his experiments in which, by the action of radium on bouillon, microscopic bodies, termed "radiobes," appear. These seem to divide by fission, like a micro-organism, and not by cleavage, as obtains in a crystal. Mr. Burke concludes that the continuity of structure, assimilation, and growth, and then subdivision, together with the nucleated structure as shown in a few of the best specimens (of radiobes), suggests that they are entitled to be classed amongst living things, in the sense in which we use the words, whether we call them bacteria or not. In the *Independent Review* Dr. Charlton Bastian writes on the origin and development of living matter on the earth, and discusses his theories of archebiosis and heterogenesis. With regard to the former, the formation of living matter by a process of synthesis from its primitive elements, Dr. Bastian recognises the extreme difficulty of proving it, and suggests that when the results are negative in a "sterile" fluid this may be due to the degrading influence on the fluid of the heat employed for sterilisation. But "sterile" nutrient fluids, *e.g.* egg-white and blood-serum, may be obtained without the use of any treatment. As regards heterogenesis, the development of one form of living matter into another, *e.g.* amœbæ from a bacterial zooglœa, bacteriologists will not accept this until it has been proved that the germs of the species which is supposed to have developed were not present in the original zooglœa.

THE London County Council has issued an admirable little handbook (price 1*d.*) to the case in the Horniman Museum, Forest Hill, arranged as an introduction to the study of birds' eggs. It is illustrated by six reproductions from photographs of specimens in the case intended to show variation in colouring, protective coloration, the numbers in clutches of different species, size as compared to that of the parent, form, and grain of the shell. The first two plates require, of course, to be coloured in order to bring out the distinctive features of the specimens, but this would probably have involved too great expense.

IN the report of the Manchester Museum of Owens College for 1904–5, an appeal is made to the public for aid in preventing its work and expansion being crippled for want of funds. The most important event recorded during the year under review is the presentation by Mr. J. Haworth of his collection of Egyptian antiquities, which contains a large proportion of the specimens obtained by Prof. Flinders Petrie between the years 1888 and 1897. The museum has issued as one of its handbooks the second and third parts of Mr. H. Bolton's paper on the palæontology of the Lancashire Coal-measures, originally published in the *Transactions of the Manchester Geological and Mining Society* for 1904.

IT is satisfactory to learn from *Science* that Trinity College, Connecticut, has made arrangements for establishing a floating laboratory of marine biology for the purposes of explorations in oceanography, collecting specimens, and supplying teaching and scientific institutions with material for the study of marine organisms. A suitably fitted vessel of about 90 tons will be dispatched next summer for the Bahamas. In connection with this announcement, we may refer to a communication from Prof. M. E. Henriksen, of Ohio University, published in *Biologisches Centralblatt* of August 15, with reference to a proposal for the establishment of a biological station in Greenland, which, it is urged, would be sure to yield results of great scientific importance. "Back to nature" is the cry of the writer, who insists that biological progress now depends upon the observation of the relationship of organisms to their environment rather than on microscopic work in the laboratory.

EVER since the 'fifties, when the late Dr. H. Falconer wrote a note on the subject, strenuous efforts have been made to discover the origin of the so-called "bee-hole borings" which ruin the heart-wood of so much Burmese teak timber. Mr. E. P. Stebbing, who has been fortunate enough to discover the insect causing this serious damage, has recorded, albeit in a somewhat prolix manner, his investigations which led up to the discovery in a pamphlet published by the Calcutta Government Press under the title of "The 'Bee-hole' Borer of Teak in Burma." The offender turns out to be the larva of a large moth, which, after living for some time in the bark, when about to pupate bores large channels right into the heart-wood of saplings. As the sapling grows into a tree the borings remain in the heart, and thus completely ruin the timber for many purposes. Suggestions are made with regard to remedial measures.

THREE out of the four biological papers in the issue of the *Journal of the Straits Branch of the Royal Asiatic Society* for July are by H. N. Ridley, director of the Singapore Botanical Gardens, and relate to botanical subjects. In the first the author discusses the Gesneraceæ of the Malay Peninsula, and in the second the aroids of Borneo, while in the third he continues his descriptions of new and little known Malay plants. In the one zoological paper Mr. P. Cameron publishes a third contribution to our knowledge of the Hymenoptera of Sarawak. Among short notes, Mr. H. C. Robinson, of the Selangor Museum, records from the district where he is stationed that rare mammal the pen-tailed tree-shrew (*Ptilocercus lowei*), hitherto known only from Borneo.

THE flowering of bamboos, which a short time ago formed the subject of correspondence in NATURE, is discussed in a short article by Prof. F. A. Forel in the *Gazette de Lausanne* (August 1). In the spring a general flowering of the plants of *Bambusa gracilis*, a garden variety, took place at Morges, Canton Vaud, and flowering was observed at Nyon, Territet, Versoix, and Bex. The writer raises the questions whether the flowering is due to inherent causes or dependent upon climatic conditions, whether the seed produced is fertile, and whether all the plants die after flowering, and he requests that observations on these and similar points may be forwarded to him at the University of Lausanne.

WE have received the tenth volume of Dr. Otto Baschin's "Bibliotheca Geographica," dealing with the year 1901. The volume shows no specially new features, a certain advantage in publications of the kind, and it maintains the fulness and accuracy of its predecessors.

IN view of recent proposals to "utilise" Lake Titicaca, a paper on the basin of that lake, contributed by Mr. A. F. Bandelier to the August number of the Bulletin of the American Geographical Society, is of more than usual interest. Mr. J. Russell Smith publishes a paper on the economic importance of the plateaux in tropic America in the same number, which also contains a well illustrated mountaineering paper on the Alaskan Range by Mr. Alfred H. Brooks.

AN elaborate memoir on the commercial significance of the Suez Canal, by the late Herr Martin Voss, appears in the *Abhandlungen* of the Vienna Geographical Society. Herr Voss's paper contains much statistical and other information in small compass, and should be extremely useful, especially if studied in relation to Ungard's work on the same subject, recently published in Vienna. Herr W. Schjerning contributes to the same publication a paper on the equidistant projections used in cartography.

A DESCRIPTION of a new apparatus for demonstrating the elementary principles of mathematical geography is given by Dr. Hermann v. Graber in *Petermann's Mitteilungen*. The fundamental idea is the application of the orthogonal projection to the ordinary wire model or "tellurium," hence the name "orthogonal-tellurium." Besides being available for teaching purposes, the instrument affords the means of making angular measurements with sufficient accuracy to be of use for rough work in the field.

THE scorification assay for gold telluride ores has long been believed to give low results by reason of volatilisation, and it is now seldom used for ores of that class, the assay by crucible being supposed to be more trustworthy. The results of a careful investigation of the subject by Mr. W. F. Hillebrand and Mr. E. T. Allen, published in Bulletin No. 253 of the United States Geological Survey, show that the doubts entertained as to the accuracy of the dry method are not well founded. There is no reason to question the substantial accuracy of the crucible method. Indeed, it is clearly established that the fire assay by crucible for gold telluride ores gives results which are quite equal to those obtained by the wet way, provided due corrections are made for slag and cupel losses. The gold loss in the slag is very small, but the cupel losses are considerable, the cupellation loss of gold by volatilisation being small as compared with that by absorption.

THE Cripple Creek gold deposits in Colorado were discovered in 1891, and up to 1904 yielded 124,415,022 dollars of gold and 646,193 ounces of silver. The district was surveyed for the United States Geological Survey in 1894 by Messrs. W. Cross and R. A. F. Penrose, and at the request and at the cost of the State of Colorado it has now been re-surveyed by Messrs. W. Lindgren and F. L. Ransome, and a summary of the facts of immediate importance has been published (Bulletin No. 254). There are some 300 mines in the district, and every accessible one was examined. The deepest shaft is the Lillie, which is more than 1500 feet deep; and the productive district is covered by the area of a circle 3½ miles in diameter. An interesting feature of the ore-deposits is the occurrence of gas which in some cases issues in large volumes. Analysis shows it to consist of nitrogen, with about 20 per cent. of carbon dioxide and a small quantity of oxygen.

AT the St. Louis Exhibition last year an investigation of the coals and lignites of the United States was carried out under the direction of the director of the United States Geological Survey, the sum of 6000*l*. having been voted by Congress for the purpose. Testing machinery was generously contributed by various manufacturers, and much valuable work was done with the plant, such an elaborate series of coal analyses having never before been made in the United States. The preliminary report on the operations of the plant, drawn up by Messrs. E. W. Parker, J. A. Holmes, and M. R. Campbell, the committee in charge, has been issued as Bulletin No. 261 of the United States Geological Survey, and is of far-reaching importance in the solution of the fuel and power problems upon which the varied industries of the United States depend. Most of the American bituminous coals and lignites can, it was found, be used as a source of power in a gas-producing plant, the power efficiency of bituminous coals when thus used being 2½ times greater than their efficiency when used in a steam-boiler plant. Some of the lignites from undeveloped but extensive deposits in North Dakota and Texas showed unexpectedly high power-producing qualities. It was found, too, that some of the American coals and the slack produced in mining them could be made into briquettes on a commercial basis.

THE weather over the British Islands has been very unsettled during most part of the last week, rainfall being very prevalent generally; in the south of England and all the western districts the amount was much above the average. Strong gales occurred in many places, especially on the western and southern coasts, and the sea has been very rough at times. The Meteorological Office reports on Tuesday showed a considerable improvement, with clear sky over most parts of the kingdom, but a renewal of unsettled weather was anticipated in the western and northern districts. The rainfall from January 1 is still below the average in most districts, the deficiency amounting to about four inches in the north-east of England, but in the north of Scotland and Ireland the fall is considerably above the average.

THE assistant director of the Meteorological Service of Canada (Mr. B. C. Webber) has prepared a very useful paper entitled "The Gales from the Great Lakes to the Maritime Provinces." The tables show the number of areas of low barometric pressure, and gales, with information regarding them, for each month of thirty-one years (1874–1904). The results are published primarily for the use of the forecast officials in the Dominion, but they are valuable for reference by other persons. On the average, November is the stormiest month on the Great Lakes, and January in the Maritime Provinces; December and February also give a high percentage of storms. The diminution in the number of gales in March and September is opposed to the old idea of the stormy character of the periods of the equinoxes. The author states that the figures afford ample ground for suspicion that towards the maximum of sun-spots there is a maximum of low pressure areas, and that at the sun-spot minimum there is a paucity of such areas. The work has, of course, been prepared under the direction of Mr. R. F. Stupart, the director of the service.

WE have received the *Jahrbücher* of the Austrian Central Office for Meteorology and Terrestrial Magnetism for the year 1903; the work consists of two large quarto volumes, containing (1) carefully prepared results of 400 stations, and (2) special discussions, including an important contribution by M. Margueles on the energy of storms, being an elaborate mathematical analysis of that branch of the physics of the atmosphere; a discussion of much interest for weather prediction, by Dr. F. M. Exner, in connection with the behaviour of the weather during conditions of high atmospheric pressure to the north of the Alps, illustrated by a number of weather charts; also comprehensive researches relating to the formation and propagation of thunder and hail storms, by K. Prohaska. We have before directed attention to the value of the observations made at the high-level stations in the Austrian system; thirty-two of them have an altitude of 1000 to 1500 metres, fifteen others from 1500 to 2500 metres, and the Sonnblick 3106 metres. Meteorologists are much indebted to Dr. Pernter, the able director of the service, for the publication *in extenso* of the hourly results at some of these mountain stations.

MR. WM. BUTLER, of 20 Crosby Road, Southport, whose "swingcam" camera stand was referred to in NATURE of May 25 (p. 89), has sent us a series of twelve small prints of photographs of the recent partial eclipse taken by his son, who is only fifteen years of age, with the use of the apparatus. The pictures are clear, and show several phases of the partial eclipse very distinctly.

A LIST of scientific papers published by the National Physical Laboratory, or communicated by members of the staff to scientific societies or institutions, or to the technical journals, has just been issued. During 1900 and 1904, thirty-three papers on work connected with the laboratory were prepared and published by members of the staff, and in addition eleven papers were published by members of the staff independently.

MESSRS. MACMILLAN AND CO., LTD., will publish shortly "The Chemistry of the Proteids," by Dr. Gustav Mann, of the physiological laboratory at Oxford. This book is based upon the second edition of Dr. Cohnheim's "Chemie der Eiweisskörper," and has been prepared with the author's sanction. Dr. Cohnheim's work, which in its second edition has been entirely re-modelled, is of special interest to professional chemists, both organic and inorganic, but particularly to biologists, including zoologists, physiologists, and pathologists; while among the special features of Dr. Mann's book are, that for the first time the chemical derivatives of albumins and proteids are so arranged as to give a clear idea of the evolution from simple into more complex compounds, and for the first time also a very full account of the synthetic work of Curtius and Fischer is given.

OUR ASTRONOMICAL COLUMN.

NOVA AQUILÆ NO. 2.—Very little further news of Nova Aquilæ is yet to hand, but Circular No. 79 of the Kiel Centralstelle informs us that several visual observations of the star's magnitude and position have been made.

Prof. Max Wolf reports that, according to observations made at the Königstuhl Observatory on September 4, at 9h. 30·0m. (Königstuhl M.T.), the magnitude was 9·3. The position was determined as R.A. = 18h. 54m. 24s., dec. = −4° 39′ (1855).

A telephone message to Kiel from Dr. P. Guthnick on September 6 gave the following positions:—

1855. R.A. = 18h. 54m. 25s., decl. = −4° 38′·8
1905. ,, 18h. 57m. 4s., ,, −4° 34′·8

and stated that the magnitude on September 5 was about 10·2, whilst the star was of a yellowish colour. A star of magnitude 10·5 precedes the Nova by 10s., and is 0′·7 north of it. As the present Nova is the second known to have appeared in the constellation Aquila, it will be designated, according to precedent, Nova Aquilæ No. 2. The first Nova Aquilæ was discovered in July, 1900, on one of the Draper memorial chart plates which had been taken on July 3, 1899, and exhibited the characteristic "Nova" bright-line spectrum. The object itself was recorded for the first time, as a seventh magnitude star, on a plate taken on April 21, 1899.

VARIATION OF A NEWLY DISCOVERED ASTEROID.—According to a telegram from the Kiel Centralstelle, Dr. Palisa has found that the minor planet 1905 QY, which was discovered by Prof. Max Wolf on August 23, is subject to a remarkable fluctuation of magnitude. When discovered, this asteroid had a magnitude of 11·3, and on August 31 Dr. Palisa recorded it as being of the eleventh magnitude; at 11h. 44m. (Vienna M.T.) on September 5, however, it had sunk to the twelfth.

The position of this body at 11h. 39·9m. (Königstuhl M.T.) on August 23 was R.A. = 22h. 37·9m., dec. = $-7° 55'$, and on September 5d. 11h. 4·4m. (Vienna M.T.) R.A. = 22h. 27m. 47·3s., dec. = $-9° 5' 45''$.

INTERPRETATION OF SPECTROHELIOGRAPH PICTURES.—In No. 4044 of the *Astronomische Nachrichten,* M. N. Donitch discusses the results obtained by Messrs. Hale and Ellerman, regarding the different chromospheric layers shown on their spectroheliograph negatives, in a new light. He points out that in spectrograms of the chromosphere taken during total eclipses of the sun, the lower layers of the eruptions, *i.e.* those nearer to the moon's limb, appear to be the most extensive, but in Prof. Hale's photographs (plate v., No. 1, vol. xix., of the *Astrophysical Journal*) the opposite appears to be the case, the higher, less dense layers being more extensive than those near to the photosphere.

This discordance between the two results is, in the opinion of M. Donitch, only apparent, and may be explained by the suggestions he advances. He assumes that the inequalities on the surface of the photosphere are so small as to be incomparable with those in the layers of calcium vapour which overlay it. Where this vapour is thin it will only produce the ordinary narrow reversal, producing on the negative a calcium area which is at a low pressure, and, therefore, according to Messrs. Hale and Ellerman, is situated in the upper regions of the chromosphere. This same reversal is also shown by the vapours, which are, in reality, at a greater elevation, so that, using the monochromatic reversal, one obtains on the photograph the forms of the calcium clouds of which the temperature and pressure are relatively low, whatever may be their elevation above the photosphere. For this reason, as M. Donitch believes, the first photograph, which shows more extensive areas of calcium vapour, and according to the Yerkes observers represents simply the upper layers of the disturbed areas, really also represents the thinner extensive layers of vapour which are shown on eclipse spectrograms as the broad bases of the eruptions.

A second photograph taken with the secondary slit set on the *broadened* H reversal ($\lambda = 396{\cdot}2\ \mu\mu$) only registers those layers of calcium vapour which, being part of a thick layer, are subjected to a sufficient difference of temperature and pressure to produce the broadening; and these may, in many cases, be at a greater elevation than the thin layers shown as part of the "calcium" area on the first photograph.

Similarly in regard to the two photographs shown on plate viii. of Messrs. Hale and Ellerman's paper, M. Donitch believes that it is the second, taken with the secondary slit set at λ 3968·6, that reveals the general distribution of the vapours in projection, whereas the first only reproduces the higher agglomerations of the vapour which dominates the lower layer.

THE OBSERVATORY OF PARIS.—M. Lœwy's report for the year 1904 is far too lengthy to be reviewed as a whole in these columns, but one or two of the more important details may be mentioned. In his introduction, the director mentions the progress made during the year in the Eros campaign, and also indicates how the photographs of the moon, taken for the large atlas he is preparing, afford evidence that the moon, and, inferentially, the planets, solidified from the surface towards the centre.

M. Bigourdan has temporarily arrested his observations of nebulæ with the equatorial of the east tower in order that the dome and instrument may be prepared for the determination of the absolute constant of aberration by M. Lœwy's new method.

A study of the garden meridian circle showed that a difference of 0″·45 existed between the readings of the two circles. Various possible causes for this discrepancy were examined, and finally it was discovered that the method of illuminating the microscope wires was at fault. The microscopes have been replaced by others, and the difference thereby eliminated.

The astrophysical department is awaiting the arrival of apparatus before making celestial observations, but in the meantime M. Hamy has carried out several laboratory researches, the chief of which related to the constancy of wave-lengths in the solar spectrum. He found that when the temperature of cadmium vapour in a vacuum tube was raised about 15° C., in the neighbourhood of 300° C., the line at λ 508 diminished several units of the order of $1\ \mu \times 10^{-6}$, and he suggests that the variation of temperature in the solar atmosphere may produce similar results.

During 1904, 80 catalogue and 31 *carte* plates were obtained in connection with the *carte du ciel* operations, whilst 67 plates containing 16,656 star-images were measured.

AN ELECTRIC MICROMETER.[1]

THERE is no finality in experimental measurement. In physics it is a common experience for a present-day worker, with better appliances and a wider horizon than his forerunners, to surpass all previous experimental work in accuracy. As knowledge increases it becomes more minutely exact, and nowadays the physicist has often to measure lengths much less than anything visible in any microscope.

There are various means of measuring small distances. We will take them in order, commencing with the least sensitive:—(1) The unaided eye cannot perceive much less than 1/10 millimetre. (2) With the aid of the microscope the eye can see as little as 1/5000 millimetre. (3) The measuring machine used for engineering gauges will detect differences of 1/8000 millimetre. (4) By using interference bands of light we can perceive movements of 1/100,000 millimetre. (5) In the optical lever a beam of light falls on a pivoted mirror; if a body push the mirror at a point very near the axis of the pivot the beam of light is deflected by a large angle. By this means a movement of the body by 1/400,000 millimetre may be detected. (6) The most modern and sensitive method, the electric micrometer, is due to Dr. P. E. Shaw, who produced it in 1900, and has improved it until he can now measure less than 1/2,000,000 millimetre. The nucleus of the apparatus is shown in the figure. A fine screw M has a graduated head N. The screw in rising pushes up the long arm of a lever pivoted at B. The short arm of the lever falls, and in so doing lets down the long arm of a second lever. This process is carried on through six levers, which all rest under their own weight on the blocks shown. The last lever carries a measuring point P, just above which is a measuring surface Q. If the joint leverage of the lever system be 2000/1, an upward movement of the screw point M by 1/1000 millimetre produces an upward movement of P by 1/2,000,000 millimetre.

As a simple example, suppose we wish to find the thermal coefficient of expansion of the rod R, we proceed thus:—Bring P and Q into contact. The screw M is worked up, while a telephone (Tel.), in the electric circuit shown, is on the observer's head. When P touches Q a circuit is completed, and the telephone sounds. Read the graduated disc N. Now lower the temperature of R by any desired amount, taking care that little or no heat reaches the pillars F′ or any part but R. R contracts, and by working screw M up the observer causes P to touch Q again; the telephone sounds, and N is again read. The expansibility can thus be found, when we know the movement of P and the change in temperature.

The screw, the levers, and the frame F′ are all carried by a massive girder I. The whole is surrounded by a box thickly wrapped in felt to minimise temperature changes, and is suspended by long rubber cords from the ceiling, to insulate the measuring apparatus from vibration.

The screw M is not touched by hand, but is worked by a pulley cord of rubber which passes from a hand pulley round pulley O. This is done to avoid the comparatively rough touch and tremor of the hand. There are many precautions as to shape, size, cleanliness, and other matters which must be observed.

[1] Based upon a paper by Dr. P. E. Shaw read before the Royal Society.

The smallest measurements ever yet made, viz. 1/2,000,000 millimetre, were in connection with the movements of a telephone diaphragm. The problem was to find what movement of the diaphragm produces a sound which is only just audible.

This is done as follows:—Place a telephone to the ear and pass through it a steady current. On stopping the current a sharp sound is heard in the telephone. Alter the strength of the current until when it is stopped the sound can only just be heard. Observe on a galvanometer the strength of that current (C). Next put the telephone in the electric micrometer in place of the rod R, pass the current (C), and measure the movement of the diaphragm in the usual way. This movement then produces a sound in the telephone which is just audible.

Another use of the instrument is to measure the sparking distance between two surfaces, the potential difference of which is known. The surfaces used are P, Q in the figure. Suppose the potential difference between these surfaces is very small, say 1/1000 volt. Find the contact position as above, and draw P away from Q. Now make the potential difference between P and Q equal to 1 volt. On making P approach Q the contact position has changed by an amount D. Thus the sparking distance for 1 volt is D (supposing the spark distance for 1/1000 volt is negligible). This is found to be about 1/100,000 mm.

In problems on the constitution and molecular properties of matter there are obvious possibilities before this apparatus, for by it we can bring two surfaces of any hard metal to molecular distance (or less) from one another, and keep them there while any desired physical change is produced in the surfaces or in the medium surrounding them.

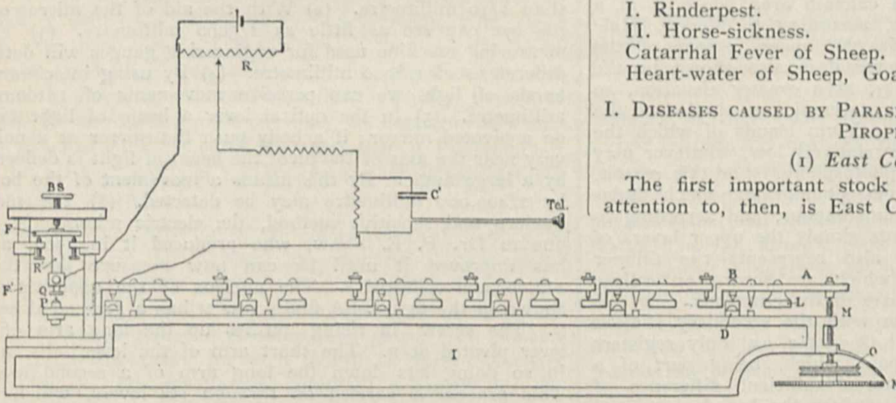


FIG. 1.—The Electric Micrometer.

THE BRITISH ASSOCIATION.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY COLONEL D. BRUCE, M.B., F.R.S., C.B., PRESIDENT OF THE SECTION.

The Advance in our Knowledge of the Causation and Methods of Prevention of Stock Diseases in South Africa during the last ten years.

TEN years ago, when I first came to South Africa, I was led to take an interest in the various great stock diseases which do so much damage and so retard the progress of South Africa as a stock-raising country. I thought, therefore, that a good subject for my address, in the centre of the foremost stock-raising Colony of South Africa, would be a review of the work done in advancing our knowledge, during the last ten years, of the causation and methods of prevention of stock diseases in South Africa. South Africa is particularly rich in animal diseases, every species of domestic animal seemingly having one or more specially adapted for its destruction. Now it is evident that, in an address of this kind, it will be impossible to take up every stock disease, but I think you will agree with me that those shown on this table are among the most important:—

East Coast Fever; ordinary Redwater or Texas Fever; Biliary Fever of Horses; Malignant Jaundice of Dogs; Nagana or Tsetse-fly Disease; Trypanosomiasis of Cattle; Rinderpest; Horse-sickness; Catarrhal Fever in Sheep; Heart-water of Sheep, Goats, and Cattle.

Now we may group these diseases in various ways; for example, as below, where they are divided into two main divisions: *A* division, in which the parasite is known; and *B* division, in which the parasite is unknown.

A. Parasite known.

I. Diseases caused by parasites belonging to the genus Piroplasma:—

(1) East Coast Fever (Koch), *P. parvum.*

(2) Redwater or Texas Fever, *P. bigeminum* (Theiler).

(3) Biliary Fever of Horses, Mules, and Donkeys, *P. equi.*

(4) Malignant Jaundice of Dogs, *P. canis.*

II. Diseases caused by parasites belonging to the genus Trypanosoma:—

(1) Nagana or Tsetse-fly Disease, *T. brucei* (Bradford and Plimmer).

(2) Trypanosomiasis of Cattle, *T. theileri* (Bruce).

B. Parasite unknown.

I. Rinderpest.

II. Horse-sickness.

Catarrhal Fever of Sheep.

Heart-water of Sheep, Goats and Cattle.

I. DISEASES CAUSED BY PARASITES BELONGING TO THE GENUS PIROPLASMA.

(1) *East Coast Fever.*

The first important stock disease I would direct your attention to, then, is East Coast Fever. This name was given to it by Prof. Robert Koch, of Berlin. In the Transvaal the disease is usually called Rhodesian Redwater. This term is not a good one, since the disease is not restricted to Rhodesia, nor did it arise there, nor is this a disease similar to the ordinary Redwater. Ten years ago, East Coast Fever was unknown in the Transvaal. The first known outbreak occurred only some three and a half years ago, when it broke out at Koomati and Neilspruit, in the Barberton district, and in the east of the Colony. The disease had broken out some time previously in Rhodesia, and the outbreaks in both Colonies were due to infection from Portuguese territory. Although this disease has only been introduced to the country during the last few years, it has already produced an enormous amount of damage among stock, and is probably the most dangerous disease that the people of the Transvaal have to cope with at the present time, and for some years to come.

In the Annual Report of the Transvaal Department of Agriculture there is a most excellent report by Mr. Stockman, the then Principal Veterinary Surgeon, on the work of the veterinary division for the year 1903–1904. A large part of this report is given up to East Coast Fever, and I must here express my indebtedness to Mr. Stockman for much of the following account of this disease. In the same Annual Report there is also an account by Dr. Theiler, the Veterinary Bacteriologist, of the experimental work. Messrs. Stockman and Theiler evidently worked together, and I must congratulate them on the immense amount of good, useful work done by them, and I would also congratulate the Government on having had the services of two such accomplished and energetic gentlemen during the late troublesome times. Unfortunately for the Transvaal, Mr. Stockman has accepted the post of Veterinary Adviser to the Board of Agriculture in England, but I have no doubt his successor, Mr. Gray, from Rhodesia, will continue the good work begun by him.

East Coast Fever was first studied by Prof. Koch at Dar-el-Salaam, in German East Africa, and he at first mistook it for ordinary Redwater. It seems to occur as an endemic disease along a great part of the East Coast of Africa, but appears to be restricted to a narrow belt along this coast-line. The cattle inhabiting this region have become immune to the disease, and are, therefore, not affected by it. Cattle passing through the Coast district to the interior, or brought to the Coast district from the interior, are apt to take the disease and die. It was by the importation of cattle, therefore, which had passed through the dangerous Coast district that the disease was introduced into Rhodesia and into the Transvaal. On this map which I throw on the screen I have marked out the probable endemic area of this disease, and in the next slide the present distribution of the disease in the Transvaal is also marked out.

Nature of the Disease.—This disease only attacks cattle, but in them is an exceedingly fatal malady: in every hundred cattle attacked only about five recover from the disease. The duration of the disease after the first symptoms have occurred is about ten days.

The cause of the disease is a minute blood parasite called the *Piroplasma parvum* (Theiler). This parasite lives in the interior of the red blood corpuscles.

I now throw on the screen a representation of the blood from a case of Rhodesian Redwater, magnified about a thousand times, showing these small piroplasmata in the interior of the red blood corpuscles. As in the case of so many of these blood diseases, the parasite causing it is carried from the sick to the healthy by means of a blood-sucking parasite. In this particular disease the tick which most commonly transfers the poison or living parasite from one animal to another is known as the "brown tick," *Rhipicephalus appendiculatus*. Koch supposed that the common "blue tick" was the agent. The credit belongs to Dr. Lounsbury and Dr. Theiler of having shown that it is chiefly the "brown tick" which acts as carrier; but Theiler has proved that *R. simus* is also able to transmit the disease. Without the intervention of a tick, so far as we know at present, it is quite impossible that the parasite of this disease can be transferred from one animal to another. For example, if we take a quantity of blood containing enormous numbers of these piroplasmata, and inject it into the blood circulation of a healthy animal, the latter does not take the disease. In the same way, if cattle affected by East Coast Fever are placed among healthy cattle in a part of the country where none of these "brown ticks" are found, the disease does not spread. It is evident, therefore, that some metamorphosis of the parasite must take place in the interior of the tick, and this new form of the parasite is introduced by the tick into a healthy animal,. and so produces the disease. In this particular disease the virus or infective agent is not transmitted through the egg of the tick, as is the case in some of these parasitic diseases, but only in the intermediate stages of the tick's development; that is to say, the larva which emerges from the egg of the tick is incapable of giving the disease. What happens is this. The larva creeps on to an infected animal and sucks some of its blood. It then drops off, lies among the roots of the grass, and passes through its first moult. The nympha, which is the name given to the creature after its first moult, is capable of transferring the disease to a healthy animal: that is to say, if it crawls on to a healthy animal and sucks blood from it, it at the same time infects this healthy animal with the germ of E.C.F. In the same way, if a nympha sucks infected blood from a sick animal, it is able, after it has moulted into the adult stage or imago, again to give rise to the disease if placed, or if it crawls, upon a healthy animal.

The Life-history of the Brown Tick.—I throw on the screen a slide representing the four stages of the life-history of the brown tick: The egg, the larva, the nympha, and the adult or imago. The eggs are laid on the surface of the ground by the adult females, which deposit several thousands at a time; and these hatch out naturally, if the weather is warm and damp, in twenty-eight days. But this period of incubation of the eggs may vary very greatly owing to differences in temperature. Immediately after the larva is born it crawls to the summit of a blade of grass or grass stem, and there awaits the passage of some animal. If an ox passes by and grazes on the grass, the tick at once crawls on to the animal, and, having secured a favourable position, starts to suck the ox's blood. It remains on the ox for some three or more days, when, having filled itself with blood, it drops off and lies among the grass. The first moult, under favourable conditions, takes twenty-one days, when the nympha emerges. In the same way the nympha crawls on to an animal and fills itself with blood. As a nympha it also remains on the animal for about three or four days. It again drops off into the grass, and at the end of eighteen days emerges from its second moult as the perfect adult male or female. The males and females again crawl on to an ox, where they mate. After this the female tick ingests a large quantity of blood, which is meant for the nourishment of the eggs, and again drops off, sometimes as early as the fourth day, into the surrounding grass. After about six days she lays her eggs in the ground, and the cycle begins again.

These ticks are very hardy, and in the intermediate stages can resist starvation for long periods, so that a larva or nympha or adult tick may remain perched at the end of a blade of grass for some months without finding an opportunity of transferring itself to a suitable animal. On this account it comes about that even if all infected cattle are removed from a field the ticks in that field will remain capable of transferring the infection to any healthy cattle which may be allowed into this field for a period of about a year. At the end of a year or fifteen months, however, the infective ticks are all dead, and clean cattle may be allowed into the field without any risk. If one takes these facts into consideration it will be seen that a single ox may spread this disease for a distance of some 200 miles, if trekking through the country at the average rate of ten miles a day. For example, an ox is infected by a tick; for fourteen days the animal remains apparently perfectly well; it has no signs of disease, nor has it any fever. It is capable of doing its ten miles' trek a day. At the end of fourteen days the temperature begins to rise, and the animal begins to sicken with the disease, but for the next six days the ox is, as a rule, able to do its ordinary day's march. During most of this time the brown ticks have been crawling on to this ox, becoming infected, and dropping off every three or four days. It can readily, therefore, be seen how much mischief a single infected animal can do to a country between the time of its being infected by the tick and its death some twenty-four days later. As a matter of experience, however, the disease has never been found to make a jump in this way of more than fifty or sixty miles, as, of course, it is very rare that a transport carrier will take his oxen more than that distance during the twenty days.

At the present time it may be said that there are about 500 infected farms in the Transvaal. During last year some 15,000 cattle have died of the disease, and in the affected districts it may be said that there are still some 30,000 cattle alive. When one considers the value of the cattle dead of this disease, which may be said to be about 200,000*l.*, it is evident that money spent on the scientific investigation of the causes and prevention of stock diseases is money well spent. I am informed that all the South African Governments are cutting down their estimates this year, and are inclined to reduce their veterinary staffs and the amounts devoted to research regarding animal diseases. Ladies and gentlemen, if this is so, I have no hesitation in saying that this is the maddest sort of economy and the shortest-sighted of policies.

Methods of combating the Disease.—During the last three years an immense amount of work has been done in the elucidation of this disease—how the animals are infected, how the poison is spread from the sick to the healthy, and so on. In 1903 Prof. Koch was asked by the South African Colonies to study this disease, in order to try to find some method of artificial inoculation or some other means of prevention. He did his work in Rhodesia, and especially directed his energies towards discovering some method of preventive inoculation. At first it was thought that he would be successful in this quest, as in his second report he announced that he had succeeded in producing a modified form of the disease by direct inoculation with the blood of sick and recovered animals. As you are all aware, the only method of conferring a useful immunity upon an animal is to make it pass through an attack of the disease itself, so modified as not to give rise to above a few deaths in every hundred inoculated. This is the method that has been employed in such diseases as Rinderpest, Anthrax, Pleuro-pneumonia, and many other diseases. The great difficulty in this disease in finding a method of preventive inoculation is the fact that the blood of an affected animal does not give rise to the disease in a healthy one when directly transferred under the skin of the latter. It is only after its passage through the body of the tick that the parasite is able to give rise to the disease in a healthy animal. It is evidently, on the face of it, difficult to so modify the parasite during its sojourn in the tick's body as to reduce its virulence to a sufficient degree.

Prof. Koch in his third and fourth reports recommended that cattle should be immunised by weekly or fortnightly inoculations of blood from recovered animals, extending over a period of five months. Even though this method of Koch had given the desired result, viz. that it rendered the inoculated cattle immune to the disease, it is evident that the method itself can hardly be made a practicable one on a large scale in the field. The expense and trouble of inoculating cattle on twenty different occasions would be very great. It is apparent now that Prof. Koch fell into error through mixing up East Coast Fever with ordinary Redwater. His plan of preventive inoculation was, however, tried on a large scale in Rhodesia by Mr. Gray, now the P.V.S., Transvaal, and found to be useless. At present, therefore, we must look to some other means of preventing the disease and driving it out of the country than preventive inoculation.

Dipping.—Much can be done to prevent the spread of this disease by ordinary methods. For example: in the case of Texas Fever in Queensland dipping cattle in solutions of arsenic or paraffin, in order to destroy the ticks, has met with very fair success; but in the case of this disease we cannot expect to get as good results as in the case of Redwater. The species of tick which conveys Texas Fever remains on the same animal through all its moults, instead of falling to the ground between each different one. If it is not possible to spray or dip cattle oftener than once in ten or fifteen days, it is evident that ticks may crawl upon such animals, become infected, and drop off every three or four days, and so escape destruction by the dipping solution. At the same time every infected tick that is killed by spraying or dipping operations is a source of infection destroyed.

Fencing of Farms.—Again, the fencing of farms must also be useful in the same direction. As the ticks do not travel to any extent when they fall among the grass, it is evident that the cattle on a clean farm which is properly fenced will not become infected by this disease, although all the country round about should be infected. This fencing of farms and subdividing the farm itself into several portions is a most important factor in the prevention of contagious diseases amongst stock. It is, of course, impossible that this can be done at once, as the expense would be prohibitive.

Moving Cattle from Infected Pasture to Clean Pasture.—From a study of this disease and a study of the life-history of the tick it is evident that by a combination of dipping or spraying the cattle so as to destroy almost all the ticks, slaughtering the sick, and moving the apparently healthy on to clean veld—and repeating this, if necessary, a second or third time—it is obvious that by these means, if circumstances are favourable, an outbreak of this disease may be nipped in the bud without much loss to the stock.

Stamping out the Disease.—In May, 1904, an inter-Colonial Conference held at Cape Town resolved that the only effective method of eradicating East Coast Fever is to kill off all the cattle in the infected areas, and to leave such areas free of cattle for some eighteen months. By this means all the centres of infection would be destroyed, and at the end of eighteen months, as all the infected ticks would be dead, it is evident that the disease would be completely stamped out. There is no doubt that this drastic method would be the quickest and most complete one of getting rid of this extremely harassing disease. If compensation were given, it could be done at a cost of, say, a quarter of a million. The Government decided, however, that on account of the difficulty of carrying out such a drastic scheme another policy had to be considered. This policy provides for the fencing-in of infected farms, places, lands, or roads, on generous terms; the compulsory slaughter of stock with compensation in the case of isolated outbreaks; the removal of all oxen from infected or suspected farms; and, lastly, the stabling of milch cows in infected areas. It is quite evident that under this less drastic policy the final stamping-out of the disease will be a much slower process than if the more drastic scheme of compulsory slaughter of all cattle on infected areas had been carried out. The benefits, however, from the modified scheme are undoubted; and if carried out thoroughly and intelligently for a period of several years will probably result in the stamping-out of the disease.

Allow me to sum up in regard to the advance in our knowledge of this important stock disease during the last ten years. Ten years ago nothing was known. Now the causation of the disease has been made out very fully; the parasite that causes it is known; the ticks which carry the infection are known. Although no method of conferring immunity on healthy cattle has been found out, or any medicinal treatment discovered which will cure the sick animal, yet our knowledge of the life-history of the parasite and the ticks enables regulations to be framed which, if patiently carried out, must be crowned with success.

(2) *Redwater or Texas Fever.*

I may dismiss this disease in a few words. It is a most interesting disease and of great importance to stock farmers. It only affects cattle.

Geographical Distribution.—It is a disease found in almost every part of the world. It was first studied in North America; hence the name Texas Fever. To Kilborne and Smith is due the honour of elucidating the causation of this disease, and their work forms one of the most interesting chapters in the history of pathological science. They discovered that it was caused by the presence in the red blood corpuscles of a protozoal parasite closely related to the parasite found in E.C.F.—the *Piroplasma parvum.* This organism is called *Piroplasma bigeminum.* They further discovered that this parasite was conveyed from sick to healthy cattle by means of a tick. They also showed that the cattle born and bred in certain southern districts are immune to the disease, whereas cattle in the northern districts are susceptible. Hence, if southern cattle were driven into the northern district, they gave rise to a fatal disease among the northern cattle; and, *vice versâ*, if the susceptible northern cattle were driven into the southern district among the apparently healthy cattle of that district, they took Texas Fever and died.

Texas Fever was introduced about 1870, and is now endemic throughout most of South Africa. For many years the native cattle have been immune to the disease; that is to say, on account of being born and bred in a Texas Fever locality they had inherited a degree of resistance to the disease which enabled them to pass through an attack when they were young, and so they became immune. But there is one peculiarity about Texas Fever which does not occur in Rhodesian Tick Fever, and that is that the blood of an animal which has recovered from Texas Fever remains infective—the germs remain latent—and so the native cattle of South Africa, although apparently healthy, are capable of infecting imported susceptible cattle with this very fatal malady. This is what makes it so difficult to import prize stock into this country.

When the Boers visited Mooi River, at the beginning of the war, they found a prize short-horn carefully stabled in Mr. P. D. Simmon's farm. They killed most of his stock for food, but left this short-horn bull alive. When they left the farm they turned this bull into the nearest field, in order, of course, that it might procure food. They had much better have eaten it. It promptly took Texas Fever and died.

This disease, then, has become of secondary importance to South Africa in these days. The native cattle have become naturally immune, and the disease is only fatal to susceptible imported cattle. This, of course, discourages the importation of prize stock; but with the knowledge we possess it ought to be possible, by good stabling and prevention of contact with tick-infected cattle, to keep the prize stock alive for a reasonable time. The question of the feasibility of immunising the prize stock while calves in England might be considered.

In regard to methods of conferring immunity on susceptible cattle many have been tried, but none are absolutely free from risk.

We may sum up in regard to Redwater or Texas Fever by saying that our knowledge of its causation and methods of prevention is much the same as it was ten years ago. The work done by Smith and Kilborne on this disease was of such a brilliant nature, and was done so thoroughly, that little has been left for later workers to do.

(3) *Biliary Fever of Horses, Mules, and Donkeys.*

This is a disease of horses, mules and donkeys very similar to Redwater in cattle, and is caused by a closely allied parasite, the *Piroplasma equi*, discovered for the first time in South Africa by Bordet, Danysz, and Theiler, and named by Laveran of Paris.

It is similar to Redwater, in that animals which have recovered from the disease remain a source of infection during the remainder of their lives to susceptible animals. The native South African horse is, like the cattle, immune to the disease. It is also conveyed by a tick, which has been shown by Theiler to be the "red tick" (*Rhipicephalus evertsi*), the infection being taken in the nymphal and transferred in the adult stage. Theiler has also made the very important observation that if a horse is injected with blood from a donkey which has recovered from the disease, as a rule a mild form of the disease is produced, so that this opens up a method of immunising susceptible horses which may probably prove of practical value. Theiler has also made another curious discovery. This disease of horses was found to greatly complicate certain immunising experiments he was making against Horse-sickness. He found he was introducing the *Piroplasma equi* at the same time he injected Horse-sickness virus. But he found out that as the virus of Horse-sickness keeps its virulence for years, whilst the *Piroplasma equi* dies out in a short time, this danger could be avoided by keeping the Horse-sickness serum and virus for some time before using it.

(4) *Malignant Jaundice of Dogs.*

This disease is most important to sportsmen or to importers of valuable dogs, as most of these are attacked sooner or later by this disease, and most of them succumb. It is also caused by a species of Piroplasma (*Piroplasma canis*), and is spread by the dog tick (*Haemophysalis leachii*).

Like Redwater and Biliary Fever, the blood of dogs which have recovered remains infective.

The story of the tick infection is a curious one, and the credit of its discovery is due to Lounsbury. It is only in the adult stage that the tick is capable of producing the disease. It is therefore evident that the Piroplasma must remain latent in the egg, the larval and nymphal stages, and only attain activity in the adult stage.

According to Theiler there exists a peculiar phenomenon which may be made use of to confer immunity. The blood of a dog which has recovered from this disease and has been hyper-immunised is, as mentioned above, capable of giving rise to the disease in a susceptible dog. Now, if serum be obtained from this blood and a quantity added to a small amount of the blood, this infected blood loses its infectivity and no disease results.

II. DISEASES CAUSED BY PARASITES BELONGING TO THE GENUS TRYPANOSOMA.

(1) *Nagana or Tsetse-fly Disease.*

We now come to the second group of diseases. These are also caused by blood parasites belonging to the same class of living things as the Piroplasma, but which are free organisms, swimming in the fluid part of the blood, and not contained in the red blood corpuscles, as are the others.

The first of this group I would direct your attention to is that disease called *Nagana* or the *Tsetse-fly Disease.*

This fly renders thousands of square miles of Africa uninhabitable. No horses, cattle, or dogs can venture, even for a day, into the so-called "Fly Country." Now what was our knowledge of this disease ten years ago? At that time it was thought that the tsetse-fly killed animals by injecting a poison into them, in the same way as a snake kills its prey. Nothing was known as to the nature of this poison in 1894. In 1895, on account of serious losses among the native cattle in Zululand from this plague, the then Governor of Natal and Zululand, Sir Walter Hely-Hutchinson, started the investigation of this disease. The result of this investigation was the discovery that Tsetse-fly Disease was not caused by a simple poison elaborated by the fly, as formerly believed, but that the cause of the disease was a minute blood parasite which gained entrance to the blood of the animals. This parasite is known by the name Trypanosoma, which signifies a screw-like body.

Ten years ago two species only had attracted much attention—one living in the blood of healthy rats, discovered by Surgeon-Major Lewis in India; and the other, a trypanosome, found in the blood of horses and mules suffering from a disease known in India as "Surra." As the result of this investigation in Zululand, which lasted two years, it was proved that this trypanosome was undoubtedly the cause of the death of the horses and cattle struck by the fly, and that the tsetse-fly merely acted as a carrier of this blood parasite.

Here is a representation of the trypanosome of Nagana on the screen. These trypanosomes consist of a single cell; are sinuous, worm-like creatures, provided with a macronucleus and a micronucleus, a long terminal flagellum, and a narrow fin-like membrane continuous with the flagellum and running the whole length of the body. When alive they are extremely rapid in their movements, constantly dashing about, and lashing the red blood corpuscles into motion with their flagellum. They swim equally well with either extremity in front. These organisms multiply in the blood by simple longitudinal division, and often become so numerous as to number several millions in every drop of blood. They are sucked, along with the blood, into the stomach of the fly, live and multiply in the alimentary tract for several days, and, when the fly has its next feed on an animal, take the opportunity of gaining access to the blood of the new host, and so set up the disease.

Let me now throw on the screen a representation of the tsetse-fly (*Glossina morsitans*) which does all the mischief. Experiments were made which showed that the fly could convey the parasite from affected to healthy animals for at least forty-eight hours. It is a curious fact that among all the blood-sucking flies the tsetse-fly alone has this power, and up to the present the cause of this has not been thoroughly cleared up. Lately, however, evidence has been brought forward to show that an enormous multiplication and development of the trypanosomes take place in the fly's intestine, a few trypanosomes multiplying to masses containing numberless parasites within twenty-four hours. Now, if this multiplication only takes place in the intestine of the tsetse-fly, and not in the other kinds of biting flies, this would probably account for the curious connection between the tsetse-fly and the disease. This multiplication of the trypanosomes in the tsetse-fly was discovered by Gray and Tulloch, two young army medical officers, while working in Uganda on "Sleeping Sickness" during the present year.

Not only was it found that the tsetse-flies could convey the disease from sick to healthy animals, but it was also proved that the wild tsetse-flies brought from the "Fly Country" and straightway placed on healthy animals also gave rise to the disease. The question then arose as to where the tsetse-flies living in the "Fly Country" came by the trypanosomes. There were no sick horses or cattle in the "Fly Country." Investigation brought to light the curious fact that most of the wild animals—the buffalo, the koodoo, the wildebeeste—carried the trypanosomes in small numbers in their blood, and it was from them that the fly obtained the parasite. The wild animals act as a reservoir of the disease. The trypanosome seems to live in the blood of the wild animals without doing them any harm, just as the rat trypanosome lives in the blood of healthy rats; but when introduced into the blood of such domestic animals as the horse, the dog, or ox it gives rise to a rapidly fatal disease. The discovery that the wild animals act as a reservoir of the disease accounted for the curious fact that Tsetse-fly Disease disappears from a tract of country as soon as the wild animals are killed off or driven away.

In 1895 the living trypanosome which causes the Tsetse-fly Disease was sent to England in the blood of living dogs, in order that it might be studied in the English laboratories. These trypanosomes have been kept alive ever since by passage from animal to animal, and have been sent all over Europe and America, so that our knowledge of this kind of blood parasite has rapidly grown.

Koch, in a recent address, says that our knowledge of protozoal diseases is based on three great discoveries—that of the malarial parasite, by Laveran; of the *Piroplasma bigeminum*, the cause of Texas Fever or Red-water in cattle, by Smith; and, lastly, this discovery of a trypanosome in Tsetse-fly Disease.

We may, therefore, I think, congratulate ourselves on the growth of our knowledge of this great stock disease during the last ten years.

Since 1895 many other trypanosome diseases have been discovered in all parts of the world. The latest and most important of these is one which affects human beings, and is known as "Sleeping Sickness." This "Sleeping Sickness," which occurs on the West Coast of Africa, particularly in the basin of the Congo, has within the last few years spread eastward into Uganda, has already swept off some hundreds of thousands of victims, is spreading down the Nile, has spread all round the shores of Lake Victoria, and is still spreading southward round Lakes Albert and Albert Edward. This disease is in all respects similar to the Nagana or Tsetse-fly Disease of South Africa, except that it is caused by another species of trypanosome and carried from the sick to the healthy by means of another species of tsetse-fly—viz. the *Glossina palpalis*.

I now throw on the screen a map of Africa, showing, so far as is known up to the present, the various fly districts, and you will see from this map that it is not at all improbable that this human Tsetse-fly Disease may spread southward through the various fly districts to the Zambesi, and may even penetrate as far as the fly districts of the Transvaal and Zululand.

I am sorry to say that, in spite of innumerable experiments directed towards the discovery of some method of vaccination or inoculation against these trypanosome diseases, nothing definite, up to the present time, has been discovered. At present there does not seem to be any likelihood that a serum can be prepared which will render animals immune to the Tsetse-fly Disease. In the same way it has also been found impossible, up to the present, to so modify the virulence of the trypanosome as to give rise to a modified, non-fatal form of the disease. Again, all attempts at discovering a medicine or drug which will have the power of killing off the parasites within the animal organism, without at the same time killing the animal itself, have not as yet been successful, although some drugs, such as arsenic and certain aniline dyes (Ehrlich), have a very marked effect in prolonging the life of the animal. As this disease is fatal to almost every domestic animal it attacks, it seems very improbable that there is much chance of cultivating an immune race of horses, dogs, or cattle which will be able to withstand the action of the parasite. It is quite evident that if an acquired immunity of this kind could be brought about, such a race of immune animals would now be found; but, as a matter of fact, there are no horses, dogs, or cattle in the "Fly Country." In other protozoal diseases, such as the Piroplasmata, this acquired immunity seems to come about fairly readily.

To sum up, then, the increase in our knowledge of Tsetse-fly Disease during the last ten years, we may say that we have discovered the cause in the shape of the small blood parasite Trypanosoma; we have found that the reservoir of the disease exists in the wild animals, and that we can blot out this disease from any particular tract of country by the simple expedient of destroying or driving away the wild animals. We still have no means of preventive inoculation or successful medicinal treatment in this disease.

(2) *Trypanosomiasis of Cattle.*

This disease seems to be widespread over all South Africa. It cannot be said to be of much practical importance, as the cattle infected do not seem to be seriously affected by it. It is caused by a species of trypanosome remarkable for its large size, which was discovered by Dr. Theiler some years ago, and named *T. theileri*.

Dr. Theiler states that it is conveyed from animal to animal by the common horse-fly, *Hippobosca rufipes*.

This, then, is a short account of the trypanosome diseases which affect South Africa.

Of late years the Tsetse-fly Disease has become of less practical importance to the Transvaal, from which it has practically disappeared. This is due to the disappearance of the game, killed off by Rinderpest; but with the preservation and restoration of the reserves with big game the disease is certain to reappear. Why the fly should disappear with the game is not known.

B. Parasite unknown.

I. *Rinderpest.*

We now turn our attention to the important diseases of the second group. In these the parasites causing them are unknown—that is to say, no parasites can be detected by the microscope or by culture—but it is equally true that they must be present in the blood and fluids of the sick animals in some form or other. In all probability they are ultra-microscopic—too small to be seen with our present instruments. This is borne out by the fact that they are able to pass through the pores of porcelain filters, which keep back the smallest micro-organisms we are able to recognise.

The first of the second group of diseases is Rinderpest, which has overrun and devastated South Africa within the last ten years.

Rinderpest has been known from time immemorial in Europe and Central Asia, and is an exceedingly fatal disease, killing 90 to 100 per cent. of the cattle attacked.

The recent epidemic, according to some, originated in the Nile provinces, and slowly crept southwards, reaching the Transvaal in 1896, after a journey lasting some fifteen years. Great efforts were made to oppose its passage, but nothing seemed to avail. In parts of the country where there were few or no cattle the epidemic spread by means of the wild animals—particularly the buffalo—which have been exterminated in many places.

Ten years ago the symptoms and contagious nature of this disease were well known, but nothing was known as to methods of prevention, and it is to the investigation of this epidemic in South Africa that the discovery of practical methods of immunising cattle, and in this way of stamping out the disease, is due.

As soon as it was apparent that the epidemic was spreading into South Africa, all the Colonies made strenuous efforts to combat it. The Transvaal Government invoked the aid of the Pasteur Institute, and Messrs. Bordet and Danysz were sent out to discover some method of prevention. They worked near Pretoria, and were assisted by Dr. Theiler, then the Principal Veterinary Surgeon. Before they arrived on the scene the Natal Government had dispatched Mr. Watkins-Pitchford, their Principal Veterinary Surgeon, to the Transvaal, where he also at first had Dr. Theiler as his colleague, and where he did some good pioneer work in the serum therapeutics of the disease. In the Cape Colony Dr. Hutcheon, the Principal Veterinary Surgeon, and Dr. Edington, the Government bacteriologist, were no less active. It is, however, to Prof. Robert Koch, of Berlin, that the honour is undoubtedly due of first publishing a practical method of immunising cattle against Rinderpest. He arrived at Kimberley on December 5, 1896, and in the incredibly short space of time of two months was able to report two methods of immunising, viz. by the injection of Rinderpest bile, and, secondly, by the injection of serum from immune animals. I have always thought that the discovery that the injection of bile taken from an animal dead of Rinderpest rendered cattle immune was particularly brilliant. Up to that time no one had dreamt that bile could possess such a quality. It is true that both Transvaal and Orange Free State Boers are said to have used a mixture of bile and blood from dead animals before Koch's researches, and also that Semmer in 1893 showed that serum might be used for protective purposes; but still to Koch is due the credit of making these processes practical. After he left South Africa his work was continued by Kolle and Turner, who greatly improved the methods; and it is to them, and to the other workers mentioned above, that we owe the fact that Rinderpest has now lost its terrors.

In the last recrudescence of this disease in the Transvaal, in 1904, Mr. Stewart Stockman, the Principal Veterinary Surgeon, and Dr. Theiler, thanks to the experience and knowledge gained during the last ten years, were enabled to stamp out the disease rapidly and completely. It is to them also that we owe our knowledge of the dangers of the intensive method of inoculation, much used in the past and due to Kolle and Turner, and the introduction of the fighting against the plague by the inoculation of the healthy cattle by injections of immune serum alone.

In the Tsetse-fly Disease our advance in knowledge has been in regard to the causation of the disease, and not in its prevention; it is quite otherwise with Rinderpest. The contagion or cause of Rinderpest is absolutely unknown. We know it exists in the blood, nasal, mucous, and other secretions of the sick animal, as all these are infective, but no one has seen it. The smallest quantity of blood will give the disease if injected under the skin of a healthy animal. We also know that the contagium is not very resistant. Blood soon loses its virulence after it leaves the body, and the effect of drying or the addition of chemical preservatives, such as glycerin, act also injuriously to the contagium, whatever it may be. It evidently belongs to the ultra-visible sort of micro-organisms, as it is said to pass through a porcelain filter.

How the contagium passes from the sick to the healthy is assumed to be by contact. No experiments have, so far as I am aware, been made as to whether it is conveyed by insects as well; but, as Prof. John MacFadyean says, as it spreads in all countries and climates and seasons, and the contagium is easily carried on the persons or clothes of human beings, it is improbable that insects have anything to do with it.

It is in the methods of protective inoculation that the great advance has been made in our knowledge of this disease. Ten years ago no means were available to stay the progress of this plague; now it has lost its terrors. As soon as it appears it can be immediately attacked and stamped out. This is done by rendering the surrounding cattle immune to the disease by injecting immune serum. This serum is prepared by taking immune cattle and hyper-immunising them by the injection of large quantities of virulent blood, so as to make their blood serum as anti-toxic as possible. If there are no immune cattle at hand, cattle can be immunised by Koch's bile injection method and then hyper-immunised; but, of course, in practice—for example, here in the Transvaal—large quantities of immune serum are kept ready for emergencies, and a herd of immune cattle kept up for the supply of the serum. This satisfactory state of affairs, so far as this disease is concerned, is, of course, the outcome of an immense amount of thought and experiment, and I have already mentioned the chief scientific men to whom this country owes this great boon.

Different methods of immunising have been tried during these years. Up to 1903 the prevailing custom was to use what was known as the virulent-blood and serum method. That is to say, immune serum and virulent blood were injected at the same time, in order that the animal might pass through a modified attack of the disease. Since 1903, however, in the Transvaal this method has been stopped, and the "serum alone" method introduced. This method is based on the fact that the virus of Rinderpest does not retain its infective property outside the body for more than a day or two; that it dies out in the animal, as a rule, in fourteen days, but in chronic cases only after thirty days, and that therefore the healthy cattle in an affected herd must be protected for this length of time. Now "serum alone" only protects for about ten days, and therefore the cattle must be inoculated three times at intervals of ten days. The doses of serum must also be large—from 50 c.c. to 200 c.c.—so that this method of stamping out Rinderpest, although quite efficacious, entails a good deal of labour. It is necessary, then, to spare no expense in making the Veterinary Department efficient, and any cheese-paring legislation in this direction may be disastrous.

II. *Horse-sickness.*

The next stock plague I would bring before your notice is Horse-sickness. This is a disease which only affects equines—the horse, mule, and rarely the donkey. It is a very fatal disease, carrying off thousands of horses every year. It is one of the most important diseases in South Africa, and, if it could be coped with, would enable the Transvaal to become one of the best horse-breeding countries in the world. At present it is dangerous for anyone in Natal and many parts of the Transvaal to possess a valuable horse, the chances of losing it by Horse-sickness being so great.

In 1895, when I went to the north of Zululand with the Ingwavuma Expedition, we lost all our horses with this disease. We started with a hundred horses, and had to march back on foot, every horse having died.

Ten years ago, when I arrived in South Africa, our knowledge of this disease was confined to the disease itself; nothing was known as to its causation or prevention. Credit is due to Dr. Edington for having accurately described the lesions and shown its ready inoculability, period of incubation, &c. He, however, fell into the mistake of attributing its causation to a species of mould fungus.

Etiology: Geographical Distribution.—Horse-sickness is widely distributed throughout Africa. It is common in Natal, Zululand, the greater part of the Transvaal, Rhodesia, Bechuanaland, and Portuguese East Africa. In Cape Colony it occurs in epidemics, with intervals of ten to twenty years. It is undoubtedly a disease which prevails chiefly *in low-lying localities* and valleys, and is but rarely met with in elevated exposed positions. It, however, is met with now and then in river valleys up to an elevation of some thousands of feet. *Season* has also a remarkable influence on its development, being exceedingly common in summer and disappearing on the appearance of the first frosts of winter.

Ten years ago various theories were held as to the cause of this disease. Some people thought that it was due to eating poisonous herbs; others, to some peculiarity or state of the night atmosphere; others, to eating grass covered with dew; and still others, to the eating of the spiders' webs which may be seen on the grass in the morning. It was known at that time not to be contagious in the ordinary sense of that term; that is to say, a horse could be stabled alongside a case of Horse-sickness without incurring the disease, or a horse might be placed without danger in the same stall in which a horse had recently died of Horse-sickness.

Nature of the Disease.—A horse which has been exposed to infection shows no signs of the disease for about a week. Its temperature then goes up rapidly, and it dies after four or five days' illness. Very often the horse appears perfectly well until within a few hours of death. For example, my horse was the last one to die on the Ingwavuma Expedition. On the day of his death I rode him until noon without noticing anything amiss. He then became rather dull in his movements, and I handed him over to the groom to lead. He died that evening immediately after we got into camp. It is, therefore, a very rapidly fatal disease, and almost every horse which is attacked by it succumbs. I have never seen a case of Horse-sickness which had been brought on by artificial inoculation recover. But there can be no doubt that a small percentage of horses infected naturally do recover, and these recovered horses are, more or less, immune in future to the disease. There is no necessity for me to describe the symptoms of this well-known disease, as everyone who has to do with horses in South Africa is perfectly familiar with it, and everyone has seen dead horses with the characteristic mass of white foam issuing from their nostrils, due to the effusion of the liquid part of the blood into the lungs and trachea.

Nature of the Virus which causes this Disease.—There can be no doubt that this disease, like the Tsetse-fly Disease, is caused by some form of blood parasite. A small quantity of fluid taken from any part of a horse suffering from Horse-sickness is capable of giving rise to the disease if injected under the skin of a healthy horse. For example: the thousandth part of a drop of blood from a sick horse will, in many cases, give rise to the disease if injected under the skin of a healthy horse. It must be admitted, however, that some horses require a larger dose than others, but it may be said that no horse has yet been found to withstand more than a comparatively small quantity of infective blood thrown under the skin. Now, although every drop of blood must contain many of the organisms of this disease, yet the most careful examination of such blood under the highest powers of the microscope reveals nothing. Again, if we filter Horse-sickness blood through a porcelain filter—a filter which is capable of keeping back all the known visible micro-organisms—the filtrate is found to be virulent. It is evident, then, that we are here dealing with a blood parasite so small in size as to be absolutely invisible to the highest powers of the microscope, and also so minute as to readily pass through the pores of a Chamberland filter. What the nature of this parasite is one cannot tell. It behaves in many curious ways. For example, Horse-sickness blood which is simply dried and pounded into powder is found to be perfectly inert. On the other hand, blood kept in the moist condition remains virulent and capable of giving rise to the disease for years. Or, again, the germ of Horse-sickness is so resistant to external agencies that if, as described by MacFadyean, a part of the liver of a horse dead from Horse-sickness be buried in the ground and subjected to putrefaction, it is found that the liver tissue retains its infectivity for months. Although a very small quantity of blood introduced under the skin of a horse will almost certainly give rise to the disease, it is quite different if the blood is introduced into the stomach. In the latter case a small quantity of blood has no effect, and the horse requires to be drenched with a pint or more before the disease can be given in this way.

The question now arises as to how horses are infected by this disease in Nature. On account of the small quantity of blood which will give rise to the disease if injected under the skin, and the large quantity required before the disease can be conveyed through the stomach, for a long time it has been supposed that it must be conveyed from sick to healthy horses by means of some biting insect. Experiments have been made within the last few years by Watkins-Pitchford and others in order to clear up this aspect of the question. Horses have been placed in fly-proof shelters in exceedingly unhealthy places, and it was found that in no case did any of these protected horses incur the disease; whereas horses allowed to feed in the same place, but without any shelter, soon succumbed to the disease. But, up to the present, so far as I am aware, the particular biting fly, mosquito, or other insect which is the carrier of this disease has not been discovered, and there can be no doubt that one of the most important facts to make out in the etiology of this disease is the discovery of the particular insect which conveys the disease from the sick to the healthy. By this discovery a flood of light may be thrown on the causation of the disease, and some means discovered of combating the disease through the insect, as has been successful in some instances in regard to the case of human malaria.

Prof. MacFadyean also suggests that experiments are needed to show what is the "reservoir" of the virus.

Prevention.—Although we have been unfortunate up to the present in not being able to make out the exact nature of the parasitic cause of this disease, or to discover the exact insect which carries it, a large amount of patient persevering work has been done within the last ten years in regard to its prevention by protective inoculation.

In this important work Bordet, Edington, Koch, Theiler, Watkins-Pitchford, and others have laboured for many years, and, according to recent reports, with some measure of success.

Dr. Edington, for example, who has been working at this problem for several years, reports that Heart-water is identical with Horse-sickness, and that by inoculating mules with Heart-water blood he has been able to salt them against Horse-sickness. He says that experiments testing this vaccine show it to be an ideal one. It gives a high protection to the animals inoculated. Its keeping powers are excellent. No animal has died as the result of this inoculation nor has any dangerous symptom been produced. He states that he is not in a position to supply a vaccine for Horse-sickness in horses, but has every hope of attaining this successful end very shortly.

We must congratulate Dr. Edington on his results, and trust that this method of conferring immunity may prove itself to be successful when put to practical use. For my part, I am somewhat sceptical of Dr. Edington's methods of immunising against Horse-sickness. I am sure he will forgive my expression of scepticism when I recall to his memory the various methods he has already brought forward, just as optimistically, which have all been tried and found wanting.

Dr. Koch has lately recommended a method of immunisation against Horse-sickness. This is the artificial establishment of an active immunity in susceptible animals by gradually increased doses of virulent blood, alternated in the early stages of treatment with the injection of serum prepared from the blood of highly fortified salted horses. Mr. Gray reports that the experiments already conducted on these lines show that the process as laid down by Koch requires important modification before the process of establishing immunity against Horse-sickness can be of any practical use.

Mr. Watkins-Pitchford in Natal is also hopeful of succeeding in producing immunity against Horse-sickness.

Dr. Theiler, too, reports that he has succeeded in producing a serum which can be utilised in connection with virulent blood to confer active immunity. He informs me that his method is a subcutaneous injection of serum and an intra-jugular injection of virus carried out simultaneously. The death rate in mules, from the effect of the inoculation, he states to be about 5 per cent. It is higher in horses, but he expects shortly to attain the same result in them. During the last Horse-sickness season he exposed 200 immunised mules to natural infection in various parts of the country. Of that number only one died with symptoms of Horse-sickness. As Dr. Theiler is himself communicating his method in detail to the Association, I need not enter more fully into it.

The man who discovers a practical method of dealing with Horse-sickness will be one of the greatest benefactors of this country. There has always been a tradition that a large money reward is awaiting this discovery. I do not know whether this is well founded or not, but certainly such a work would well deserve the highest possible reward. The best reward is to give the successful investigator more opportunity and more assistance in pursuing his beneficent work. The reward given by the French people to Pasteur was the Pasteur Institute; by the German Government to Koch, the Imperial Hygienic Institution.

Catarrhal Fever of Sheep: Blue Tongue.

This disease was first described by Hutcheon, the Chief Veterinary Surgeon of Cape Colony.[1] It is very similar in many respects to Horse-sickness. Both these diseases occur most often in low-lying, damp situations, such as river valleys and the coast plain. They also occur at the same time of the year; that is, from January to April. Blue Tongue, like Horse-sickness, is probably carried from the sick to the healthy by means of some night-feeding insect. At the same time the diseases are not identical, since the inoculation of Horse-sickness blood into a sheep does not give rise to Blue Tongue, nor the blood of the sheep injected into the horse give rise to Horse-sickness.

To Mr. Spreuill, Government Veterinary Surgeon in

[1] It is to Mr. Hutcheon that South Africa owes its knowledge of many stock diseases. For the last twenty-five years he has laboured with the utmost earnestness in Cape Colony, often under trying conditions, and his description of the various diseases formed the basis of all the modern work done on the subject.

Cape Colony, acting under the advice of Hutcheon, is due the credit of proving that a preventive serum could be prepared capable of immunising sheep against this disease. Dr. Theiler informs me he has repeated Mr. Spreuill's experiments, and they hope to introduce this method of inoculation at an early date.

Heart-water of Cattle, Goats, and Sheep.

This disease was also first clearly described by Mr. Hutcheon. It occurs in the Transvaal, Natal, and Cape Colony, and is responsible for much of the yearly loss among the cattle, sheep, and goats.

Like the last disease—Blue Tongue—it resembles Horse-sickness in many ways, and, in fact, has been described by Dr. Edington as being identical with it. Like Horse-sickness, it is a blood disease with an invisible parasite, so that blood injected under the skin of susceptible animals gives rise to the disease. One difference between the parasites of the two diseases is, that whereas that of Horse-sickness is contained in the fluid of the blood, that of Heart-water is probably restricted to the red blood corpuscles. The serum separated from the blood is incapable of giving rise to the disease, and the straw-coloured pericardial fluid, when injected into susceptible animals, fails to give rise to any symptoms of the disease. Horse-sickness blood filtered through a porcelain filter is still infective; the opposite holds good up to the present with Heart-water. Horse-sickness blood can be kept for years without losing its virulence; Heart-water blood loses it in forty-eight hours.

Heart-water has a peculiar distribution, being restricted to the certain tracts of country with a warm, moist climate. It is known to farmers that if they remove their flocks to the high veld the disease dies out.

To Lounsbury is due the credit of explaining these facts. He found that the disease is carried from sick to healthy animals by means of the bont tick, *Amblyomma hebraeum.* This tick leaves its host between each moulting, and a larva which sucks the blood of an infected animal is capable of giving rise to the disease in a susceptible animal either as a nympha or imago. The distribution of this tick corresponds to the distribution of the disease. If this tick could be killed off, the disease would disappear from the country. This could doubtless be done on individual farms by long-continued dipping; but in the meantime some method of immunisation might be devised.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

The next session at the South-Eastern Agricultural College, Wye, will commence on Monday, October 2, when an address will be given by Prof. Marshall Ward, F.R.S.

The new session of King's College will be opened on October 3, when an address will be delivered by Prof. Clifford Allbutt, F.R.S., on "Medical Education in London." On October 4 an inaugural lecture will be given by Prof. Arthur Dendy on "The Study of Zoology."

The inquiry into the general conditions of the home life of the Berlin brass-workers, their education and trade conditions, which the small party of Birmingham delegates carried out last April, is embodied in an interesting and entertaining manner in a report recently issued—"The Brass-workers of Berlin and of Birmingham," by Messrs. R. H. Best, W. J. Davies, and C. Perks (P. S. King and Son, price 1*s.*). The sensible inferences and criticisms contained in the report are ample evidences of close and accurate observation. The net practical conclusion of the inquiry seems to be that so long as the Birmingham brass-worker confines himself to the reproduction of a number of plain models, his work, especially his polished brass-work, is excellent, both in price and in finish; but "the Berlin training schools have produced a class of artisans with artistic talent, who find ready employment and are of great assistance to the employers. . . . A proper apprenticeship to his trade has fitted him (the Berlin brass-worker) and placed him in a position to supply the internal construction of intricate work without every minute detail being put down for him on paper. In the bronzing and treatment of the finish a greater freedom is apparent and a greater variety and novelty"; in fact, "they lead the way, we follow. . . ." The moral is obvious; indeed, in the further discussion of this point we find what is undoubtedly the most generally applicable and valuable criticism in the whole report:—"It is on the intellectual side that Birmingham requires to adapt itself to changed conditions: not to cheapening its wares but to getting more conception into them."

SOCIETIES AND ACADEMIES.

London.

Royal Society, April 13.—"The Amplitude of the Minimum Audible Impulsive Sound." By Dr. P. E. **Shaw.**

In a previous paper (*Phil. Mag.*, December, 1900) the author found this quantity by direct measurement, and Rayleigh, Franke, Toepler, and Boltzmann have investigated the minimum audible for continuous sound. In each of the above researches the micrometer was not sensitive enough actually to measure the least audible amplitude; the relation of current to amplitude was determined for relatively large amplitudes, and separate measurements were made of the current which gives the least audible sound. Extrapolation then gives the amplitude in question.

The present paper shows how the amplitude can be measured directly without extrapolation; it is even possible, as shown in the tables, to measure movements the amplitude of which is too small to be audible. The instrument is the improved electric micrometer described at the Royal Society (see p. 495), which is capable of showing a movement of 0·4 $\mu\mu$.

There are two distinct parts in the determination:—

(1) Observe the position of the diaphragm of a telephone when at rest, by making electric contact; draw away the measuring point of the micrometer and pass a steady current through the telephone so as to move the diaphragm to a new position of rest. Now move up the measuring point to the diaphragm, watching the micrometer screw and listening to the contact. Thus measure the movement of the diaphragm due to a set of steady currents down to such small ones as cause imperceptible motion. Plot the relation between movement and current.

(2) Apply the ear to the telephone and pass through it the same set of currents as before. For each current, except the smallest, a sound is heard when the current is stopped. We thus learn the relation of current to audibility.

The curve above at once gives the relation of amplitude to audibility. The sound is impulsive, for the diaphragm is released from a position of strain, vibrates under great damping, and soon comes to rest.

Both right and left ear of the author were used. He found, averaging results, 0·7 $\mu\mu$ as result for the right ear, and 0·9 $\mu\mu$ for the left.

The fundamental of the diaphragm when clamped hard to the case was found by testing it against tuning forks to have frequency about 580.

The following table of amplitudes is given:—

	A	B
Just audible	0·7 $\mu\mu$	0·14 $\mu\mu$
Just comfortably loud	50 $\mu\mu$	10 $\mu\mu$
Just uncomfortably loud .	1000 $\mu\mu$	200 $\mu\mu$
Just overpowering ...	5000 $\mu\mu$	1000 $\mu\mu$

The word "just" here implies in each case the lower limit. The amplitude of the diaphragm must not be confused with that of the air which it vibrates. Lord Rayleigh obtained the relation between these amplitudes to be roughly 5 to 1.

Column A gives numbers actually found in the telephone, and using Rayleigh's factor we obtain column B for the corresponding amplitude of the air.

It should be observed that 0·14 $\mu\mu$ is the smallest audible amplitude for an expectant ear when the conditions as to silence are exceptionally favourable; yet 10 $\mu\mu$ is the amplitude for the smallest audible sound in air, about which the ear can be quite sure when the conditions are normally favourable, and the ear not listening for the sound.

From the results found the author calculates the amplitudes near the source of various great sounds, *e.g.* thunder, cannon firing, and volcanic explosions. He gives reasons for supposing that in rough terms these are not more than 1/12 mm., 1/4 mm., 1/200 mm. respectively. The volcanic sounds are carried to very great distances; but the sound source is very large in extent, and the amplitude at the source therefore may not be very great.

June 16.—"The Absorption Spectrum and Fluorescence of Mercury Vapour." By W. N. **Hartley**, F.R.S.

The author having undertaken the investigation of the absorption spectra of metals in a state of vapour, the first substance examined was mercury. It was volatilised in a flask of Heraeus's quartz glass, with a side tube to the neck from which the metal may be distilled and condensed. The rays from a condensed spark were passed through the flask and on to a cylindrical condensing lens of quartz which focused the rays on to the slit of a quartz spectrograph.

The Absorption Spectrum.—The whole rays were transmitted from the red to a point in the ultra-violet where there is a tin line at λ 2571·67. From there to λ 2526·8 there is a very sharply defined and intense absorption band, somewhat degraded on the side towards the red, beyond that the rays are transmitted with full intensity to a wavelength about 2000.

The Fluorescence.—When the mercury was boiling briskly the whole side of the flask nearest to the spark was lighted up with a green fluorescence; this penetrated about one-third of the space within the flask, and lighted up the interior. The quartz glass itself was not fluorescent in the slightest degree. Solutions of mercuric chloride showed no absorption band.

The absorption band in the vapour of mercury belongs to the vapour, and is accompanied by strong fluorescence between a certain maximum and minimum of temperature lying very near to the boiling point. It is a question still undecided whether the rays absorbed by mercury vapour, as shown by the band measured, reappear with a lowered refrangibility as yellowish-green light in accordance with the law of Stokes.

NEW SOUTH WALES.

Royal Society, June 7.—Mr. H. A. Lenehan, president, in the chair.—On the so-called gold-coated teeth in sheep: Prof. A. **Liversidge.** Paragraphs in some of the London and Sydney newspapers have stated that gold-coated teeth have been found in Australian sheep. The author recently received the lower half of a sheep's jawbone from Dubbo, the teeth of which are more or less completely incrusted with a yellow metallic substance, but more like iron pyrites (marcassite) or brass than gold. The deposit is about 1/32 of an inch, or less than 1 mm. in thickness. Under a half-inch objective it is seen to be made up of thin translucent layers, but there is no recognisable organic structure. The metallic lustre is due to the way in which the light is reflected from the surface of the superimposed films. The scale partly dissolves in dilute acids. The residue consists of filmy organic matter, still possessing a metallic sheen, although white in colour instead of yellow. The chemical examination shows that the incrustation on the teeth is merely a tartar-like deposit, made up principally of calcium phosphate and organic matter.

July 1.—Mr. H. A. Lenehan, president, in the chair.—Observations on the illustrations of the Banks and Solander plants: J. H. **Maiden.**

PARIS.

Academy of Sciences, September 4.—M. Troost in the chair.—Researches on the insoluble alkaline substances formed by humic substances of organic origin, and their *rôle* in plant physiology and in agriculture: M. **Berthelot.** The experiments were made with fresh and old specimens of humic acid prepared from sugar, with dead leaves, and with soil. The substances extracted by maceration with water and by distillation with water in presence of potassium and calcium salts were analysed.—The eclipse of the sun of August 30 observed at Paris: M. **Lœwy.** In spite of the interference caused by cloud, the partial eclipse was observed at Paris under good conditions. The times of first and second contacts were obtained, and numerous photographs were taken.—Actinometric measurements carried out during the eclipse of August 30: J. **Violle.** The observations at Trappes, Bordeaux, and on the Pic du Midi were spoilt by the weather, but satisfactory results, details of which will be communicated later, were obtained at Bagnères and Sfax.—On the existence in certain gooseberry trees of a compound furnishing hydrocyanic acid: L. **Guignard.** In the case of the common red gooseberry, hydrocyanic acid has been obtained from the leaves at all stages of their growth, but is absent from the fruit. The leaves of several other species have been examined for prussic acid with negative results.—On the glycuronic acid of the blood: R. **Lépine** and M. **Boulud.**—The secretary read telegrams from various observers relating to the solar eclipse of August 30, from which it would appear that satisfactory observations were obtained at Alcasebre, Sfax, Guelma, and Philippeville, clouds interfering at Cistierna, Burgos, Tortosa, and Alcalá de Chisbert.—Observation of the eclipse of August 30 at Alcalá de Chisbert (Spain): Marcel **Moye.** The brilliant corona was the most marked feature of the eclipse.—On the same: R. **Mailhat.** Remarks on some photographs taken at Paris.—On the envelopes of spheres of which the two sheets correspond with conservation of the angles: A. **Demoulin.**—On the importance of the effect of irradiation in spectrophotography: Adrien **Guébhard.**—The constitution of the copper aluminium alloys: Léon **Guillet.**—On the origin of lactose. The effects of injection of glucose into females during lactation: Ch. **Porcher.**—The geology of the southern Carpathians: G. M. **Murgoci.**—The influence of the solar eclipse of August 30 on the earth's magnetic field at Paris: Th. **Moureaux.** The oscillations observed during the eclipse were much greater than the regular diurnal variations.—On the polarisation of the sky during the eclipse of the sun: M. **Piltschikoff.**

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