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THE DETERMINATION OF ORBITS.

Die Bahnbestimmung der Himmelskörper. By Julius Bauschinger. Pp. xv+653; mit 84 Figuren im Text. (Leipzig: Wilhelm Engelmann, 1906.)

Die Gauss-Gibbssche Methode der Bahnbestimmung eines Himmelskörpers aus drei Beobachtungen. Mit einem Anhang zum "Grundriss der theoretischen Astronomie." By Prof. Johannes Frischauf. Pp. 47. (Leipzig: Wilhelm Engelmann, 1905.)

THE development of convenient and general methods for calculating the orbit of any body around the sun from a limited number of observations constitutes a classical problem in the annals of astronomy. Its history, which has yet to be adequately written, now covers a period of rather more than two centuries, and during that time it has attracted the attention of many famous mathematicians whose successes and failures are alike remarkable. At the time of Newton long records had made the principal features of the orbits of the known planets familiar, and no addition to their number was made within the next hundred years. Hence in the eighteenth century efforts were mainly directed to the determination of the parabolic orbits of comets. Yet the completely satisfactory solution was deferred until 1797, when Olbers's celebrated work appeared. Why Olbers succeeded when far greater mathematicians, such as Euler and Lagrange, had met with comparative failure is an interesting question. The fact is that the determination of orbits is an art demanding as such a sense of arithmetical technique and not merely an insight into the mathematical principles involved.

In the nineteenth century, on the other hand, the discovery of minor planets, which are now being found at the average rate of one a week, has required general methods of dealing with planetary orbits. The deduction of an orbit from the necessary three observations has been based mainly on the methods of Gauss's "Theoria Motus." Even in matters of detail the variations which have been added have been for the most part slight and unimportant. In a less degree use has been made of the earlier method of Laplace, which has been generally regarded as inferior in practice. In reality the two solutions are essentially equivalent as regards their mathematical foundation, a remarkable theorem due to Lambert standing as the formal connecting link. Again the difference is a matter of technique rather than of principle.

The determination of orbits, considered in a wide sense, forms a subject so complicated and so closely dependent on other branches of astronomy that comprehensive treatises serving to bring together what experience has shown to be the most practical methods have rendered indispensable service. In England, owing, perhaps, to the too exclusive predominance of one school of thought, little has been contributed to the development of the theory and nothing to its connected presentment. The well-known treatise of Watson we owe to America. Of other works, by far the most notable is that of Oppolzer. Unfortunately, the second volume of this book is now out of print and has become scarce.

In these circumstances a warm welcome must be extended to Dr. Bauschinger's treatise. His position as Director of the Recheninstitut in Berlin, the prominent feature of the work of which is the surveillance of the rapidly accumulating multitude of minor planets, leads us to expect an eminently practical treatment, and we are not disappointed. No great originality will be found, nor was it to be looked for, so far as regards the fundamental methods themselves. The aim of the author has evidently been to follow the path which has been proved by experience, and any originality must be sought in the modes of presentation, which are always elegant, concise, and lucid.

A most important feature of a work of this kind is the choice of illustrative examples of actual computations. In both the liberal selection and the arrangement of these Dr. Bauschinger has done well. The diagrams are neat and clear. The style of printing, a matter of which the importance in the case of a mathematical work can hardly be exaggerated, will bear comparison with the best English examples of a similar class. It is impossible that all errors should have been detected in the course of proof-reading, but though two or three have certainly escaped notice, it is unlikely that there will be any necessity for a list of corrections such as that inserted in Oppolzer's second volume.

Some time ago Dr. Bauschinger published a very useful collection of astronomical tables. Frequent reference is made to these in the present work, which is thus relieved of a large amount of additional matter, while the tables themselves are available in a handier form than as an appendix to a bulky volume. As it is, the author has covered the same ground as Oppolzer's "Bahnbestimmung," and even included some additions within the limits of a single volume. But it is of necessity a large one, and can scarcely fail to suggest the question whether its size could not be reduced by omissions or compression without prejudice to its utility. At first sight this would certainly seem to be the case. The first part, containing a discussion of astronomical coordinates, is occupied with matter which ought to be accessible in general treatises on practical astronomy. The chapter on the method of least squares might be replaced by simple references to some work devoted to that subject, and what is given in the chapter on mechanical integration ought to be found in treatises on the calculus of finite differences. But apart from the fact that this supposes the existence of ideal books which have not yet been written, it is a distinct advantage to be saved the trouble of consulting a number of separate works, even when these are at hand. The fuller treatment must be justified by a severely concise and practical discussion of all subordinate topics, and in this respect little fault will be found with Dr. Bauschinger's handling of his material. It is difficult to believe, however, that some matters of elementary mathematics could not have been omitted without detriment. Thus the discussion, at the beginning of the second part, of the equations of a conic, based on the definition of a conic as the plane section of a right circular cone, must be superfluous for a reader who is capable of following the whole of the first part intelligently. But the fault is doubtless on the right side.

The whole work consists of seven parts. The first deals with those portions of general astronomy which are relevant to the main purpose. The chapters on time and on precession and nutation seem particularly clear and good. That on aberration follows the traditional lines of Gauss and Bessel, and criticism would be out of place here. Yet the exposition of Gauss, which seems to assume the apparent composition of the velocities of light and of the earth as a matter of course, appears to be imperfect in view of the difficulties in the physical theory. Is it not more logical to consider the apparent composition as an inductive result instead of the explanation of the astronomical phenomena?

The second part contains a discussion of undisturbed heliocentric motion. Dr. Bauschinger asserts (p. 170) that Lambert's equation is of little use in the case of ordinary elliptic orbits. This opinion may be disputed. It is true that the development in series is of little assistance owing to slow convergence, but in its original form the equation can be easily solved in all ordinary cases. The natural expression of the formulæ for motion in a hyperbola involves hyperbolic functions. The use of these is entirely avoided, presumably because tables of hyperbolic functions are not as a rule accessible to the computer.

The properties of the apparent or geocentric motion are discussed in the third part. Here will be found Bruns' elegant proof of the theorem of Lambert on the curvature of the apparent orbit. Incidentally it may be remarked that Lambert seems to have missed that measure of fame to which his unquestionable eminence as a mathematician entitles him.

The longest part is the fourth, in which the various methods of determining a preliminary orbit are described. An excellent feature is the compendious arrangement of the working formulæ. This part is followed by that on the adjustment of an orbit by the method of least squares. In both sections numerical examples are fully and clearly worked out.

The sixth part contains the theory of special perturbations. Three methods are given, according to which the perturbations can be calculated in the elements, or in polar or in rectangular coordinates. In the preliminary chapter, on mechanical integration, the usual German notation for interpolation formulæ is employed. It is difficult to see the advantage of this over the ordinary notation of finite differences. The last chapter of this section brings the reader to the determination of the definitive orbit.

Here the work might have ended, but Dr. Bauschinger has added a final part, in which he investigates the determination of the orbits of meteors, satellites, and double stars. These last chapters are necessarily brief, and it may be doubted whether, as regards unity of subject, their inclusion is justified. But that on satellites is certainly valuable, especially in view of recent discoveries.

The source of the numerous theorems which are met with in the work has generally been indicated, but this is not always the case. Thus the theorems on p. 184 are due to M. Radau (Bull. Astr., x. p. 11) and to Mr. Shin Hirayama (Monthly Notices, R.A.S., lxii., p. 620). Such references add greatly to the interest, but of course it is always difficult to be sure that the sources are strictly original. For instance, the proposition attributed (p. 131) to van der Kolk was, as has been recently pointed out, previously given by Whewell. There is an index at the end of the volume, but it is not so complete as it should have been. A full index of names is needed.

An outline of the method of Gibbs will be found in Dr. Bauschinger's work, but for fuller details the pamphlet of Dr. Frischauf may be consulted with advantage. The method is based on the use of a particular expression for the ratio of a triangle to the corresponding sector of an ellipse. The form is mathematically elegant and the degree of approximation is high, but it was thought to entail greater complexity in the computations, while, on the other hand, the method by itself gave little assistance when a still closer approximation proved necessary. This defect was remedied by Prof. Harzer. The modified method is described by Dr. Frischauf in a clear and interesting manner; the practical value of his account would have been enhanced by the addition of a fully worked example. The pamphlet also contains a number of supplementary notes to the author's "Grundriss der theoretischen Astronomie," a work of which a second edition appeared in 1903 after an interval of thirty-two years from its first publication. H. C. P.

INDUCTION AND CONDUCTION MOTORS.

Moteurs a Collecteur a Courants alternatifs. By Dr. F. Niethammer. Pp. 131. (Paris: *L'Éclairage Électrique*, 1906.)

THE title leads one to believe that the author is going to deal with at least all the principal types of modern alternate-current commutator motors, whereas the book is practically restricted to a consideration of the series induction and conduction motors. Shunt induction motors of the commutator type are occasionally touched upon, but all remarks concerning these must be considered as quite erroneous. Generally speaking, the number of mistakes is too great.

In chapter i. the historic part does not deal with the machines out of which those modern single-phase commutator motors have been directly evolved, which are afterwards considered more closely. The preliminary consideration of some of the types now in use is full of errors, and much prominence is given to the least important of these types. The indiscriminate use of the expression "repulsion" motor leads to the usual confusion.

In the second chapter, which is the most important in the whole book, we find the author trying to establish exact diagrams which will cover all types of motors. It may be possible to achieve this, but the task is not an easy one, and the solution offered by the author can certainly not be accepted. Take the two simple diagrams Figs. 32 and 33; the first illustrates the action of the motor shown in Fig. 30, the second (which is not referred to in the text) is probably intended to illustrate the action of the motor shown in Fig. 31. The E.M.F. (J_aW_a) in Fig. 32 is responsible for the current J_a flowing in the short-circuited rotor; it must therefore be the resultant of all those E.M.F.'s which are effective so far as the short-circuiting brushes are concerned. These E.M.F.'s are E_r, E_i, E_r', E_i', and E_s'. When the motor is standing, E_r and E_r' are nil, but they increase in direct proportion with the speed, with the result that J_aW_a must, according to the diagram, increase with the speed independently of the load! In other words, the rotor current J_a must increase with the speed, consequently also the stator current J_f. Seeing that the machine is one with a series characteristic, it is very obvious that the diagram in question cannot be correct. In a machine of the kind the tendency of the current is, of course, to diminish with the speed. The fact of the matter is that the phase of E_r' is shown incorrectly. If the direction of rotation is such that E_r is in phase with the flux K_a, then E_r' must be of opposite phase to the flux K_q, for these fluxes are not only at right angles to each other in space, but also nearly at right angles to each other in phase. The presence of this very serious mistake evidently prevented the author from grasping the full meaning of the various vectors of his diagram. (E_i) must be considered as the working E.M.F.; (E_r') is then the back E.M.F., ($E_s'+E_i'$) represents the self-induction of the rotor circuit, whilst E_r (and not E_r', as stated by the author on p. 32) must be looked upon as the compensating E.M.F. It is nearly opposed to ($E_s'+E_i'$), therefore tends to cancel the effect of the self-induction in the rotor and to bring J_a more and more into phase with E_i. Since E_r increases with the speed, it follows that with increasing speed the phase of J_a will approach that of E_i, and that the power factor will rapidly improve.

The writer also fails to agree with the author's Fig. 33. Owing to a mistake similar to that present in Fig. 32, we get the following curious and impossible result. It is obvious that E_r, which appears at the brushes (*aa*), must be responsible for the flux K_q; it is generally admitted that a magnetic field *lags* by about 90 degrees behind the E.M.F. responsible for it, yet in Fig. 33 K_q actually *leads* E_r by nearly that amount. The author also ignores the fact that for the arrangement of brushes shown in Fig. 31 we have *two* currents in the rotor, the one flowing from (*b*) to (*b*), the other from (*a*) to (*a*), the former being the working current, the latter producing K_q.

The value of the next fundamental diagram (Fig. 35) is greatly reduced because the author mistakes, in Fig. 34, the axis K_a for the axis K_q, thus making a comparison between Fig. 34 and Figs. 30 and 31 quite impossible. In Fig. 34 the motor-field axis K_q is the *vertical* axis, and *not* the *horizontal*, as has been assumed by the author, so that E_r' is not nil as stated. No more is E_i nil, although it is now impressed on the rotor by conduction, and not by induction, as in Figs. 30 and 31.

The writer's space is limited, and he must therefore cut his remarks short. The fundamental diagrams of chapter ii. having been proved to be wrong, the value of the whole chapter is naturally greatly discounted. The chapter, however, contains a number of other mis-statements, some of which we will note in passing.

On p. 34 it is stated that the transformer flux in a short-circuited transformer is zero! On p. 42 that the motor shown in Fig. 53 is compensated in the same manner as the Winter-Eichberg machine, whereas compensation is due to the alteration brought about in the phase of the motor field by the introduction into the exciting circuit of the auxiliary E.M.F. derived from S_1. In diagram 43 the E.M.F. (E_r') is shown as being of opposite phase to the E_r' of Fig. 32, although both diagrams refer to the same motor. The remarks on commutation are difficult to follow, because of the attempt to deal with the various types of motors at one and the same time. It is recommended that flux K_a should be chosen low at starting for motors of the series induction type, whereas it is the flux K_q which at that time should be small. Contrary to the author's statement, the commutation difficulties with polyphase commutator motors are just about of the same order as those met with in the series induction motor. In dealing with the power factor (p. 59), the author makes a statement in the last paragraph which reveals a great confusion of ideas. This mistake probably arises out of the confusion of the axes of K_q and K_a already pointed out in connection with Fig. 34; in addition, the notation is now suddenly changed. It is, however, evident that for the case of the series conduction motor (Fig. 34) k_q stands for the field coaxial with the armature brushes and due to the armature ampere turns; k_q is perpendicular to K_q, and by neutralising k_q as shown in Fig. 37 or 39 the power factor is improved as stated. But in a "repulsion" motor such as Fig. 30, k_q does not exist; it is neutralised *ipso facto* because the energy is conveyed into the rotor by induction, and not by conduction as in Fig. 34. Furthermore, if k_q did exist, it would be coaxial with K_a. If k_q is a misprint for K_q, then by neutralising it the torque of the motor would be destroyed, for K_q is the *motor field.* As to speed regulation, and contrary to the author's opinion, any so-called repulsion motor can be satisfactorily controlled by suitably influencing the rotor circuits.

Chapter iii. only deals with motors full descriptions of which have appeared from time to time in the technical Press. As to the notes on the predetermination of alternate-current commutator motors, these are very superficial, and mainly apply to the series conduction machine.

On the whole, the book is more likely to bewilder the reader than teach him anything; it ought to be very thoroughly revised and corrected before it can be recommended. The author will find it easier and more profitable to treat each type of motor separately, and then to point out the differences between the various types, than to try and establish diagrams and formulæ which will meet all cases.

VAL. A. FYNN.

SUBAQUEOUS TUNNELLING.

Tunnel Shields, and the Use of Compressed Air in Subaqueous Works. By W. C. Copperthwaite. Pp. xv+390. (London: Archibald Constable and Co., Ltd., 1906.) Price 31*s.* 6*d.* net.

THIS fine quarto volume furnishes a very valuable and comprehensive history of a system of tunnelling, especially under rivers and in water-bearing strata, which was inaugurated by Sir Marc Isambard Brunel, as regards the employment of a shield, in the celebrated Thames Tunnel between Rotherhithe and Wapping, commenced in 1825, but, owing to the inrush of the river into the works on two occasions through breaks in the stratum of clay, and financial difficulties, only completed in 1843.

The second important step in the development of the system in a practical form was, curiously enough, taken in constructing a second tunnel under the Thames rather higher up the river, crossing just above the Tower, which was commenced in February, 1869, and completed in November the same year. This Tower Subway, originally proposed by Mr. Peter Barlow, but eventually executed by the late Mr. Greathead, whose name will always be prominently associated with the system of tunnelling under consideration, was carried forward through the London Clay under the shelter of a shield, similar in principle to, though much smaller than, the Thames Tunnel shield. The shield in this instance consisted of a short wrought-iron cylinder laid horizontally, 4¾ feet long and slightly more than 7 feet internal diameter, stiffened at its front cutting-edge, and provided inside with a vertical plate diaphragm having a central opening, which could be readily closed, through which the men passed for excavating the ground in front preparatory to pushing forward the shield by a series of screws. The novelty consisted in the lining of the tunnel being formed of a series of cast-iron rings, composed of segments bolted together, which were erected under the shelter of the rear part of the cylindrical portion of the shield as it was pushed forward; and as the shield overlapped the lining of the tunnel, and left a slight annular space between the lining and the clay stratum, lime grout was injected through holes provided in the casting, so as to fill up the vacancy left by the shield in its advance. This subway traverses the London Clay throughout, at a minimum depth of 22 feet below the river-bed, no water having been encountered; and it indicates the general method of constructing tunnels by this system. The shield serves to protect the completed end of the tunnel from the fall of earth at the working face, and acts like timbering in supporting the superincumbent mass and preventing settlement above during construction, which is further insured over the completed tunnel by filling the cavities left by the advancing shield with grout.

The system, however, as successfully carried out, in the absence of water, in the Tower Subway, was not adapted for passing through water-bearing strata; and a third step, consisting in the introduction of compressed air, was essential to enable this system to cope effectually with the conditions liable to be encountered in tunnelling under rivers, or at a considerable depth below the surface, in loose ground. The completion of this system of tunnelling, by the combined use of a shield, a cast-iron lining put together under shelter of the shield, and compressed air to exclude the water from the works in traversing water-bearing strata, has enabled abandoned tunnels to be completed, and tunnels to be successfully carried out under such unfavourable conditions as would have been considered impracticable by the methods previously in use. This combination of shield, cast-iron lining, and compressed air, for carrying a tunnel through water-bearing strata, was resorted to by Mr. Greathead for the first time in 1887, in constructing the City and South London Railway, the first of the metropolitan tube railways, where it passes through the loose, water-logged gravel of the Thames basin, overlying the London Clay; and in 1889 it was adopted for continuing the Hudson Tunnel in the silt underlying the Hudson River separating New York from the mainland, when different systems of carrying forward an iron lining by the aid of compressed air, under the shelter of which a brick tunnel was constructed, proved increasingly difficult as the work advanced.

The shield for the continuation of the two single-line Hudson tunnels was 10½ feet long and 20 feet outside diameter; whilst the cast-iron lining has an external diameter of 19½ feet and 18 feet internal diameter, formed of rings 1½ feet long, made up of eleven segments and a key, put in place by a revolving hydraulic erector. This work was stopped for want of funds in 1891, but was resumed in 1903 and completed last year. Where the silt traversed was very soft, the shield was kept closed and pushed forward by sixteen hydraulic rams; and to avoid unequal settlement of the tube under the weight of a train, it has been supported at intervals on iron piles driven down to a hard stratum underlying the silt. Compressed air had been used successfully for many years in constructing foundations and piers of bridges under water, or in water-bearing strata, before it was applied to subaqueous tunnelling; but whereas in bottomless, vertical caissons, the compressed air forces out the water uniformly all over the bottom, the pressure of the air at the open end of a horizontal tube meets with less opposition from the water at the top than at the bottom, where the head of water is greater, in proportion to the diameter of the tube. Accordingly, in large tubes there is a liability in traversing loose soil for the air to escape through the stratum at the top, and for the water to rush in simultaneously at the bottom. To provide for the safety of the men in such a contingency, in addition to two or three platforms at the back of the diaphragm of the shield, with openings at each stage which can be readily closed, a metal screen is hung down the upper half of the tube at the back to provide an air space at the top, to which the men can escape by an air-lock through the screen on the occurrence of an inrush of water, and pass out through an emergency air-lock in the bulkhead behind.

The author has collected together a large quantity of information from a variety of publications, so as to present a fairly complete record of the numerous subaqueous tunnels carried out by means of a shield, and more particularly those where compressed air has been also resorted to, of which there are several interesting examples in Great Britain, France, and the United States, all constructed within the last twenty years. The clear descriptions are very well illustrated by numerous drawings; and the book deserves a cordial welcome from all persons who are concerned or interested in the latest developments of subaqueous tunnelling.

PROBLEMS IN METABOLISM.

Problems in Animal Metabolism. By J. B. Leathes. Pp. viii+205. (London: John Murray, 1906.) Price 7s. 6d. net.

THIS volume is the latest of the series that Mr. Murray is issuing in connection with the work of the physiological laboratory of the London University. The subject Dr. Leathes took for his lectures is perhaps the most important one in the whole of chemical physiology. In a study of metabolism one seeks to understand the innermost workings of the living cells, and thus to comprehend the sum total of the chemistry of life. In order, however, to pave the way for such complete knowledge it is necessary to study individual chemical reactions, the items that go to form the final sum; and so in the interesting book Dr. Leathes has produced he is mainly concerned with a separate consideration of the way in which the carbohydrates, fats, and proteids are utilised, and finally catabolised.

The author has taken infinite pains to get his facts correct, and has presented the subject in an extremely clear way. He is able to point out quite lucidly how far present knowledge carries us, and where speculation steps in to fill up the gaps. One becomes conscious of the width of these gaps when one realises that any exact knowledge of how simple substances like sugar are ultimately converted into water and carbon dioxide in the body is at present lacking. In the case of the more complex materials, such as the proteids, hypotheses are still more numerous, because our facts are still scantier.

The whole work is full of pregnant suggestions, and the writing is so attractive that one can confidently recommend it to all those who desire a picture of exactly where physiology stands at the present day in relation to these important matters.

The spirit of the physiological chemist should not be to make this branch of science an offshoot of chemistry, but to use organic chemistry as the means to an end. This is the correct attitude that Dr. Leathes assumes throughout. In the remote past so-called physiology was largely anatomy. When all that anatomy could contribute had been learnt, it was found that the real work of the physiologist was only beginning. So, too, as Dr. Leathes points out, we look forward to a future in which chemistry will have contributed its share, and the workers will discover that physiology has still problems before it which cannot be learnt from pure chemistry, any more than the whole of physiology can be learnt by dissections.

The subject of proteid metabolism is in the air just now, so it is specially interesting to ascertain what views Dr. Leathes holds in relation to it. He accepts the view which is daily gaining greater credence, that in digestion the albuminous molecule is broken up into quite simple substances, mainly of the amino-acid variety. He believes that these are absorbed as such, and that the work of proteid synthesis is carried out by the living cells of the tissues from these crystallisable products transported to them by the blood and lymph. He admits this hypothesis is in the unproven condition, but has himself been successful in showing that the nitrogen of the blood, combined in amino-acids and molecules of that order, is increased during absorption. To identify the individual amino-acids is a matter of much greater difficulty, and a simple calculation shows how greatly even the most abundant of them must be diluted by the whole mass of the blood even during the progress of the absorption of a considerable meal.

His views on the catabolism that proteids undergo very largely coincide with those of Folin. The nitrogen of ingested albumin is readily split off with comparatively little loss of energy and discharged *viâ* the liver as urea. The non-nitrogenous residue is therefore available as a source of heat and energy in much the same way as fat and carbohydrates are. Until, therefore, we know how the cells dispose of such simple organic compounds as fat, our knowledge regarding the fate of the fat-like moiety of proteids must be in abeyance. Dr. Leathes puts this much more fully, but very clearly, which makes one wonder why, in another part of the book, all his arguments are against the possible origin of fat from proteid intra-cellularly.

Is it, then, advisable to limit our proteid intake to the low level advocated so forcibly by Chittenden? Should we take only sufficient to balance the small amount of proteid waste that is associated with tissue activity? In his answer to this question Dr. Leathes has taken an independent and original line. He admits that the necessary minimum is much less than the conventional dietary of 100 grams daily, but he thinks it does not necessarily follow that it is unphysiological to take more than the minimum, any more than it is unphysiological to take any food which yields more than the minimum of fæcal refuse. In the infant, the dietary provided by nature in the amount of milk it takes is, even after making due allowance for growth, at least ten times greater than the minimum. The minimum can therefore hardly be normal for the adult; and a possible reason for this is that there may be a few members of the amino-acid group which are required in large amounts for cell repair, and that it is only the commoner amino-acids which are not required in the amount usually taken, and which are consequently so rapidly discharged from the body.

This example of the manner in which the puzzles of metabolism are grappled with will be sufficient to show the character of the book, and one hopes that those interested in these fundamental questions will themselves study in full what a reviewer is only able to state imperfectly in barest outline or in samples.

W. D. H.

OUR BOOK SHELF.

Poverty and Hereditary Genius; a Criticism of Mr. Francis Galton's Theory of Hereditary Genius. By F. C. Constable. Pp. xvi+149. (London: Arthur C. Fifield, 1905.) Price 2s. net.

THE criticism which Mr. Constable brings forward in this book is that reputation is not a test of ability, and as Galton's theory of hereditary genius is based on this assumption, it has to be discarded. The statistical evidence given in "Hereditary Genius" has to be explained away, and Mr. Constable attempts to do this by what he calls the "swamping effect of poverty." We quite agree with Mr. Constable that it is harder for a poor man with uninfluential parents to achieve success as a judge than for a rich one with influence, but this does not seem to us to justify Mr. Constable in discarding the conclusions of "Hereditary Genius," for if the social conditions of both parents and offspring are relatively about the same, it seems as if the omission of the ability in poverty-stricken parents and their children is rather like leaving out of account the addition of numbers to both the numerator and denominator of a fraction. The omission may therefore not affect the result at all, and whether fuller statistical evidence should modify Mr. Galton's conclusions is a matter which can only be decided by statistics other than those which Mr. Constable discusses. He appears, however, to have overlooked altogether in his argument that other statistics exist and tend to show that psychical and physical characteristics are inherited in the same way, a point which seems to us to upset a good deal of Mr. Constable's criticism.

Mr. Constable does not refer to Mr. Galton's other books, and apparently quotes from the 1869 edition of "Hereditary Genius." It is a pity that Mr. Constable does not always succeed in expressing himself very clearly, and his habit of putting his arguments in the form of questions becomes somewhat tiresome, and makes the book seem a rather disjointed composition.

Modern Cosmogonies. By Agnes M. Clerke. Pp. vi+287. (London: A. and C. Black.) Price 3s. 6d. net.

THIS popular account of the structure of the universe, so far as it can be understood with the means of inquiry now at the disposal of astronomers, should serve a useful purpose in directing attention to the position of the most difficult problem of celestial science. To early philosophers it was sufficient to regard the heavens as a solid and crystalline firmament in which the stars are fixed; facts of observation were not considered essential for the metaphysical foundation upon which the great minds of antiquity sought to support their universe. The ingenious framework of solid concentric spheres and epicyclic motions was shown to be a baseless fabric by Tycho Brahe's considerations of the orbits of comets, and was finally discredited by the law of gravitation.

What may be regarded as the modern era of scientific cosmogony, in which serious attempts were made to explain what is seen on the background of space, opened about a century and a half ago with Wright's "cloven disc" theory of the Milky Way and Lambert's view of it as a sidereal ecliptic. These considerations of the nature of the universe are related to those of its origin adumbrated by Swedenborg and Kant as the nebular hypothesis, and afterwards worked out in mathematical detail by Laplace. During the past few years several objections of a mathematical and physical nature have been raised to this hypothesis, which has proved to be vulnerable at many points. In Miss Clerke's words, "It has, indeed, become abundantly clear that the series of operations described by Laplace could scarcely, under the most favourable circumstances, have been accomplished, and in a thin nebulous medium would have been entirely impossible. The nebular cosmogony has not, then, stood 'Foursquare to all the winds that blew.' Its towers and battlements have crumbled before the storms of adverse criticism. It survives only as a wreck, its distinctive features obliterated, although with the old flag still flying on the keep."

Tidal evolution, the meteoritic hypothesis, and other views developed in recent years to satisfy the demand for a cosmogony consistent with existing knowledge of the heavens, particularly with spectroscopic observations, are described by Miss Clerke. While we cannot subscribe to all her judgments and interpretations, her work contains a large amount of material, both observational and speculative, and general readers will find much to interest them in it.

R. A. G.

The Geometry of the Screw Propeller. By W. J. Goudie. Pp. 47. (London and Glasgow: Blackie and Son, Ltd.) Price 1s. 6d. net.

THIS is a small book presenting "a simple exposition of the geometrical principles connected with the screw propeller, and illustrating the various ways in which these may be applied to obtain a correct delineation of the propeller on paper, in the drawing office, and in the foundry." It is intended principally for the use of engineering students in technical schools, but is likely to prove useful in other directions, since it contains a clear and admirably illustrated account of the geometry of screw propellers.

The writer is a lecturer on mechanical engineering in Paisley Technical College, and possesses a good knowledge of workshop practice in addition to thorough familiarity with the geometry of his subject. He does not attempt any discussion of the design of a screw propeller most suitable for a new ship, but restricts attention to the preparation of drawings, patterns, and moulds required in the manufacture of propellers for which the dimensions and forms have been determined. This is a wise discretion, for while the geometry of screw propellers admits of exact treatment, the selection of the most efficient propeller for an individual steamship is even now a matter not admitting of exact scientific treatment when precedent has to be departed from; experiments alone can be trusted.

Mr. Goudie describes in clear and simple language the methods by which helical surfaces of uniform or variable pitch may be constructed, and illustrates in detail the practical methods of moulding the blades in the foundry. For the benefit of students who may not have the opportunity of actual work in the foundry the author indicates how, with the aid of a few simple tools and materials, skeleton models of the various types of screw surfaces can be constructed. He also gives detailed explanations of the work requiring to be done in the drawing office of an engine factory in connection with the design of screw propellers. While securing sufficient accuracy for all practical purposes, he shows how approximate methods may be substituted in many cases for exact geometrical methods.

The little book may well be placed in the hands of all engineering draughtsmen and apprentices whose training includes attendance at technical schools, as well as workshop practice.

Geographical Gleanings. By Rev. F. R. Burrows. Pp. 75. (London: G. Philip and Son, Ltd., 1906.) Price 1s. 6d. net.

MUCH yet remains to be done before geography is taught and studied in schools according to reasonable methods. Everybody agrees that geography, like most other subjects, can be made a valuable educational instrument provided that it is taught by practical methods and that the teachers are familiar with its realities. Mr. Burrows describes some methods of teaching geography, and shows how the subject may be usefully approached. There is little new in his views or advice; nevertheless, the book may serve to place aspiring teachers in a position to give satisfactory lessons in geography.

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.*]

Chinese Observation of Nature.

I AM venturing to send you two quotations from "L'Empire Chinois," by M. Huc.

(I) Refers to an instance of mutation, and seems to me to be markedly interesting on account of the date of the observation recorded, and the use made of the discovery.

(II) Refers to a different matter—*Polype vinaigre.* Possibly this creature is well known to scientific workers, but I have failed to identify it, although I have searched all reference books at hand. Unfortunately, we have no scientific reference library, and I venture to hope that a reader of NATURE will tell us what it is!

W. HOSKYNS-ABRAHALL.

14 Woodstock Road, Redland Green, Bristol.

I.

Les Chinois doivent principalement à leur caractère éminemment observateur leurs nombreuses découvertes en agriculture, et le parti qu'ils savent tirer d'une foule de plantes négligées en Europe. Ils aiment à examiner et à étudier la nature. Les grands, les empereurs même, ne dédaignent pas d'être attentifs aux plus petites choses, et ils recueillent avec soin tout ce qui peut avoir quelque utilité pour le public. Le célèbre empereur Khang a ainsi rendu plus d'un service important à son pays. On trouve dans de curieux mémoires écrits par ce prince, le passage suivant:

"Je me promenais, dit l'Empereur Khang-hi, le premier jour de la sixième lune, dans des champs où l'on avait semé du riz qui ne devait donner sa moisson jusqu'à la neuvième. Je remarquai, par hasard, un pied de riz qui était déjà monté en épi. Il s'élevait au-dessus de tous les autres et était assez mûr pour être cueilli; je me le fis apporter. Le grain en était très-beau et bien nourri; cela me donna la pensée de le garder pour un essai, et voir si, l'année suivante, il conserverait ainsi sa précocité; il la conserva en effet. Tous les pieds qui en étaient provenus montèrent en épis avant le temps ordinaire, et donnèrent leur moisson à la sixième lune. Chaque année a multiplié la récolte de la précédente, et, depuis trente ans, c'est le riz qu'on sert sur ma table. Le grain en est allongé et la couleur un peu rougeâtre; mais il est d'un parfum fort doux et d'une saveur très-agréable. On le nomme *Yu-mi*, 'riz impérial,' parce-que c'est dans mes jardins qu'il a commencé à être cultivé. C'est le seul qui puisse mûrir au nord de la grande muraille, où les froids finissent très-tard et commencent de fort bonne heure; mais, dans les provinces du midi, où le climat est plus doux et la terre plus fertile, on peut aisément en avoir deux moissons par an, et c'est une bien douce consolation pour moi que d'avoir procuré cet avantage à mes peuples."

L'Empereur Khang-hi a rendu, en effet, un service immense aux populations de la Mantchourie, en propageant la culture de cette nouvelle espèce de riz, qui vient à merveille dans des pays secs, sans avoir besoin d'irrigations perpétuelles comme le riz ordinaire.

Huc, "L'Empire Chinois," vol. ii., p. 359, second édition, 1854.

Kang-hi—1661–1721—"was indefatigable in administering the affairs of the empire, and at the same time he devoted much of his time to literary and scientific studies under the guidance of the Jesuits."

Article "China," "Encyclopædia Britannica," ninth edition.

II.

Polype vinaigre.

Le tsou-no-dze est un être qui, à raison de sa bizarre propriété de fabriquer d'excellent vinaigre, mérite une mention particulière. Ce polype est un monstreux assemblage de membranes charnues et gluantes, de tubes et d'une foule d'appendices informes qui lui donnent un aspect hideux et repoussant; on dirait une masse inerte et morte. Cependant, quand on la touche, elle se contracte ou se dilate, et se donne des formes diverses. C'est un animal vivant, dont la structure et l'existence ne sont pas plus connues que celles des autres polypes. Le tsou-no-dze a été découvert dans la mer Jaune, et les Chinois le pêchent sur les côtes du Leao-tong; mais on n'en prend qu'un petit nombre. Peut-être sont-ils plus abondants ailleurs, où l'on néglige de les prendre faute de connaître leur propriété. On place ce polype dans un grand vase rempli d'eau douce à laquelle on ajoute quelques verres d'eau-de-vie. Après vingt ou trente jours, ce liquide se trouve transformé en excellent vinaigre, sans qu'il soit besoin de lui faire subir aucune manipulation, ni d'y ajouter le moindre ingrédient. Ce vinaigre est clair comme de l'eau de roche, d'une grande force et d'un goût très-agréable. Cette première transformation une fois terminée, la source est intarissable; car, à mesure qu'on en tire pour la consommation, on n'a qu'à ajouter une égale quantité d'eau pure, sans addition d'eau de vie. Le tsou-no-dze, comme les autres polypes, se multiplie facilement par bourgeons, c'est-à-dire qu'il suffit d'en détacher un membre, un appendice, qui végète, en quelque sorte, grossit en peu de temps et jouit également de la propriété de changer l'eau en vinaigre. Ces détails ne sont pas uniquement basés sur les renseignements que nous avons pu recueillir dans nos voyages. Nous avons possédé nous-mêmes un de ces polypes; nous l'avons gardé pendant un an, faisant usage journellement du délicieux vinaigre qu'il nous distillait. Lors de notre départ pour le Thibet, nous le laissâmes en héritage aux chrétiens de notre mission de la vallée des Eaux-Noires.

"L'Empire Chinois," Huc, vol. ii., chap. x., pp. 414–415.

A Large Meteor.

ON Sunday, August 5, at 10h. 33m., I saw what I presume to have been a fine and rather early Perseid. It crossed the star λ Aquilæ, and the flight was recorded from about $287\frac{1}{2}°-2°$ to $282°-9\frac{1}{2}°$. The meteor was much brighter than Venus, and left a streak of 5° visible for some twenty seconds, though the full moon was shining brilliantly at the time.

I would be much interested in hearing of any other observations of this meteor. It was probably situated over the English Channel, and must have presented a magnificent appearance as seen from the counties of Somerset, Dorset, and Devon.

W. F. DENNING.

44 Egerton Road, Bishopston, Bristol, August 6.

ATMOSPHERIC PRESSURE CHANGES OF LONG DURATION.

IN previous numbers of this Journal (vol. lxvii., p. 224, and vol. lxx., p. 177) I described a barometric variation of short duration and world-wide in extent which behaved in a see-saw manner in an easterly and westerly direction between antipodal parts of the earth. The investigation, which included the examination of pressure changes at ninety-five stations scattered over the globe, indicated that there was a transference of air from west to east and from east to west alternately, a surge, in fact, raising and lowering the mean annual pressure values. Thus, when the pressure in any year in India the East Indies, and Australia behaved alike, while the South American region behaved in an inverse manner. The present inquiry was therefore limited to these areas. For the first three a considerable amount of data is available, but this is not the case for the last-mentioned region; to mitigate this deficiency, curves for several separate stations have had to be employed in order to determine over several years the variation in operation there.

The first step taken to prepare the data for this comparison was to eliminate so far as possible the variation of short duration. This was satisfactorily accomplished by grouping the years in sets of four, and employing the mean values of each of these groups; thus the means for the years 1873 to 1876, 1874 to 1877, &c., were determined. The curves here shown are all composed of such means, and are formed by connecting the points plotted on squared paper; the same scales are employed throughout.

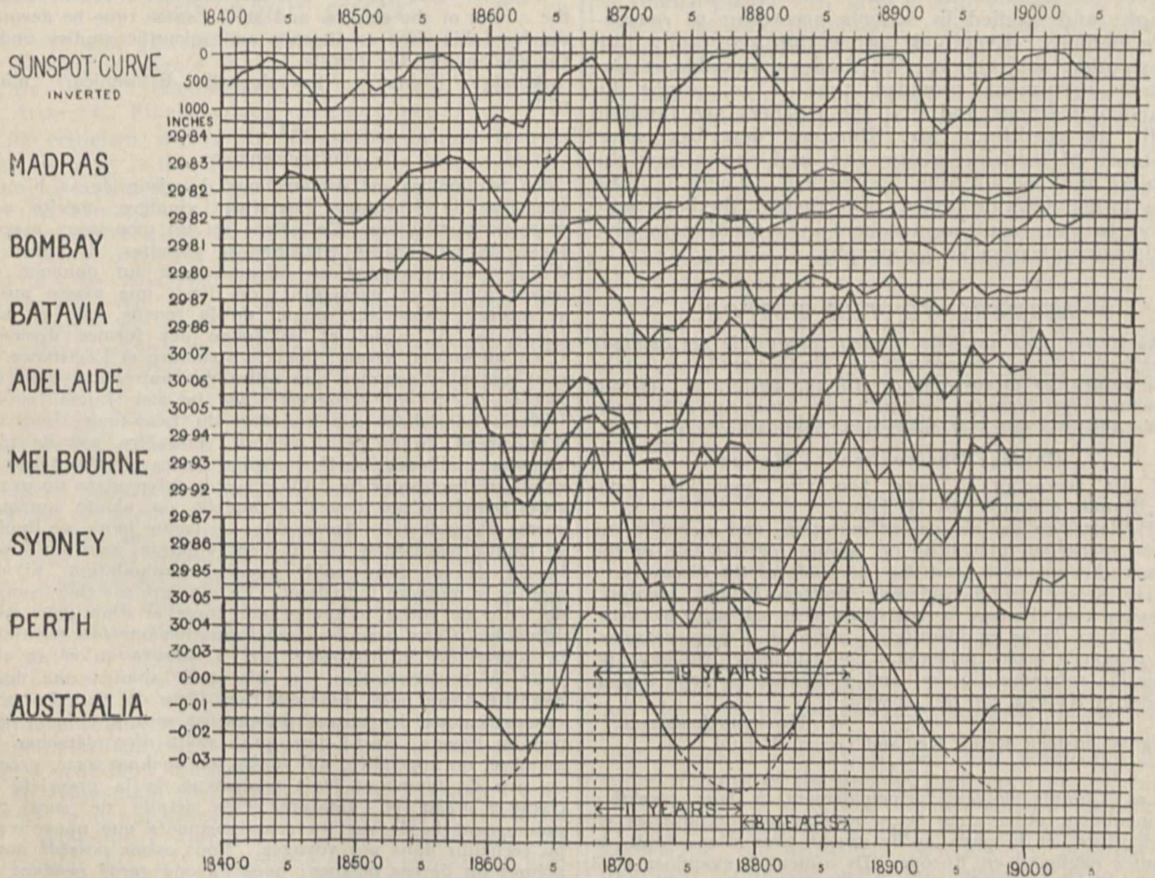


FIG. 1.—Long barometric changes which occur in the Indian, East Indian and Australian areas. The Indian variation is compared with the *inverted* sun-spot curve.

or Australia was in excess, that recorded in South America showed a deficiency.

During this inquiry it was noticed that there were changes going on which extended over a longer period of time than the short one (about 3.8 years) to which reference above has been made. In order to find out whether these long variations were similar all over the earth, or whether they also were of an opposite nature in different areas, several sets of long series of pressure observations have been carefully examined. The result of this limited survey recently formed the subject of a communication by the writer to the Royal Society,[1] and the following is a brief account of the results arrived at in the paper.

In the case of the variation of short duration, India,

Fig. 1 illustrates the series of curves, all drawn on the same scale, for the Indian, East Indies, and Australian areas. Bombay and Madras represent the pressure changes of the first, Batavia the second, and Adelaide, Melbourne, Sydney, and Perth are types for Australia.

An examination of these curves leads one to the following conclusions:—

First, the Indian curves are very alike, and suggest a variation of an oscillatory nature, the maxima or minima occurring about every ten or eleven years. Second, the amplitude of these curves, that is, the difference between the maximum and minimum

[1] "Barometric Variations of Long Duration over Large Areas." By Dr. William J. S. Lockyer. Read June 21, 1906.

values, has decreased considerably of recent years, and has nearly obliterated the eleven-year variation.

Going further afield, the curve for Batavia (East Indies) is very similar to that of Bombay. Coming to the Australian continent, it will be noticed that the eleven-year variation is well indicated in the Adelaide curve, but the amplitudes are much greater. Particular attention is directed to the maximum about the years 1876–1878, because in the curves for Melbourne, Sydney, and Perth this becomes quite insignificant. In fact, it is the dropping out of this maximum which gives the Australian curves quite a different appearance from those of India, although in many other respects they closely resemble the Indian changes.

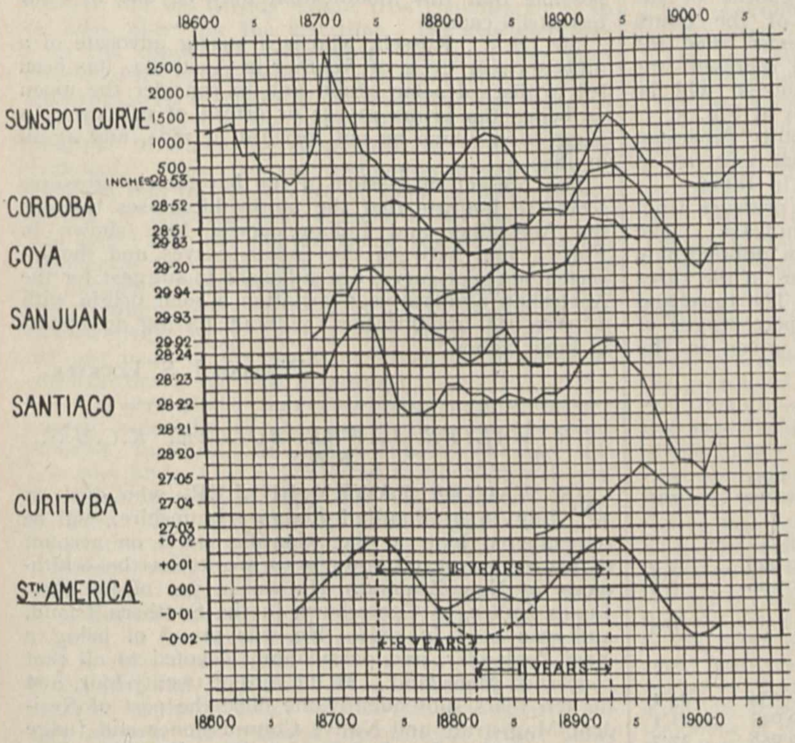


FIG. 2.—Long barometric variations in operation in South America.

The Australian curves thus indicate two principal maxima about the epochs 1868 and 1887, with an intermediate subsidiary maximum about 1878; the principal maxima are thus *nineteen years apart.* The curve given at the bottom of Fig. 1 is drawn to represent in a general manner this variation, and to serve as a comparison to the other curves which follow.

An examination of the South American pressures was next undertaken. Here, as I have said before, the data are not too numerous, but I think they are sufficient to demonstrate a long variation that is in operation and the epochs of the maxima and minima.

The same method of four-year means was employed as before, and curves drawn for five stations. Three series of observations represent the Argentine Republic stations Cordoba, Goya, and San Juan, while Santiago (Chili) and Curityba (Brazil) are also used, as they are stations situated more westerly and easterly respectively. Curves representing barometric changes at these places are all given in Fig. 2, and are drawn on the same scale. Although they extend over different periods of time, there is sufficient overlapping in all cases to allow one to draw conclusions as to the general kind of variation over this area.

As was done in the case of Fig. 1, a curve is here drawn at the foot of the South American curves to show the general nature of the variation in this region. Two principal maxima are very obvious about the years 1874 and 1893, while there seems to be an indication of a subsidiary maximum the mean of which is about the year 1883. We are here in the presence of a barometric change of long duration the principal maxima of which are also about *nineteen years apart*, so far as these observations inform us.

The question now arises, How does this South American variation compare with those shown to exist in India and Australia? This can be easily answered by comparing the curves brought together in Fig. 3.

The first point of importance is that the South American and Australian curves have principal maxima about nineteen years apart, while situated between them is another maximum of a subsidiary nature. The second is that the epochs of these maxima in these two widely separated areas *are not coincident.* Further, we are not here in the

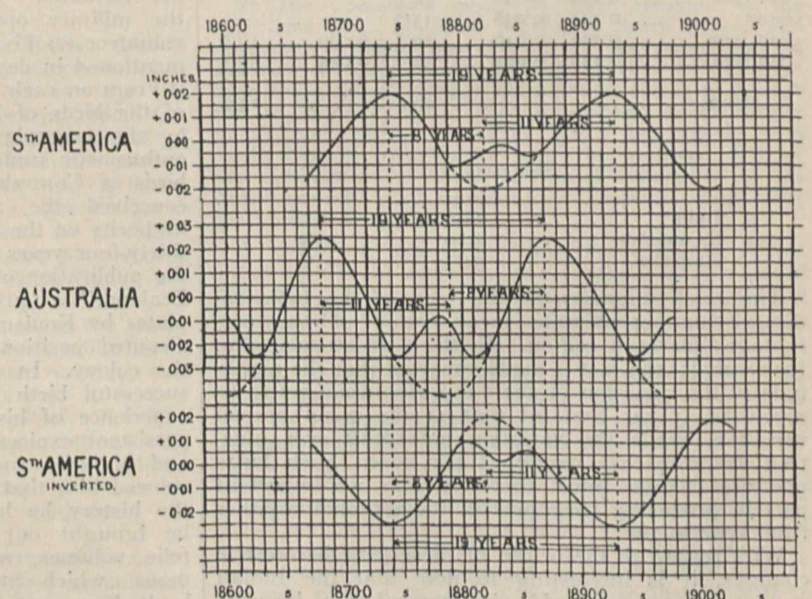


FIG. 3.—The barometric changes in Australia and South America compared with each other.

presence of a barometric see-saw, or opposite pressure variation, because the Australian maxima do not occur simultaneously with the South American minima; there seems to be a general time-difference of phase amounting to about six years, the epochs of the Australian maxima preceding those of the South American region. If a see-saw did exist, then the *inverted* South American curve should represent the Australian variation. That this is not so will be seen by comparing the two lower curves in Fig. 3.

It will thus be seen that the South American pressure type is closely similar to that existent in Australia, but unlike that in operation in India.

The magnitudes of these changes of pressure from year to year are by no means insignificant. The following table shows in compact form approximate measures of the amplitudes of the curves in the cases of both the short and long variations. The third and fifth columns of figures represent, in percentages of the annual variations, the amplitudes given in the second and fourth columns of figures:—

PRESSURE AMPLITUDES.

Station	Mean Annual Variation	Short Variation	Per cent.	Long Variation	Per cent.
	Inches	Inches		Inches	
Bombay	0·283	0·033 ...	11·7	0·026 ...	9·2
Madras	0·297	0·036 ...	12·1	0·026 ...	8 8
Means		. . . .	11·9	. . . .	9·0
Adelaide	0·226	0·077 ...	34·0	0·054 ...	23·1
Melbourne ...	0·204	0·076 ...	37·2	0·043 ...	21·1
Sydney	0·212	0·071 ...	33·0	0·058 ...	27·3
Means		. . . .	34·7	. . . .	23·8
Cordoba	0·177	0·037 ...	20·9	0·032 ...	18·1
Curityba	0·188	0·028 ...	14·9	— ...	—
Goya	0·248	0·038 ...	15·3	— ...	—
San Juan ...	0·236	0·046 ...	19·5	0·039 ...	16·5
Santiago	0·128	0·042 ...	32·7	0·045 ...	35·1
Means		. . . .	20·6	. . . .	23·2

Summary.

	Per cent.	Per cent.
India	11·9 ...	9·0
S. America	20·6 ...	23·2
Australia	34·7 ...	23·8

The brief summary at the foot of the table indicates an approximate mean value of the percentages for each region. In the case of Australia, for example, the fact is made apparent that the amplitude of the variation of short duration amounts to as much as 35 per cent. of that of the mean annual variation, while the variation extending over nineteen years reaches nearly 25 per cent. Such large pressure changes must therefore play an important part in producing variations in the seasonal weather from year to year.

With regard to the origin of these long barometric changes, it is interesting to note that the Indian pressure curves resemble in general the inverted curve representing solar activity as deduced from the area of sun-spots. This fact has for many years been known, and was pointed out by Brown, Hill, Eliot, Blanford, Douglas Archibald, and others. It will be seen from the curves, however, that the resemblance was far more striking before the year 1880 than after it.

Since the Australian curves are allied to but somewhat modified forms of the Indian variation, it seems possible that this modification may be due to some terrestrial cause.

Mr. H. C. Russell, who is a strong advocate of a nineteen-year cycle of weather in Australia, has been led to discard solar action and to consider the moon as being the prime mover or origin of this cycle, a suggestion which he put forward in 1870, and again in 1896.

The present discussion of the barometric pressures seems to indicate that the family likenesses between the Australian and Indian curves, here shown in Fig. 1, and between the Indian curves and the inverted sun-spot curve, are sufficient to suggest for the Australian nineteen-year variation a solar origin with a terrestrial modification without having to appeal to lunar action.

WILLIAM J. S. LOCKYER.

SIR WALTER LAWRY BULLER, K.C.M.G., F.R.S.

SIR WALTER LAWRY BULLER, who died on July 19 at Pontdail Lodge, Hampshire, will be remembered long in the scientific world on account of his accurate and sumptuous works on the ornithology of New Zealand. He was a son of the Rev. James Buller, of Canterbury, in the Southern Island, and was born in 1838. He was proud of being a New Zealander, and passionately devoted to all that concerned Maoriland. At the age of twenty-four, and for ten years subsequently, he filled the post of Resident Magistrate and Native Commissioner and Judge of the Native Land Court of New Zealand. Few had so intimate a knowledge of the Maoris as he possessed. In 1865, during a critical period of the Maori War, when Sir George Grey, the Governor, determined to take a personal hand in the contest in his endeavour "to quicken the slow dragging on of the military operations," Sir Walter served as a volunteer on his staff, and had the honour of being mentioned in despatches.

From an early age Sir Walter was a close observer of the birds of his native country. Fired no doubt by the example of (among others) Mr. Potts, an enthusiastic student and recorder of the habits of the birds of Canterbury, he, it would seem, very early conceived the ambition of making himself the authority on the birds of New Zealand. He was only thirty-four years old when, during the years 1872–3, the publication of his "History of the Birds of New Zealand," a quarto volume illustrated by coloured plates by Keulemans, placed him at once in the undisputed position of ornithologist *par excellence* of the colony. In bringing this splendid work to its successful birth he was greatly aided by the wide experience of his friend Dr. Bowdler Sharpe. The persistent exploration of the recesses of the country and his own continued study of its avifauna soon showed him that he had made but a contribution to the history he had undertaken. After fifteen years he brought out a second edition, in two costly folio volumes, also profusely illustrated by Keulemans, which attained a success which few bird books have ever met with. For seventeen years more Sir Walter continued gathering in the aftermath of his already great harvest, the results of which he had determined to issue as a supplement in two volumes, which, superbly illustrated like their predecessors, were only quite recently distributed.

Early in the year Sir Walter Buller was taken seriously ill, and only a few months ago the writer was permitted, during what was hoped by the sufferer himself and his friends was a true convalescence, to see him, alas! for the last time. He was dictating from his couch the concluding pages of the final volume of his supplement "to get them off his mind." Unfortunately, a relapse supervening he was removed into the country to the home of Mrs. Madocks, the daughter to whom the supplement is "affectionately dedicated," "his constant companion during its preparation, and the contributor of some beautiful photographs of New Zealand scenery to its pages." It was hoped that the change would restore the patient sufficiently to enable him to take a long, curative sea voyage. These hopes have been disappointed, and this distinguished ornithologist's life closed at the comparatively early age of sixty-eight years, with the last page of the work on which he laboured so enthusiastically for half a century.

Sir Walter Buller published many natural history papers, especially in the Transactions of the New Zealand Institute, on other subjects besides his favourite birds. He was elected to the Fellowship of the Royal Society in 1879, and the honorary degree of D.Sc. was conferred by Cambridge in 1903 in recognition of his scientific work.

Besides being a busy City man, Sir Walter held many public offices. He acted as Commissioner for New Zealand at the Colonial and Indian Exhibition of 1866, on the executive council of the Paris Exhibition in 1889, and for five years on the governing body of the Imperial Institute. He was created K.C.M.G. in 1886. A large donor to many museums at home and abroad, he received decorations from many foreign States in recognition of his generosity.

F.

THE YORK MEETING OF THE BRITISH ASSOCIATION.

THE seventy-sixth meeting of the British Association may be described as a very successful one. The Association was founded in York in 1831. It visited York again in 1846, and also in 1880. On the present occasion the citizens, who are proud of the connection of their ancient city with the association, welcomed the members with the greatest cordiality and hospitality. The meeting was favoured with exceptionally good weather, and as the programme left little to be desired, those who visited York on this occasion carried away with them very pleasant memories.

The old city looked its best. Socially, the meeting was everything that guests and hosts alike could have wished. The attendance at the meeting was 1959; that at the meeting in 1831 was 359.

We gave in our last number Prof. E. Ray Lankester's presidential address, as well as the names of the distinguished foreign men of science who attended the meeting, a number of whom received honorary degrees at Leeds University on Saturday, August 4.

The exhibition building proved very satisfactory; it would, in fact, be difficult to find a building better adapted for such a *rendezvous*. The reception room was adequate in all respects, and the great hall, handsomely decorated, had the appearance of a new building. Shrubs and bamboos with a well-judged sprinkling of *Lilium speciosum* relieved the eye, and hanging baskets at intervals depended from the galleries. The best thanks of citizens and visitors alike are due to the local secretaries, Mr. Charles E. Elmhirst and Mr. Henry Craven (Town Clerk of York), as well as to the acting secretary, Mr. Fred. Arey, whose experience in such matters proved invaluable.

The two evening discourses in the great hall of the exhibition buildings were delivered by Dr. Tempest Anderson and Dr. A. D. Waller, F.R.S., the subject of the former being "Volcanoes," while that of the latter was "The Electrical Signs of Life, and their Abolition by Chloroform." Large and attentive audiences packed the building, and showed every sign of interest in the subjects laid before them. The photographs of the late eruption of Vesuvius and its results were specially attractive.

The various sections were attended by large audiences, and offered so many subjects of interest that it is difficult to say which proved the most generally attractive. In many of the sections the presidents, in their opening addresses, dealt with the advance of science during the period of twenty-five years which has elapsed since the last meeting of the society in York.

At a meeting of the General Committee on August 1, the report of the Council was read. Action has been taken by the Council in accordance with the recommendations made in the following resolutions from Sections A and H:—

From Section A.—(1) The Committee, being of opinion that the completion of the Geodetic Arc from the South to the North of Africa is of the utmost scientific importance, and that the establishment of a Topographical Survey is of an importance that is at once scientific and economic, respectfully request the Council to make representations in such form as they think fit to urge upon the British South Africa Company the desirability of taking advantage of the present favourable opportunity for joining up the triangulation north and south of the Zambesi, and also to urge upon the Governments of the South African Colonies the immense practical and economic importance of commencing the topographical survey.

(2) The Committee desire to draw attention to the importance of a Magnetic Survey of South Africa, and respectfully request the Council of the Association to approach the Cape Government with a view to urging on them the great advantages which would accrue to Science and to South Africa if the Government would further support and assist the Survey which has already been partly made by Prof. Beattie and Prof. Morrison, and for the continuation of which a Special Committee of the Association is being appointed to cooperate with these gentlemen.

A grant of 300*l.* from the Special South Africa Fund has been made by the Council to Sir David Gill, for the purpose of completing the connection between the Rhodesian and Transvaal triangulations along the thirtieth meridian of East longitude.

From Section H.—(1) That it is desirable that the Governments of the South African Colonies be urged to take all necessary steps to collect, record, and preserve the knowledge and observations of men, such as missionaries, administrators, and others, who were living in intimate relations with the native tribes before the advance of civilisation began to obscure and even obliterate all true traditions, customs, and habits of the South African peoples; such steps to be taken without delay, especially in view of the old age and growing infirmities of most of the men referred to, and of the danger that with their deaths the knowledge which, if carefully recorded and preserved, would form a most valuable contribution towards the history of the aboriginal population, would be irrecoverably lost; and that the Council be recommended to communicate with the South African Association and suggest the appointment of a committee to deal with the matter.

(2) That, owing to the use by different writers and Government authorities of various names for the same groups of South African natives, much confusion and difficulty have arisen in anthropological and historical literature; that it is consequently desirable that Government authorities and others should confer as to the proper nomenclature of such groups (clans, tribes, and nations), with a view to ascertaining their inter-relationships, and to suggesting the most appropriate name for each group, and the best method of spelling that name phonetically; and that the Council be recommended to communicate with the South African Association and take such other steps as may conduce to this object.

(3) That the Committee are of opinion that it would conduce to the greater efficiency of officers who have to administer native affairs, and contribute to the advancement of anthropological science, as well as prove of considerable advantage to the well-being of the natives themselves, if opportunity could be given to such officers before or after their appointment to study comparative ethnology for at least two terms in one of the Universities of the United Kingdom which presents facilities for the study; and that in the case of junior officers already on active service such a course of study would facilitate their comprehension of native institutions and ideas, and help to render their services more efficient; and the Committee recommends the Council to take steps for the purpose of bringing this matter before the proper authorities.

At the meeting of the General Committee on August 3, the date of the opening meeting at Leicester next year was fixed for July 30. Sir David Gill, K.C.B., F.R.S., will be the president. The meeting in 1908 will be in Dublin, and that of 1909 at Winnipeg, Canada.

Subjoined is a synopsis of grants of money appropriated to scientific purposes by the General Committee:—

	£	s.	d.
Section A.—Mathematical and Physical Science.			
Electrical Standards	50	0	0
Seismological Observations	40	0	0
Magnetic Observations at Falmouth	40	0	0
Magnetic Survey of South Africa...	25	7	6
Further Tabulation of Bessel Functions... ...	15	0	0
Section B.—Chemistry.			
Wave-length Tables of Spectra	10	0	0
Study of Hydro-aromatic Substances	30	0	0
Dynamic Isomerism...	30	0	0
Section C.—Geology.			
Life Zones in British Carboniferous Rocks ...	12	7	7
Erratic Blocks	21	16	6
Fossiliferous Drift Deposits	25	19	0
Fauna and Flora of British Trias	10	0	0
Crystalline Rocks of Anglesey	7	18	11
Faunal Succession on the Carboniferous Limestone of S.W. England	15	0	0
Correlation and Age of South African Strata, &c.	10	0	0
Investigation of the Speeton Beds at Knapton...	10	0	0
Section D.—Zoology.			
Index Animalium	75	0	0
Table at the Zoological Station at Naples ...	100	0	0
Development of the Frog	5	14	6
Respiratory Phenomena and Colour Changes in Animals	11	2	0
Experiments on the Development of the Sexual Cells	5	0	0
Section E.—Geography.			
Oscillations of the Land Level in the Mediterranean Basin	50	0	0
Rainfall and Lake and River Discharge ...	10	0	0
Section F.—Economic Science and Statistics.			
International Trade Statistics	15	0	0
Gold Coinage in Circulation in the United Kingdom	10	0	0
Section H.—Anthropology.			
Excavations in Crete	100	0	0
Glastonbury Lake Village...	30	0	0
Excavations on Roman Sites in Britain... ...	15	0	0
Anthropometric Investigations	17	17	3
Age of Stone Circles	3	0	0
Anthropological Photographs	3	3	6
Section I.—Physiology.			
Metabolism of Individual Tissues...	45	0	0
The Ductless Glands	25	0	0
Effect of Climate upon Health and Disease ...	55	0	0
Section K.—Botany.			
Physiology of Heredity	30	0	0
South African Cycads, &c....	35	0	0
Botanical Photographs	5	0	0
Structure of Fossil Plants	5	0	0
Peat Moss Deposits	7	5	7
Marsh Vegetation	15	0	0
Section L.—Educational Science.			
Studies suitable for Elementary Schools... ...	10	0	0
Conditions of Health in Schools	5	0	0
Corresponding Societies Committee.			
For Preparation of Report...	20	0	0
Total	1061	12	4

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PRINCIPAL E. H. GRIFFITHS, SC.D., F.R.S., PRESIDENT OF THE SECTION.

MY predecessors in this Chair have in general been able to make communications to the Section conveying the results of investigations of their own, or enunciating some principle which would throw a fresh light on the discoveries of others. Mine is a far less happy lot. During the past four years and a half I have been engaged in administrative duties of such a nature that no time has been available for personal scientific work, and little energy even for the study of the work of others. In these circumstances it might have seemed more fitting if I had refused the honour which the Council of the British Association conferred upon me by the request that I would undertake the arduous duties which fall to the lot of the President of Section A. Nevertheless, after much hesitation, I decided to accept the invitation, in the hope that as a looker-on at the struggle of others, and with the experience of an old participator in the fray, I might be able to communicate some impressions which had possibly escaped the notice of those whose attention was necessarily more directed to some special branch of inquiry.

I trust that these words of apology may to some extent explain the nature of what must appear a fragmentary discourse.

In the interval which has elapsed since the last meeting of the Association we have lost many men whose names were household words within the walls of the physical laboratory. It is here only possible briefly to refer to the labours of a few of those distinguished seekers after natural knowledge.

The work of Dr. Sprengel has been by no means an unimportant factor in the advance of our knowledge of radiant energy, X-rays, &c., if only on account of the perfection of the apparatus for obtaining high vacua which will ever be associated with his name. The practical effect of his discoveries was considerable, for the business of electric lighting is undoubtedly greatly indebted to his labours. Born in 1834, he settled in England at the age of twenty-five. He was elected a Fellow of the Royal Society in 1878, and resided in this country during the remaining years of his life.

The death of Charles Jasper Joly, F.R.S., at the early age of forty-one, robbed mathematics and astronomy of one of their most devoted disciples. His "Manual of Quaternions" is well known, and those acquainted with his astronomical work are confident that, had his life been spared, he would, as Astronomer Royal of Ireland, have added lustre to an office held by many distinguished predecessors.

Samuel Pierpont Langley was born in 1834. In 1866 he became Director of the Alleghany Observatory at Pittsburg. His first work was the institution of a uniform system of time from the Atlantic seaboard to the Great Lakes. This, the first successful attempt to introduce uniformity of time over a large area, was subsequently widely imitated. In 1880 he invented the bolometer, and thus opened out a large new field of investigation into the invisible rays of long wave-length proceeding from heated bodies. He analysed in minute detail the lunar heat spectrum, and, more recently, he conducted an inquiry into the nature of the radiations emitted by the glow-worm. In 1881 he conducted his researches into the solar heat of the earth's atmosphere. In 1887 he became Secretary to the Smithsonian Institution. The result of twenty years' labour is to be found in the accurate determination, by temperature alone, of more than seven hundred lines in the invisible red spectrum, lines which are fixed with an average probable error of about one second of arc. In 1891 he published his experiments in aërodynamics, in 1893 "The Internal Work of the Wind," and in 1896 he demonstrated by actual experiment that a body nearly a thousand times heavier than air can be driven through and sustained by it. His published works show great literary charm. He especially excelled in the presentation of abstruse subjects in simple and non-technical language. This is, perhaps, hardly the occasion to refer to his social qualities. Those who had the privilege of his acquaintance, however, can best testify to his quickness of insight, his intense sympathy, especially with the young, and the impression of capability which he produced upon all with whom he came in contact.

The tragic death of Prof. Curie was felt as a calamity, not only by those closely interested in the march of scientific discovery, but also by those who had but a superficial knowledge of his work. A teacher for more than twenty years, he was nevertheless enabled by his enthusiasm and energy to perform those researches which will ever be connected with his name and that of his wife. So entirely has public attention been attracted to their joint work on the separation of the compounds of radium and their properties that we are apt to overlook other great services he rendered to science. His paper on "The Effect of Temperature on the Magnetic Properties of Bodies" led to the discovery of the law that for feebly magnetic substances the coefficient of magnetism varies inversely as the absolute temperature. He also pointed out that the magnetisation of diamagnetic substances appeared to be independent of the temperature and physical state, indicating diamagnetism as an atomic property.

It is pleasing to reflect that the importance of his discoveries received immediate recognition. It was but three years before his death that he announced to the French Academy the discovery of the new element, and in the same year he and Mme. Curie received the Davy Medal of the Royal Society and the Nobel Prize; and in July of last year he was elected to the French Académie des Sciences. He was one of the most modest and retiring of men, and this honour came to him unsought; his name will ever be remembered as one of the most notable of that brilliant band of workers who have within recent years so greatly extended the domain of physics by the discovery of radio-activity.

A quarter of a century has passed since this Section, meeting in this city of York, had the privilege of listening to a Presidential address by the pioneer of natural knowledge whom we now know as Lord Kelvin, and it may possibly be a not unprofitable task to review briefly a few of the advances which must render the interval a memorable one in the annals of science.

Lord Kelvin summarised the stores of energy from which mechanical effects can be drawn by man as follows:—

(1) The food of animals.
(2) Natural heat.
(3) Solid matter found in elevated positions.
(4) The natural motions of water and air.
(5) Natural combustibles.
(6) Artificial combustibles.

The twenty-five years which have since elapsed have not made it possible to extend this list. It is true that within the last few years the discoveries connected with radio-activity have enormously increased our estimate of the stores of energy surrounding us, but so far these additional stores cannot be regarded by us as stores from which "mechanical effects may be drawn by man." It is possible that in the ingenious radium clock which we owe to Mr. Strutt we have a source of mechanical energy unsuspected in 1881, but, at all events, regarded from a commercial standpoint, it can hardly be considered as "available by man." Nevertheless, there is a sense in which it may be said that we are profiting by atomic energy, for we are no longer bound to limit our estimate of the energy due to the radiant heat of the sun and the internal heat of the earth by previously known dynamical considerations, and, in consequence, our opinions with regard to the limit of the ages which the physicist could allot to the evolutionist have undergone profound modification.

I here wish to draw attention to some of the conclusions to which we are led by the work of Mr. Strutt.

Assuming the earth to be in thermal equilibrium, then, even if the whole of this interior heat be due to radium alone, the mean quantity per cubic centimetre cannot much exceed $1{\cdot}75 \times 10^{-13}$ gram. The conclusions of Rutherford, based on somewhat different values for the constants involved, give an equivalent of $1{\cdot}52 \times 10^{-13}$. Now Strutt has found that the poorest igneous rock examined by him, namely, Greenland basalt, contains more than ten times this quantity, and an average rock fifty or sixty times the amount. The assumption that the earth is cooling only aggravates the difficulty, and facts appear to tell against the theory that it is getting hotter. Also, we must take into consideration the heat due to the existence of uranium, thorium, &c.

We appear, therefore, to be driven to one of two assumptions: either (*a*) that the rate of heat production by radium diminishes as we approach the centre of the earth; or (*b*) that the interior of the earth differs markedly in constitution from the exterior crust.

It is true that Mr. Makower has shown that there is a slight change of activity in one of the radium products about the temperature of 1200° C., and it is very desirable that this inquiry should be pushed to much higher limits. At the same time, it appears evident that but a very slight change in activity takes place at temperatures below 1500° C.

Now Mr. Strutt has shown, arguing from known data, that the maximum temperature at the bottom of a crust of about forty-five miles in thickness, must be in the neighbourhood of 1530° C., although some amount of uncertainty is necessarily induced by our want of knowledge of the conductivity of rock at high temperatures. Anyhow, it is probable that at the depth indicated the temperature does not exceed the melting-point of platinum. Such a crust would contain about one-thirtieth of the earth's volume, and if throughout it the radium heat energy were of the average of that exhibited by many samples examined by Strutt, the temperature of the earth could be maintained until our stores of uranium suffered sensible depletion. Such an assumption would lead to the conclusion that the whole of the central portion of the earth consists of non-radio-active substances at an approximate uniform temperature somewhat below the melting-point of platinum. A brief summary of the evidence previously at our disposal may not be out of place.

In the first edition (1867) of Thomson and Tait's "Natural Philosophy" we find the tidal evidence summarised as follows: "It seems certain, therefore, that the tidal effective rigidity of the earth must be greater than that of glass."

In the 1883 edition of the same work a discussion of the question by Prof. George Darwin is given. He states: "On the whole we may fairly conclude, whilst there is some evidence of a tidal yielding of the earth's mass, that yielding is certainly small, and that the effective rigidity is at least as great as steel."

In a later paper (Proc. Roy. Soc., 1885) Darwin pointed out that this conclusion was based on the assumption that oceanic tides would have their equilibrium value, and that the validity of this assumption was open to doubt. Nevertheless, the evidence clearly indicated a high degree of effective rigidity.

Hough (Phil. Trans., A, 1895, 1896) discussed the variation of latitude, and, after correcting a small mistake of Newcomb's (who was the first to suggest the explanation), found the prolongation of the Eulerian Nutation from 305 to 430 days as indicating an effective rigidity of the earth about equal to that of steel. Wiechert (Trans. Roy. Soc. Göttingen, 197), of Göttingen, found that the mean density, ellipticity, and precessional constant were consistent with the hypothesis of homogeneous core with lighter surface layer.

Mr. R. D. Oldham (Phil. Trans., 1900), in a paper on the "Propagation of Earthquake Waves," came to the conclusion that the evidence pointed to a central metallic core, and to the existence of marked differences in the physical constants of the core and the surrounding crust. He, however, assigned a comparatively small radius to this core, viz., about 0·55 that of the earth.

I will now call your attention to the light thrown on this subject by the recent investigations of Prof. Milne. The difference in the rate of propagation of earthquake waves through the earth's interior and through the crust has led him to the conclusion that the material below a depth approximating to thirty miles is of a uniform nature, and that the change in physical constitution is abrupt at some such depth as that indicated. He writes as follows:—

"For chords which lie within a depth of thirty miles the recorded speeds do not exceed those which we should expect for waves of compression in rocky material. This, therefore, is a maximum depth at which we should look for materials having similar physical properties to those we see on the earth's surface; beneath this limit the materials of the outer part of this planet appear rapidly to merge into a fairly homogeneous nucleus with a high rigidity."

In the Transactions of the Royal Society for 1905 will be found a paper by Lieut.-Colonel S. G. Burrard on "The Intensity of the Force of Gravity in India." Colonel Burrard writes as follows:—"Geodetical observations have shown that the density of the earth's crust is variable, but they have not given any positive indications of the depths to which these observed variations extend. All calculations of the depths of subterranean variations in density and of the mountain compensation have, therefore, to be based on arbitrary assumptions of depth. The fact that the plumb-line seems generally to respond readily to the results given by the pendulum perhaps justifies the inference that the observed variations in the density of the earth's crust are not deep-seated. If an abnormal amount of matter exists in the crust near the surface, it will exercise direct effects upon plumb-lines and pendulums in the vicinity, but if it lies at a great depth its effects, especially on plumb-lines, will be less perceptible. . . . I have taken several instances of abnormal pendulum results from table, and have found in each case direct response from the plumb-lines at neighbouring stations. This conformity could hardly ensue if the variations in density extended to greater depths than thirty or forty miles. Our results do not justify us in asserting that no deep-seated variations in density exist, but they do justify the belief that the variations in density which have been discovered are apparently superficial."

It is interesting to notice the agreement between results drawn from such dissimilar sources. On the one hand we have had to deal with effects produced by almost inconceivably small particles travelling with immense velocity; on the other, with effects dependent upon the behaviour of "the huge terrestrial globe." That travellers starting from such opposite extremes should arrive at a common destination is in itself a striking example of the scope and accuracy of the work undertaken by investigators in physical science.

It is possible that the evidence from each source, considered independently, might be regarded as inadequate, but the cumulative effect is sufficiently strong to justify the belief that some marked physical change in the constitution occurs at a depth of some thirty to fifty miles.

At all events, we have indications that, with the exception of a comparatively thin crust, the earth consists of a non-radio-active substance with a rigidity approaching that of steel, with an average temperature in the neighbourhood of 1500° C., and a density at that temperature of about 5°·6 C.

An interesting question awaiting solution is the probable constitution of this core.

The above is but an example of the many fascinating problems upon which fresh light has been thrown by the revelations of recent discoveries in radio-activity, and the temptation to dwell on such themes is correspondingly great: but I feel that such a task should be committed to hands more capable than mine.

Fortunately, in the discussions which will take place during our meeting ample opportunity will be afforded those entitled to speak with authority. Nevertheless, there are one or two further aspects of the matter which I will venture to touch upon, although but an onlooker. I would, first of all, urge the importance of a study of what may be termed the natural history of the elements. We require more information as to their comparative proportions in different localities. The fact that, given the amount of uranium in a sample of native rock, we can predict with certainty the amount of radium contained in the same specimen is of startling significance.

The natural law which governs the proportions of these two substances may have a far wider reaching scope than we at present suspect. Nature appears to present to us a grouping which would not naturally have occurred to the mind of the chemist; lead and silver, copper and gold, and, again, platinum and iridium, seem invariably to be introduced to us by Nature as if bearing to each other some kind of blood relationship.

The facts we already possess seem dimly to indicate some close relation between elements which we have hitherto considered as outside the bounds of consanguinity, and for a fuller knowledge of this important branch of natural history we require the assistance of the practical engineer, the geologist, the metallurgist, and the chemist.

Many of the results arrived at by the investigators into the phenomena of radio-activity can apparently only be verified by the lapse of considerable intervals of time. It is probable, for example, that we can estimate with some degree of accuracy the time required for the dissolution of half a given mass of uranium or radium, but the complete verification of our inferences must probably be left to a future generation. If we accept this view, it is our duty to provide our successors with data on which their conclusions may be based. If, for example, carefully determined masses of the more radio-active substances could be placed in such circumstances as to remain untouched until the meeting of this Association some hundred years hence, our successors, who would doubtless be equipped with apparatus of research more accurate and more sensitive than any in our possession, would at all events be placed in a position to establish by direct methods the accuracy of inferences based upon the experimental data now at our disposal. This task is one which, it appears to me, might well be undertaken by Section A, and I trust that this suggestion may be held worthy of some consideration.

It appears probable that one gram of radium diminishes in weight by about half a milligram per annum; hence, if the funds of this Society admitted of the imprisonment of some definite mass of radium, our successors a hundred years hence would, even if they possessed only the apparatus now at our disposal, be able to determine its loss with sufficient accuracy to enable them to verify the truth of the conclusions arrived at by the physicist of to-day, while the investigation of the radio-activity of the residue would possibly throw light on many problems now awaiting solution.

It would appear that if we made a similar imprisonment of uranium, a like degree of accuracy would not be attainable until after the lapse of half-a-million years, and I am afraid that our interest in the work of our successors cannot be expected to cover so long a period. Nevertheless, it is probable that the presence of the products of decomposition could easily be detected after the lapse of a comparatively short interval of time.

The experiment might well be extended so as to include examples of all the elements capable of such treatment; and with each prisoner should be placed a full record of its physical constants, such as mass, density, electrical conductivity, specific heat, &c., with a clear indication of what is believed to be the probable accuracy of such determination.

During the past twenty-five years much thought has been devoted to the accurate determination of certain physical constants. This is very apparent in the case of one of the most important—namely, that commonly termed the "mechanical equivalent of heat," or, as I prefer to define it, the "thermal equivalent of energy." When Lord Kelvin addressed you in 1881, I think it probable that he would have indicated the value obtained by Joule—viz., 772·6 foot-pounds—at Manchester, as the quantity of work required to raise the temperature of one pound of water through 1° F. at 62° F. It is true that the results of Rowland's classical investigation were published in 1880 and 1881, but the discrepancy between his conclusions and those of Regnault regarding the change in the specific heat of water at temperatures between 0° C. and 30° C. introduced an element of uncertainty.

As a consequence of this discrepancy much experimental work on the subject has been performed in the last quarter of a century, and I think it may be said without hesitation that the value of this important constant is now ascertained with an accuracy of about one part in 2000. The amount of labour which has been employed in the determination of this thermal constant is extraordinary, and, as I have pointed out elsewhere, it well illustrates the cosmopolitan character of scientific investigation.

I have given reasons (Griffiths, "The Thermal Measurement of Energy") for specially selecting for consideration the determinations of Rowland, of Bartoli and Stracciati, of Ludin, of Callendar and Barnes, of Schuster and Gannon, and I have ventured to add my own. Thus Baltimore, Pisa, Zurich, Montreal, Manchester, and Cambridge have all contributed to the solution of the problem, and we may now with some certainty say that 777·7 foot-pounds at Greenwich are very closely the equivalent of the amount of heat required to raise 1 lb. of water through 1° on the hydrogen scale at 63°·5 F.

It may possibly appear that the result just quoted is a somewhat poor return for the expenditure of so much thought and labour. I would call attention, therefore, to the fact that the value of this equivalent is dependent on the measurements of many other natural constants; hence any agreement between the results obtained by the observations of Rowland and some of the other observers I have mentioned would only be possible in the absence of errors of appreciable magnitude in the determinations of mass, of change of temperature, and of electrical resistance and current. Certain discrepancies have led to the discovery of a hitherto unsuspected cause of inaccuracy, especially in the determination of temperature, and thus the inquiry has rendered valuable service in many branches of physical inquiry.

For example, so far back as 1893 I ventured upon a prophecy that the value assigned to the E.M.F. of a Clarke's cell was somewhat too high, and that it was possible that 1·4328 represents more truly the potential difference of a Clarke's cell at 15° C. than the ordinarily accepted value of 1·4342. In the report of the Electrical Standards Committee for 1897 will be found a discussion of this matter, and one of the consequences of the deliberations of that Committee is to be seen in the ampere balance now standing in the National Physical Laboratory.

The results of the observations obtained by this instrument will, I believe, shortly be published by Prof. Ayrton and Mr. Mather, but I am at liberty to state that, so far as the observations have been reduced, they point to the conclusion that the prophecy to which I have referred is closely fulfilled. We may say, therefore, with some confidence that the values of those units which form the basis of our system of electrical measurement are not only practically determined with a high degree of accuracy, but that also our measurements of temperature and of energy are placed on a satisfactory footing.

The last few years have been fruitful in revelations which not only profoundly affect the views of students of science, but also are of such a nature as to catch the eye of the public. In some cases the applications of these discoveries to the purposes of mankind have been evident and immediate. Every well-equipped hospital possesses apparatus for the production of Röntgen rays, and I suppose that every bluejacket in the Navy has some degree of acquaintance with those applications of science which have resulted from the discovery of Hertzian waves.

The ambition of the student is naturally fired by such examples, and there is a possible danger that the plodding but absolutely necessary work of accurate measurement may suffer by neglect. I therefore venture to repeat the well-established axiom that our advance in scientific knowledge is a function of accurate measurement, and that the student who devotes his energy to the determination of some physical constant is probably giving a "point of departure" to the pioneer. For it must ever be remembered that to the scientific investigator the rule of three has ceased to hold any significance.

When Lord Rayleigh discovered that the mean weight per litre under standard conditions of chemical nitrogen was 1·251, and that of atmospheric nitrogen was 1·257, the believer in the rule of three would have been unlikely to suspect that this difference of 0·006 would supply the clue which led Lord Rayleigh and Sir W. Ramsay to the discovery of a new element, a discovery which in its turn led to others of possibly even greater importance. For all we know the next decimal place in any hitherto accepted value may afford another example of the truth of the statement that a part may be greater than the whole.

At the time when Lord Kelvin delivered the Address to which I have already referred the truth of the second law of thermodynamics was probably not so generally accepted as is the case at the present time. Each apparent example of violation of that law has on closer examination proved to be additional evidence of its validity. We seem unable to find those "sorting demons" of Maxwell's the existence of which appears necessary for its violation.

Mr. Campbell recently expressed doubts as to the application of thermodynamic considerations to osmotics. He contended that the errors in the determination of osmotic pressure were greater than those which could be attributed to experimental sources. Now, the theoretical relation between osmotic pressure and the freezing-point is based directly on thermodynamic considerations, and it was because I entertained a belief that the most direct evidence of this much-debated matter could be obtained from the observation of the freezing-point of a very dilute solution that I embarked on a series of somewhat elaborate experiments during the years 1897 to 1901. My removal from Cambridge and the death of my assistant, Mr. C. Green, compelled me to leave that inquiry in an unfinished condition. Nevertheless, I had investigated the depression of the freezing-point in certain solutions varying in strength from 0·0003 to 0·025 gm.-molecule per litre.

Subsequently to my departure from Cambridge Mr. Bedford re-erected the apparatus in another building. After having surmounted great difficulties, he repeated many of my experiments, and he informs me that the numbers he has so far obtained are in almost entire agreement with those previously obtained by me. The molecular depression in the case of cane sugar I found to be 1·858, of potassium chloride 3·720, and I understand that Mr. Bedford's experiments agree with these results with a discrepancy of less than 1 part in 1000. The most probable number obtained from theoretical considerations would be in the former case 1·857, in the latter 3·714. As Mr. Whetham has pointed out, unless there is some balancing of opposite errors of a very improbable nature, it is difficult to imagine a more direct vindication of the application of thermodynamic considerations to the phenomena of solution. I may add that I also examined correspondingly dilute solutions of sodium chloride, barium chloride, sulphuric acid, potassium bichromate, magnesium chloride, and potassium iodide; but, owing to the circumstances to which I have referred, I was unable to repeat these experiments in such a manner as to enable me to attach great importance to the resulting figures. Nevertheless, I obtained values which strengthened the conclusions to which I was led by the more exhaustive examination of the dilute solutions of sugar and potassium chloride.

So far back as the Liverpool Meeting of this Association I expressed a hope that the experimental difficulties of the direct measurement of osmotic pressures would be overcome, as such direct measurement would afford the most useful data by means of which to obtain further light on the much-vexed question of the nature of solutions. I remember, also, that it was the general opinion of those who had given attention to this matter that the experimental difficulties were insuperable.

I am glad, therefore, to have this opportunity of stating my high appreciation of the manner in which Lord Berkeley and Mr. Hartley have grappled with the difficulties of this investigation. They have proved that the osmotic pressure obtained by direct measurement agrees with that derived from vapour-pressure observations to within less than 5 per cent.[1] The agreement is of great importance, as it diminishes our doubts as to the extent to which the imperfections of semi-permeable membranes may affect the validity of results dependent upon their behaviour, and points to the possibility of determining the osmotic pressures of concentrated solutions by measurement of their vapour pressures.

I trust it will not be thought out of place if I here refer to the interesting correspondence which has recently appeared in NATURE on the thermodynamic theory of osmotic pressure, and the allied, but by no means identical, problem of the difference between electrolytic and non-electrolytic solutions.

On the one side we have Prof. Armstrong, whose chief desire appears to be the vindication of the moral character of what he terms "the poor molecule"; and Mr. Campbell, whose doubts concerning the second law of thermodynamics are closely connected with a lurking belief in the existence of Maxwell's "sorting demons"; and by way of reserves we have Prof. Kahlenberg, who contends that "thermodynamic reasoning cannot be applied to actual osmotic processes" on account of the "selective action of the membrane" and "insists that the formation of crystals from a solution or the concentration of a solution by evaporation are not osmotic processes."

On the other hand we have Mr. Whetham, who, I confess, seems to me to be capable of holding his own without need of reinforcements. He has pointed out that confusion has arisen from the use of the term "osmotic pressure" to denote the actual pressure experimentally realised in certain conditions, as well as the ideal pressure required in thermodynamic theory. With regard to the theory of electrolytic dissociation, Mr. Whetham shows that the fact that the velocities of the ions are constant in dilute solutions and decrease slowly with increasing concentration, while the conductivity of a dilute solution is at most proportional to the first power of the concentration, appears irreconcilable with any assumption as to the existence of the active part of an electrolyte in the form of combined molecules when in solution. I would here join with Mr. Whetham in the request that those who oppose the theory of ionic dissociation would state their views as to the mechanism of electrolysis, and their reasons for supposing that the application of the principles of thermodynamics to the phenomena of solution is unjustifiable.

Prof. Armstrong remarks that it is unfair to "cloak the inquiry by restricting it to thermodynamic reasoning, a favourite manœuvre with the mathematically minded." He adds that such a course may satisfy the physicist, but "is repulsive to the chemist."

The inquiry, "Why is the application of thermodynamic reasoning repulsive to the chemist?" naturally suggests itself. I confess that at one time I regarded the extreme advocates of the theory of ionic dissociation with a certain amount of suspicion, but I think that most of those who have studied the evidence now at our disposal, or who have been engaged in experimental investigation into this interesting branch of physics, cannot fail to agree with Mr. Whetham that, as regards the fundamental conceptions of the theory, "the cumulative evidence seems overpowering." At all events, we may consider that the application to the phenomena of solution of reasoning based on thermodynamic considerations is justifiable, until we are presented with stronger arguments than those based on the repulsiveness to certain chemists of the conclusions to which it leads, or the doubt it throws upon the activities of Maxwell's demons and the selective action of semi-permeable membranes.

I will now trespass upon your forbearance and pass from the consideration of such special departments of natural science as usually engage the attention of members of this Section to some more general considerations, which naturally arise in any comparison of our knowledge of today with that which we possessed when we last met in this city.

It will, I think, generally be admitted that during the last twenty-five years the increase in our "natural knowledge" has been greater than in any previous quarter of a century.

Day by day we are adding new facts to our storehouse of information, until it has now become impossible for the individual to have more than a superficial knowledge of the contents of the building. And although this accumulation is one which we may well regard with satisfaction, it necessarily gives rise to difficulties unfelt by our predecessors.

I venture to indicate one of such difficulties, one which has been brought home to me both by my experience as an examiner and by the fact that during the past few years I have had to preside over many meetings of examiners, and to mark the effect of examinations on the teaching in our universities.

We now expect a student to acquire in a three years' course a far greater amount of information than was considered necessary, say, twenty-five years ago. The attention both of the teacher and of the taught is naturally directed to those extremities of the branches of science in which the growth has been most marked in recent years, and I venture to think that there is in consequence some danger of our neglecting the roots of the whole matter. Compare, for example, a Final paper in chemistry in any one of our universities with its predecessor of a quarter of a century ago.

The enormous advance of organic chemistry has necessarily reacted on the examinations, and thus the student is unable to devote an adequate proportion of his time and attention to the foundations of the subject. The same remark applies in the domain of physics. There is a danger, therefore, of our educational edifice becoming top-heavy.

I have heard complaints, on the one hand, from the examiners that while the candidates frequently exhibit considerable knowledge of the most recent scientific developments, they show a lamentable ignorance of the simple phenomena and the principles they illustrate. On the other hand, I have heard from candidates that many of the questions were too simple—that they were concerned with principles and facts to which their attention had not been directed since they first began the study of natural science.

My own experience has been that the simplest questions are those answered in the least effective manner. A candidate unable to give satisfactory illustrations of Newton's Laws will discourse upon the mass of an electron or the nature of the Röntgen rays, and attempt the solution of problems on such subjects as Hertzian waves and electric convection.

[1]

Concentration	Direct O.P. at 0° C.	O.P. deduced from vapour pressure at 0° C.
540 grains per lit. solution	67·5	69·4
660 ,, ,, ,,	100·8	101·9
750 ,, ,, ,,	133·7	136·0

Proc. Roy. Soc., June, 1906.

I hope that the attention of both examiners and teachers may be directed to the best methods of dealing with what appears to me to be not only a serious but an increasing evil.

To pass from one of the inconveniences which inevitably arise from growth, it is pleasant to dwell upon its more gratifying consequences.

Perhaps one of the most marked characteristics of the progress of science in recent times is the increasing public appreciation of the importance of original investigation and research.

The expansion of the university colleges in number and importance has greatly assisted and quickened this movement.

Twenty-five years ago there were comparatively few laboratories which held out any possibility of research to the English student. True, there were giants in those days, men, as a rule, working under difficulties greater than those encountered by their successors of to-day. The better equipment of our laboratories and the growth in the number and activity of our scientific societies have played no small part in stimulating public interest. Nevertheless, much remains to be done. Those who have read Prof. Perry's somewhat pessimistic words on England's neglect of science must admit that, however rapid our progress, the British people have not yet so fully awakened to the national importance of this question as some of our competitors.

The idea that a degree is one of the chief objects of education yet lingers amongst us. The conviction that it is a national duty to seek out and, when found, utilise the latent scientific ability of the rising generation for the purpose of adding to our stores of natural knowledge still needs to be brought home to the "man in the street." And here I would venture to indicate my personal belief in the necessity of more free communication between the laboratory and the market-place. It is possible that the language of science is becoming too technical, and that the difficulties with which scientific inquirers have been faced in past times have tended to habits of exclusiveness. For example, complaints are frequent that our manufacturers are less alert in grasping the practical applications of scientific discovery than their competitors in Germany and the United States. I confess, however, that it seems to me possible that the fault is not altogether on the side of the manufacturers. We want missionaries to preach the doctrine that one of the greatest of national assets is scientific discovery. If we can convince the men of business of this country that there are few more profitable investments than the encouragement of research, our difficulties in this matter will be at an end.

It is my lot to serve on the education committees of three county councils, and I have been much struck by the readiness of the members of those bodies to extend such encouragement whenever it has been possible to convince them that the results may conduce to the prosperity, the comfort, and the safety of the community.

It has also been my privilege to address meetings of the men who work in the coalfields of South Wales. I have attempted to direct their attention to the advantages which they have derived from the labours of those who have endeavoured to probe the secrets of Nature in the laboratory; I have tried to show how discoveries based on the researches of Humphry Davy, Faraday, Joule, for example, have not only diminished the dangers to which miners are exposed, but have also, by increasing the demands upon our stores of energy, given employment to thousands of their fellow-workers.

My experiences lead me to the belief that these men are ready to support the action of their representatives in extending support and encouragement to all efforts to assist the advance of scientific discovery.

It is possible that in dwelling on this matter I am trespassing on your forbearance, but I cannot resist this opportunity of pleading for the extension of your sympathies beyond the walls of the laboratory. The old toast, "Here's to science pure and undefiled; may it never do a ha'porth of good to anybody," may possibly be an excellent one in the laboratory; for, so far as I know, no great scientific principle has ever been established by labours prompted solely by desire for financial gain. Nevertheless, if we wish for the support of our fellow-countrymen, that toast is not one for public dinners. There is no scientific society which is brought into such close contact with the public as is the British Association, and affiliated with that Association are some scores of local scientific societies, containing many thousands of enthusiastic observers and inquirers. If this great organisation were seriously to take up the task of bringing home to the minds of the people of this kingdom the enormous value of the results of scientific inquiry, I believe it might be possible to change the indifference and apathy of our public bodies into active interest and encouragement. If each affiliated society would institute a series of public non-technical lectures, of such a nature as to bring home to the minds of the hearers some comprehension of the results of the work of Faraday, of Wheatstone, of Pasteur, of Maxwell, of Lister, and of Kelvin, the change in the public attitude would be real, evident, and fruitful.

In conclusion, one is tempted to seek for the underlying cause of the acceleration in the rate of advance of natural knowledge. Is it to be found in the increase in power of the human intellect, or the diversion into one particular channel of activities previously otherwise employed? It is possible that the human intellect has, by the processes of evolution, become more powerful, and that man's ability to decipher the secrets of Nature has thereby increased. I think, however, that it would require a bold advocate to support this thesis. If any such mental evolution has taken place, it is strange that it should be restricted to one particular sphere of activity. Are our poets and authors of to-day greater than Homer, our statesmen than Pericles? Or, passing into the domain of science, can we say with confidence that, in pure power of reasoning, Maxwell was undoubtedly the superior of Archimedes?

I have elsewhere indicated what appears to me to explain the mystery of this acceleration, namely, *the extension of our senses* by mechanical appliances. When we supplement our eyes by the bolometer and the electric coherer, the range of our vision is augmented a thousandfold. By the use of the electroscope and the galvanometer we have extended our senses of sight and touch until we can detect the presence of an electron.

Having realised the imperfection of our faculties, we have called upon Nature in all departments of science to supply our deficiencies, and are thus enabled to walk with confidence where previously all seemed dark.

From the time of Archimedes to that of Bacon we despised Natural Knowledge while we deified intellect and authority; hence for nearly 2000 years our record was one of retreat rather than advance. When the philosopher left his study and applied his powers of observation to the phenomena of the universe, progress became a reality, and thenceforward the march of discovery has known no backward step. We have therefore every reason to believe that when the Association again visits this ancient city our President will be able to chronicle an increase in Natural Knowledge even greater than that which has been one of the distinguishing characteristics of the last quarter of a century.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. WYNDHAM DUNSTAN, M.A., LL.D., F.R.S., F.C.S., PRESIDENT OF THE SECTION.

Some Imperial Aspects of Applied Chemistry.

THE President of the Chemical Section of the British Association must always have a large choice of subjects for his Address. He may attempt to review the chemical progress of the year, or to give an account of researches in that division of the science in which he is most interested. He may deal with the ever-recurring problems of education; or, again, he may draw attention to the importance of our science in one or other of its many relations to National and Imperial affairs. I have decided to adopt the last course, and to invite your attention at York, where several tropical products furnish the basis of important industries, to the intimate connection of our science with the problems that await solution in connection with the utilisation of the raw materials and economic products of our Colonies, and especially those of our tropical Possessions. There is a pressing need that the Imperial Government should recognise much more fully than it has hitherto done, and at least as fully as foreign Governments are already doing, the claims of scientific investigation to be regarded as the pioneer instrument of this work, and as the essential first step in the material and commercial development of our Possessions.

Although my remarks will be chiefly directed to the importance of chemistry in this connection, my plea will be more general. It is that the scientific method of experimental research should be systematically applied in each division of the sciences concerned. In the case of raw materials, however, whether vegetable or mineral, their commercial value must depend chiefly, if not entirely, upon their composition, and sooner or later the method of chemistry must therefore be applied.

In determining the value of the mineral resources of a country other specialists are also concerned, and the assistance of the geologist, the mineralogist, and eventually of the metallurgist may be required. Similarly with vegetable and agricultural products the services of the economic botanist and of the entomologist will be needed. It will therefore be necessary for me in dealing with the subject as a whole to touch upon several aspects in which other sciences are concerned, and with which the science of chemistry must cooperate in attaining a practical end—namely, the material development of the countries concerned. I need make no apology for many allusions to scientific agriculture, for this subject is this year attached to this Section, and indeed the science of chemistry is of fundamental importance to agricultural practice both at home and in the tropics.

In the first place I must ask you to allow me to say a few words as to the very wide interests that are involved in the proper solution of the problem of colonial development.

It is all-important that the wage-earning community of this country should have an adequate supply of tea, coffee, cocoa, rice, tobacco, and other commodities, and that our manufacturers should be able to count upon a regular supply of cotton, jute, rubber, and other raw materials as far as possible under their own control. All these products are derived almost exclusively from the tropics, and experience shows that it is a great disadvantage to the manufacturer not to be able to exercise control in the direction of securing the regular production of these materials, and especially not to be able to avoid the great and sudden fluctuations in their price, which are often the result of financial speculation on the part of a foreign capitalist who has secured the control of the output of a foreign country.

The almost entire dependence of the great textile industries of Lancashire upon the cotton crop of the Southern States of America has placed this industry at the mercy of American speculators, whose tactics may lead, as in 1903, to such a rise in the price of the raw material as to render it imperative for the manufacturer to close his mills, and by throwing large numbers out of employment to bring poverty and misery to many thousands of people.

The great principle which must now necessarily guide our system of administration and expenditure in our tropical Colonies and Protectorates has as its purpose the utilisation of natural resources and the creation and development of native industries with the aid of European supervision and advice. Adequate supplies of produce, natural and agricultural, will thus be ensured to British manufacturers and consumers from territories within the administration of the British Crown. This principle of employing our "undeveloped estates" for the advantage of our manufacturers and consumers, and at the same time for the benefit of the natives who inhabit these countries, was put into action by Mr. Chamberlain during his long tenure of office as Secretary of State for the Colonies, and this recognition of a vitally important principle must always be associated with his name.

Excepting India and the self-governing Colonies, the Crown Colonies and Protectorates, for which alone the Imperial Government is directly responsible, include an area of about two and a half million square miles and a population of about forty millions. The value of these possessions to us at the present time may be judged from the value of their import and export trade with the United Kingdom. The value of the exports of these countries in 1904 was estimated at about four and a half million pounds sterling, and the imports from the United Kingdom at about twelve and a half million pounds sterling. In gauging the importance to this country of the development of these Possessions, the export trade of which is only in its infancy, it should be remembered that the profits arising from the export as well as from the import trade are chiefly domiciled in this country; since practically the whole of this trade is in the hands of British merchants, and the entire profits, including those of shipping, &c., are therefore subject to our national system of taxation, and represent a very substantial annual contribution to the British Exchequer.

It is therefore only reasonable that a certain sum should be expended from British funds to aid the applications of science to the commercial development of these Possessions. Such an expenditure in the light of the facts to which I have drawn attention may be regarded as an investment with the certainty of a profitable return.

I have thought it necessary to give this brief account of the position of our still undeveloped Crown Colonies and Protectorates and the national importance to us of their systematic development before proceeding to the principal subject of this Address, which is to emphasise the aid which science in several of its branches can render to this work of development, and especially the science of chemistry, the capacities of which in this connection have so far not been sufficiently recognised.

The importance of utilising our own tropical Possessions as sources of the raw material required by the manufacturer is now generally recognised, and very considerable progress has been made in recent years. The tea produced in India and Ceylon has largely superseded the China tea formerly used in this country. Similarly, coffee is extensively grown in India, in the West Indies, and in several of our African Possessions. The jute cultivation in India has been very successful, and the demand for this fibre is so great that the question of its cultivation in our West African Colonies is now under consideration. India-rubber, hitherto chiefly obtained from South America, is of increasing importance as a commercial article, and the South American tree has been introduced with success in Ceylon, the Straits Settlements, and the Federated Malay States, which are rapidly becoming important rubber-producing countries the produce of which is competing successfully with that of South America. The cultivation of cotton, hitherto principally carried on in the United States, is being vigorously proceeded with in India, the West Indies, and in West Africa, as well as in Egypt and the Sudan, and we may look forward in the future to these countries supplying the British manufacturer with a large proportion, if not the whole, of the cotton he requires.

There are, however, vast resources, both mineral and vegetable, in our Colonies and Protectorates which are awaiting development for an exact knowledge of their composition and properties, which can only be ascertained by scientific means and chiefly through chemical investigation, whilst the British manufacturer is in need of increased and better supplies of the raw materials on which his industrial activity depends. This demand for increased supplies now affects nearly every industry in this country. Rubber and fibres are well-known examples; oils and fats for the manufacture of soap and perfumes; and tanning materials, as well as numerous minerals, are other instances in which our manufacturers are at present anxious to discover new sources of supply. These sources can only be discovered and their value ascertained by properly directed scientific investigations.

We have heard much recently respecting the assistance which science can bring to the maintenance and development of the industrial efficiency of this country, and the Imperial Government is being urged to give its help especially by providing increased facilities for the education of scientific men, competent to aid the manufacturers of this country in improving their methods and processes. In this work the science of chemistry is one of the most important. There is scarcely an industry to which it is not able to render immense service. Within recent years this fact has slowly gained recognition, and the principle of State assistance to industry is virtually admitted, both in respect of education and of research. The most recent examples of a recognition of the principle are the grants made from the National Treasury to the new Technological College at South Kensington and to the National Physical Laboratory.

Not less important than the service which science can render to existing industries and their extension is that which it can contribute to the Imperial problem of ascertaining and rendering available for the manufacturer the vast undeveloped resources of our own Possessions. Our own experience and the example of other countries have shown that such work cannot be systematically carried on by private enterprise. Upon its successful accomplishment depends, not only the unrestricted supply of the necessary raw materials for which the manufacturer looks in increasing quantity, but also the prosperity of the country which produces these materials. This success can only be brought about by a combined effort on the part of the manufacturer and of the Government. The manufacturer can provide information as to the materials he needs. The preliminary work of discovering suitable material by scientific means, as several foreign Governments have already recognised, must be endowed, directed, and carried on with Imperial funds. It cannot be expected that private enterprise will take steps to explore the resources of little-known countries on the chance of a particular material being discovered, nor can the work, as a rule, be successfully done by this means. Experience shows that the most effective manner of promoting the commercial development of a new country is for the Government to carry out systematically with its own officers the preliminary work of exploration and examination of the natural resources, with the aid of such technical advice as may be necessary from manufacturers and users, and then, having established the fact that particular products of value can be found or cultivated in a given country, to leave commercial enterprise to do the rest. By action on these lines immense progress is being made in French, German, and Dutch possessions, whilst the United States Government has taken similar action with the Philippines. In our own case, where this work exists it is in most cases in a more or less embryonic condition, and lacks the organisation which is necessary for success.

In many of our Crown Colonies and Protectorates there already exist, or are in the process of organisation, agricultural and other scientific departments, many of which include officers who are engaged in the work of exploring and developing the vegetable resources of these countries especially by experimental planting. Chemists are attached to some, but not to all of these departments. In the West Indies the valuable work accomplished by Prof. Harrison, Mr. Francis Watts, Prof. Albuquerque, Prof. Carmody, and Mr. Cousins is well known, and illustrates the great services which the science of chemistry may render, not only to tropical agriculture, but to every branch of economic development. It is clearly desirable that at least one scientific department should be attached to the Government of each of the principal Crown Colonies and Protectorates. As a rule, it is convenient that this should be an agricultural department with the services of a scientific chemist at its disposal. In a tropical climate, and with limited appliances at his command, it must be admitted that a chemist is severely handicapped, and, as a rule, he cannot be expected at first to be able to do much beyond the comparatively simple and preliminary work, chiefly analytical, which, however, in a little-known country is of the greatest importance to an agricultural department. In addition, he would have to deal with the composition of natural products of all kinds, both vegetable and mineral, as well as with the improvement of native industries. If the chemist is able to refer complicated or special investigations to a central department at home, and is provided with assistance in the routine work, he would be in a position to undertake the scientific investigation of a selection from the numerous problems with which a chemist will be confronted.

A chemist working in the spirit of an investigator will be able to render special services to the cause of tropical agriculture, and it is therefore of importance that in future the men appointed to these posts should be chosen as far as possible on account of the promise they have shown as investigators. The determination of the constituents of little-known indigenous plants as the first step towards ascertaining their economic value is another department of work which cannot be carried out without a chemist, and the same applies to the examination of poisonous plants, and also of minerals, in addition to the determination of the composition of foods and feeding stuffs.

Tropical agriculture is a subject which is now of the first importance, especially in those countries in which our policy is to depend on a native population for the actual cultivation of the soil. We have two functions to perform in our position as supervisors: the one is to ascertain the nature and capabilities of the soil by actual experiment, for which well-organised experimental stations are a necessary part of every agricultural department; the other duty is to convey to the natives, chiefly by means of demonstration, the results of this experimental work, so that they may be persuaded to make it a part of their agricultural practice.

Work on these lines is being done under Government auspices in the French and German Colonies, and I may allude to the French successes in Algeria, in Senegal, and in the Sudan, and to the advances made by Germany in East Africa. These achievements are mainly due to a policy of continuous scientific work on agricultural lines. We shall have the privilege of hearing from Dr. Greshoff, the eminent director of the Colonial Museum at Haarlem, an account of the chemical investigations which are being carried out in connection with Java and the Dutch East Indies.

In many of our own Colonies and Protectorates active agricultural departments, equipped with the means of experimental working, are only now in process of organisation. One of the most recently organised of these is that of the Transvaal, which, at Lord Milner's initiation, has been completely equipped on the lines of that model for all such effort, the agricultural department of the United States. This department has as its chief chemist Mr. Herbert Inglis, of the Yorkshire College, now the University of Leeds.

If we are to compete successfully with foreign countries it is necessary that the position of science in relation to tropical agriculture should be definitely recognised. The days when a botanical garden served the purpose of an entire scientific establishment in a Colony have passed away, and we now require, in order that a proper return should be obtained, and the natives assisted in their agricultural practice, a scientific department with a proper complement of specially trained officers, including a consulting chemist, other specialists being added to the staff as the requirements arise. These officers should be remunerated on a scale likely to attract some of the best educated men from this country, which is at present far from being the case.

It would be out of place to discuss here the detailed organisations of these scientific departments. I merely desire to urge the necessity of their functions being extended, and of their receiving adequate financial support.

It is important that the scientific work which is being accomplished by these various departments should be brought to a focus, and that the results obtained in one Colony should be available for the information of the departments in other Colonies. The work of all such establishments requires to be unified by cooperation with a Central Department which can extend the investigations conducted in the Colonies, carry out investigations and inquiries which cannot be undertaken on the spot, maintain the necessary touch with the manufacturers, and coordinate the work undertaken and the results obtained in each of the separate Colonial establishments and systematically collate it, so that each may be aware of the results that are being obtained in other countries.

In our African Possessions at present the same investigations and inquiries have to be conducted independently, and often without the knowledge that the problem in question has been already solved.

Another increasingly urgent duty of the Central Department is to inform the Colonial establishments of the results of the work which is being conducted in foreign countries, and of the progress which is being made in the utilisation of raw materials all over the world, and to bring to their notice the constantly changing requirements of the manufacturers and users of raw materials.

So far as botany is concerned, this coordination has been to a large extent effected through the agency of the Royal Gardens, Kew, which is in touch, through the Colonial Office, with all the botanical gardens in the Crown Colonies and Protectorates. In chemistry, as well as in certain other subjects, these duties have been performed in recent years by the Scientific and Technical Department of the Imperial Institute, which is now working in cooperation, not only with the Governments of the Crown Colonies and Protectorates, but also with those of several of the self-governing Colonies, and also with the Scientific Departments which have been brought into existence in India, where at last the importance of scientific agriculture is receiving due recognition from the Government.

So little has hitherto been done in this direction that the number of problems requiring attention is exceedingly large; and even with a specially trained staff of workers and extensive laboratories, such as now exist at the Imperial Institute, it becomes necessary to select as the principal subjects for investigation those which are regarded by the Governments of the countries concerned as of the most practical importance, and in which the British manufacturer is at the moment most concerned. There must therefore remain a large number of materials of unknown composition and of problems of purely scientific interest which offer an attractive field for the chemical investigator. Already steps have been taken to provide for the investigation of these subjects by scientific men who are willing to undertake them in communication with the Institute. For example, Mr. A. G. Perkin, F.R.S., has been furnished with material which has led to the identification and determination of the constitution of the colouring matters of a number of plants which are employed as dyes in India and the Colonies. Prof. A. H. Church, F.R.S., has determined the composition of many new or little-known food grains. Dr. Crossley, Mr. Le Sueur, and Dr. Lewkowitsch have examined the constituents of a large number of fats and oils furnished by seeds of Indian and African origin. Dr. W. J. Russell, F.R.S., has been furnished with selected materials for examination in connection with his interesting investigations of those substances which affect the photographic plate in the dark, whilst the Hon. R. J. Strutt, F.R.S., has investigated the radio-activity of a number of new or little-known minerals containing rare earths. Last year more than 500 different materials and problems were submitted from the Colonies and India for investigation to the Scientific Department of the Imperial Institute, and each year there must remain an increasing number of interesting subjects which cannot be included in the Department's annual programme of work. Many of these would furnish excellent subjects for chemical research by advanced students in connection with the universities and technical colleges throughout the country. It is nearly always possible to arrange to furnish the necessary material for any competent worker to deal with. Next year a list of such subjects awaiting investigation will be available at the Imperial Institute for those in search of subjects for chemical research.

Whilst the investigation of some of these subjects may at once produce results of scientific value, many of them present difficulties in their investigation which are far more serious than those which attend the usual synthetical work in organic chemistry. I do not know of any more profitable experience for the advanced student who is already familiar with the principles of organic chemistry and of laboratory practice than the separation in the pure state of the chemical constituents of a plant and the determination of their chemical constitution. In inorganic chemistry the examination of a new mineral furnishes similar experience.

In carrying out research of the kind I am advocating, the chemical investigator will have the additional advantage of knowing that the scientific results he obtains will contribute to the knowledge of the resources of the British Empire, and possibly be the means of laying the foundations of new industries.

I need hardly remind chemists that some of the most important discoveries in our science, and many of those which have had the most profound influence on the development of chemical theory, have arisen from the examination of the constituents of raw materials. The discovery of morphia in opium led to the recognition of the new class of alkaloids; the discovery of amygdalin in the bitter almond of the new group of glucosides; the investigation by Liebig and Wöhler of the chemical properties and composition of the essential oil of the bitter almond was largely instrumental in laying the foundations of modern organic chemistry; whilst it was during the examination of the constituents of bran that Fownes was led to the discovery of furfurol and the subsequent recognition of a new type of organic compound. In more recent times the examination of the constituents of oil of turpentine and various essential oils yielded by different plants has been the means of elucidating the chemical theory of the great group of terpenes, and latterly Harries's investigation of caoutchouc has led to the discovery of the ozonides which seem likely to be of much importance as a new means of determining the constitution of certain classes of organic compounds. Lastly, I may remind you that the discovery of helium might have been long delayed had not Prof. Miers drawn Sir William Ramsay's attention to the so-called nitrogen furnished by the mineral cleveite.

I have thought that it would be of interest on the present occasion if some account were given in the Section of the chemistry of certain of the raw materials employed in the principal manufacturing industries of the city of York. These industries are vitally concerned with an adequate supply of certain raw products of tropical origin, especially cocoa and gums. In connection with the first of these, which has hitherto been obtained chiefly from the West Indies, a new industry of cocoa production has sprung up in West Africa, notably in the Gold Coast and in Lagos. This West African cocoa presents some peculiarities which have rendered it desirable to examine the nature of its constituents. Gums of the nature of gum arabic are at present chiefly derived from the French Colony of Senegal. It is, however, clear from the examination of gum collected in West Africa that that country, and especially Northern Nigeria, will be able in the future to contribute to the needs of the British manufacturer, in addition to the Sudan, India, and Australia, which will also be able to make important contributions. In connection with the investigation of these gums derived from new sources at the Imperial Institute, the very remarkable observation has been made that certain gums from India and the Colonies possess the property of evolving acetic acid when exposed to the air. The chemical constitution of one of these gums has been fully investigated at the Imperial Institute by Mr. H. H. Robinson, who will contribute a paper on the subject to the Section, in which he will show that the production of acetic acid is due to the elimination of an acetyl group by hydrolysis through the moisture of the air. He has also succeeded in elucidating to a large extent the chemical nature of the gum. Mr. Robinson will also make a report on the present position of the chemistry of gums, a class of substances the constitution of which is exceptionally difficult to unravel. Little, if any, advance has been made in recent years on the well-known researches of O'Sullivan.

There is no more important group of questions demanding attention from the chemist at the present time than those connected with the production of india-rubber or caoutchouc. An enormous increase in the demand for india-rubber has taken place in the last few years, and last year the production was not less than 60,000 tons. Until recently the supply of rubber came chiefly from two sources —the forests of Brazil, which contain the tree known as *Hevea brasiliensis*, furnishing the Para rubber of commerce which commands the highest price, and the forests of Africa, where climbing plants, generally of the Landolphia class, also furnish rubber. The increased demand for caoutchouc has led to the extensive planting of the Para rubber tree, especially in Ceylon and in the Federated Malay States. Systematic cultivation and improved methods of preparation are responsible for the fact that the product of the cultivated tree, which begins to furnish satisfactory rubber when six or seven years old, is now commanding a higher price than the product of the wild tree in Brazil. It is estimated that within the next seven years the exports of cultivated india-rubber from Ceylon and the Federated Malay States will reach between ten and fifteen million pounds annually, and that after fifteen years they may exceed the exports of the so-called wild rubber from Brazil.

The services which chemistry can render to the elucidation of the problems of rubber production and utilisation are very numerous. Methods of treatment depending on a knowledge of the other constituents of the latex have led to the production of rubber in a purer condition. Much still remains to be elucidated by chemical means as to the nature of the remarkable coagulation of the latex. As is well known, the latex is a watery fluid resembling milk in appearance which contains the rubber, or, as I think more probable, the immediate precursor of rubber, together with proteids and other minor constituents. The constituent furnishing rubber is in suspension, and rises like cream when the latex is at rest. On the addition of an acid, or sometimes of alkali, or even on mere exposure, coagulation takes place and the rubber separates as a solid, the other constituents for the most part remaining dissolved in the aqueous liquid or "serum." The first view taken of the nature of the coagulation process was that, like the coagulation of milk by acids, it is dependent upon a process of proteid coagulation, the separated proteids carrying down the rubber during precipitation.

This explanation cannot, however, be considered complete by the chemist, and there are peculiarities connected with the coagulation of the latex which are opposed to the view that it is wholly explained by the coagulation of the associated proteids. The experimental investigation of the question on the chemical side is beset with many difficulties, which are increased if access cannot be had to fresh latex. A number of experiments were made at the Imperial Institute with latex forwarded from India. The difficulties contended with in preventing coagulation during transit were great, but in the case of the latex derived from certain plants these were to some extent surmounted, and the results obtained, especially with reference to the behaviour of certain solvents towards the latex, led to the conclusion that "coagulation" can take place after removal of the proteids, and that in all probability it is the result of the polymerisation of a liquid which is held in suspension in the latex and on polymerisation changes into the solid colloid which we know as caoutchouc. Weber, by experiments conducted in South America with fresh latex, arrived at a similar conclusion, which later workers have confirmed. Although the nature of the process is not yet completely elucidated, there is little room for doubt that the coagulation is due to the polymerisation of a liquid and possibly of a liquid hydrocarbon contained in the latex. For the chemist the important question remains as to the nature of this liquid from which caoutchouc is formed.

The chemical nature of caoutchouc is a subject which has attracted the attention of distinguished chemists from the middle of the eighteenth century, among them being Faraday, Liebig, and Dalton. Faraday was the first to examine the constituents of the latex of *Hevea brasiliensis*. It is only in recent years that our knowledge of the constitution of organic compounds, and especially of the terpene group, has rendered it possible to make any great advance. It is interesting to record that Greville Williams, in 1860, made most important contributions to this subject. He identified a new hydrocarbon, isoprene, as a decomposition product of caoutchouc, and recognised its polymeric relation to caoutchouc.

The results obtained from the analytical side, and especially the formation of di-pentene and isoprene by pyrogenic decomposition of caoutchouc, had pointed to the fact that caoutchouc was essentially a terpenoid polymer of the formula $C_{10}H_{16}$. Harries finds, however, that the ozonide of caoutchouc, when distilled with steam, breaks up into lævulinic aldehyde, lævulinic acid, and hydrogen peroxide, and he concludes from this that caoutchouc is a polymer of a 1 : 5 dimethyl cyclo octadien. Whilst Harries's work has brought us much nearer the goal, and has led to the discovery of a new method of investigation through the ozonides, which is obviously of wide application, it cannot yet be said that the constitution of caoutchouc has been settled or its relation to the parent substance of the latex definitely established. It has still to be shown how a closed-chain hydrocarbon such as Harries's octadien can undergo polymerisation forming the colloid caoutchouc.

There are strong arguments for the view that the constitution of the parent substance present in the latex is nearly related to that of isoprene. This remarkable hydrocarbon of the formula C_5H_8, first obtained by Greville Williams from the dry distillation of rubber, is an unsaturated olefinic hydrocarbon which is found among the products, resulting from heating caoutchouc. It readily polymerises, forming di-pentene. Bouchardat noticed that this hydrocarbon obtained from the pyrogenic decomposition of caoutchouc furnished a substance identical with rubber when acted on by hydrochloric acid and under other conditions. To Wallach and also to Tilden is due the further important observation that when isoprene prepared from oil of turpentine is kept for some time, it gradually passes into a substance having all the characteristic properties of caoutchouc.

I have very briefly drawn attention to the present position of our knowledge of the chemistry of caoutchouc in illustration of the interest which attaches to the examination of vegetable products, and also because of the immense importance of the problem from the practical and commercial standpoint. Chemistry in this case holds the premier position in reference to this subject, and to a large extent may be said to hold the key to the future of the rubber industry in all its phases. The discovery of better methods of coagulation, preparation, and purification will be effected through chemical investigation, as will also the determination of the manner of utilising the various other plants which furnish rubber-like latices. That the physical properties of raw rubber, on which its technical value depends, are to be correlated with the chemical composition of the material there can be no doubt. The chemical analysis of raw rubber, as at present conducted, is, however, not always to be taken by itself as a trustworthy criterion of quality, and more refined processes of analysis are now needed. Although the finest caoutchouc for technical purposes is only yielded by some half-dozen plants, under the names of which these varieties of caoutchouc pass, there can scarcely be a doubt that the elastic substance in each case possesses a very similar, if not identical, chemical structure. Nearly all the latices and similar fluids furnished by plants contain more or less caoutchouc. Even opium, which is the dried juice of the capsule of the poppy, contains caoutchouc, whilst the opium yielded by certain Indian species contains a notable proportion. Chemistry must determine the means by which caoutchouc can best be separated from these relatively poor latices. In view of the increasing production of the nearly pure caoutchouc which is furnished by *Hevea brasiliensis, Funtumia elastica, Castilloa elastica, Ficus elastica*, and a few other plants which occur or can be cultivated in several of our tropical Possessions, the question is not a pressing one at the moment.

Moreover, it cannot be doubted that chemical science will sooner or later be able to take a definite step towards the production of rubber by artificial means.

The production of caoutchouc by chemical means has, indeed, virtually been accomplished in its formation from isoprene. The exact nature of this change has still to be determined. When this has been done it will only remain to cheapen the cost of production to make the manufacture of synthetic rubber a purely practical problem. I should be the last to discourage the great extension of rubber planting which is now taking place. It is warranted by the present demand for the material. It has also to be remembered that the actual cost of producing raw rubber, which is at present about one shilling per pound, will probably be reduced, and the market price of rubber may eventually be so considerably lowered that, as with quinine, the synthetic production could not be profitably carried on. That is a question which involves many factors at present unknown, and only time can decide. Chemists may, however, confidently predict that before the British Association again meets at York the synthetic production of rubber will be a fully accomplished fact.

As I have said, our science is concerned with nearly every problem connected with the great rubber industry, and in concluding these few remarks I may allude to the production of vulcanised rubber depending on the formation of additive compounds of the hydrocarbon with sulphur. In this connection I should mention the recent experiments of Mr. Bamber in Ceylon, which appear to show that vulcanisation may be accomplished by acting on the uncoagulated latex with chloride of sulphur. If this proves to be practicable, it may mean the transference to the tropics of the subsidiary industry of vulcanisation, which is at present carried on in Europe.

Owing to the importance and interest which attach to the chemistry of rubber, it is to form an important feature in the work of this Section at the York Meeting. Papers will be contributed by some of the best known workers in this field, by Prof. Tilden, and by Prof. Harries, of Kiel, who will give an account of his recent work; whilst Mr. Pickles, of the Imperial Institute, will present a report summarising the whole of our chemical knowledge of the subject.

The chemical investigation of raw materials often raises, unexpectedly, problems of great scientific interest. The examination at the Imperial Institute of the seeds of the Para rubber tree (*Hevea brasiliensis*) has shown that they contain what proves to be a valuable drying oil, and in the course of the investigation it was ascertained that there is also present in the seeds an enzyme closely allied to, if not identical with, lipase, which is capable of splitting the oil by hydrolysis into glycerin and the free fatty acid. Subsequently, during the examination of other oil seeds similar enzymes have been detected, and it would appear probable that most oil seeds may prove to contain an enzyme capable of decomposing the fatty constituent.

Another subject of great chemical interest and botanical importance which has come into prominence in connection with the Indian and Colonial work of the Imperial Institute is to be included in a joint discussion which has been arranged with the Section of Botany. I refer to the production of prussic acid by plants, which, as I have elsewhere suggested, it is convenient to refer to as cyanogenesis. In this discussion we shall have the advantage of the cooperation of Prof. Van Romburgh and Dr. Greshoff, whose work with Dr. Treub of Java on this subject is known to chemists and botanists alike. The history of the origin of the several investigations in which Dr. Henry has been associated with me is not without interest in connection with the principal subject of this Address. During the first British expedition to the Sudan against the Mahdi a number of transport animals were poisoned through eating a small vetch which springs up in the Nile Valley during the fall of the river. The plant (*Lotus arabicus*) is well known to the Arabs, by whom it is cut when fully grown, and used as fodder for animals.

The results of the investigation of this matter which were communicated to the Royal Society proved that the young plant generated prussic acid when crushed with water. It was found to contain a new glucoside, lotusin, together with an enzyme capable of decomposing it into prussic acid, dextrose, and a yellow colouring matter, lotoflavin.

The glucoside is of special chemical interest, as being the only one known which contains the cyanogen group attached in the molecule to the sugar residue. Further investigation has shown that other fodder plants which are occasionally poisonous owe this character to the existence of other cyanogenetic glucosides. In a series of papers communicated to the Royal Society, Dr. Henry and I have described the properties and constitution of dhurrin from *Sorghum vulgare*, and of phaseolunatin, which we have shown to be responsible for the production of prussic acid by *Phaseolus lunatus* (Lima beans), *Manihot utilissima* (cassava or tapioca), and by linseed (the flax plant). Phaseolunatin is remarkable in furnishing acetone as one of its products of hydrolysis. The investigation, besides fulfilling the primary purpose for which it was carried out, has raised a host of problems;—as to the constitution of glucosides, the nature of the enzymes which accompany them in the plants, and also in relation to the fundamental question of plant metabolism.

Another subject of Imperial as well as National importance is to be the subject of a joint discussion with the Section of Physiology. I refer to the problem of diet. As chemists we are interested in this subject chiefly from the point of view of the composition of foods, and of the molecular structure which is associated with dietetic value. The first attempt to deal with the matter from the scientific side was made by a great chemist, Liebig. We are now in a position to investigate the problem more minutely, and the work of American physiologists has already led to important results. We have still to learn how materials such as rice and potatoes, which are nearly free from proteids, continue nevertheless to serve as the main diet of large numbers of people. It would seem that the best plan of operations will be for physiologists to settle by the accurate methods now available the precise value of typical foodstuffs, and for the chemist to deal with these in relation to their composition, and finally with reference to the constitution of their constituents. The time has come when an advance must be made from the chemical side in the analytical methods employed for gauging the value of food materials.

I feel that I have said much, but that I have left still more unsaid on many topics. I must leave almost untouched the entire subject of mineral chemistry, which is not only important in connection with the determination of the resources of India and the Colonies, but is also a subject somewhat neglected on its chemical side, which has been recently brought into prominence through the discovery of radio-activity.

The new radio-active mineral thorianite, from Ceylon, of which Mr. Blake and I have given an account to the Royal Society, brings me at once to a subject which raises the most fundamental of chemical questions, the nature of the elements and of the atom. The recent discussions of this subject have become so purely speculative that, whilst chemistry is bound to follow the lead of physics in this matter, chemists are inclined to consider that more well-ascertained facts are needed for any further discussion to be profitable from the chemical side.

In this Address I have ventured to urge the fuller recognition by Government of the scientific method as a powerful instrument in promoting the commercial development of the Colonies, and I have drawn attention to the important part the science of chemistry can play in the Imperial work of developing the resources of our Possessions.

No apology is needed in this place for directing attention to a subject which involves a most important practical application of our science, since one of the principal functions of the British Association is to bring science into close touch with the problems of our national life, and to interest the general public in the application of science to their solution.

I have, however, also shown that many problems of the highest scientific interest arise in connection with the investigation of these economic problems.

NOTES.

A DEPARTMENTAL committee has been appointed by the Home Secretary to inquire and report what diseases and injuries, other than injuries by accident, are due to industrial occupations, are distinguishable as such, and can properly be added to the diseases enumerated in the third schedule of the Workmen's Compensation Bill, 1906, so as to entitle to compensation persons who may be affected thereby. The chairman of the committee is Mr. Herbert Samuel, M.P., and the members are Prof. Clifford Allbutt, F.R.S., Mr. H. H. Cunynghame, C.B., and Dr. T. M. Legge.

THE Paris correspondent of the *Times* states that a mission to investigate the subject of sleeping sickness is to leave Paris in October next for Brazzaville. The leader of the mission is to be Major Martin, of the French Medical Corps, who has worked at Saigon and at Lille in the Pasteur Institutes, and already had an opportunity in Guinea of studying sleeping sickness. He is to be assisted by Dr. Lebeuf, M. Roubaud, and M. Weiss. After establishing a permanent central laboratory the mission will begin the direct study of the malady up country. Special attention will be paid to the Upper Ubangi region. The mission also intends to combat the small-pox which is decimating French African possessions, but the main object is to fight the tsetse fly by every means that the resources of science can suggest.

IN a letter to the *Times* of Tuesday last, Dr. Hamilton Wright, chairman of the late Port Swettenham Sanitary Commission, directs attention to the successful measures taken to stamp out malaria at Port Swettenham. The port was designed by the Government of the Federated Malay States to replace that of Klang, on the upper tidal reach of the river of the same name. It was jungle-covered, flooded daily by tides, and incident to an average of about 100 inches of rainfall a year. The railway station and bungalows for officials and coolies were on made ground. On the formal opening of the port, Klang was abandoned, and the river closed to sea-going vessels. Severe malaria immediately broke out amongst the officials and coolies employed on the railway and shipping. A commission was at once appointed, composed of medical men, railway and works officials, and instructed to devise measures for the suppression of malaria and otherwise to sanitise the port. The recommendations of the commission involved an outlay of from 10,000*l.* to 12,000*l.* The Government, without any hesitation, accepted the recommendations made by the commission; the new port was dyked, drained, levelled, and cleared, the result being that since these sanitary measures were initiated there has been scarcely a case of malaria at the port, and from being an unhealthy, shunned swamp, the port is now sought by officials as a desirable billet.

INFORMATION has reached the *British Medical Journal* that Dr. W. J. Goodhue, medical superintendent of the Molokai Leper Settlement, has, after several years of research, succeeded in demonstrating the bacillus of leprosy in the mosquito (*Culex pungens*) and the common bed-bug (*Cimex lectularius*). Dr. Goodhue expresses the opinion that the bed-bug is more of a factor in the spread of leprosy among the natives than the gnat, for the following reasons, that the bed-bug's invasion is noiseless and occurs during deep sleep of the victim, and secondly, the beds and bedding which have belonged to a leper are after his death or segregation used by his family without adequate disinfection.

WE regret to have to announce the death of Sir Alexander Moncrieff, K.C.B., F.R.S. (the inventor of the "disappearing" gun which bears his name), which took place on Friday last at the age of seventy-seven years.

THE *Athenaeum* announces the death, in his sixty-seventh year, of Prof. G. A. P. Rayet, director of the observatory at Floirac, Bordeaux.

A MONUMENT is to be erected at Brünn to the memory of Mendel, and an international committee has been formed at Vienna to further the object.

MR. W. EAGLE CLARKE has been appointed by the Secretary for Scotland keeper of the natural history collections of the Museum of Science and Art, Edinburgh, in succession to Dr. R. H. Traquair, F.R.S., who is about to retire.

MR. HENRY REW has been appointed an assistant-secretary to the Board of Agriculture and Fisheries in succession to Major P. G. Craigie, C.B., who has just retired.

PROF. A. BERGT has been appointed acting director of the Leipzig Museum of Ethnology in place of the late Prof. Obst.

THE following telegram, dated August 2, respecting Dr. Sven Hedin's journey, has been received at Stockholm from the explorer at Leh (Kashmir):—"All well; our journey is most promising; our large, well-equipped caravan of 120 carriers is capital and our men are trustworthy."

ACCORDING to the *Museums Journal*, the portrait of Dr. A. J. Evans, F.R.S., is to be painted by Sir W. B. Richmond, R.A., and deposited in the Ashmolean Museum, in commemoration of the services rendered to archæology by Dr. Evans. A general committee, representative not only of this country, but of Europe and the United States of America, has been formed to carry out the project.

THE Moxon medal of the Royal College of Physicians of London, which is given every third year, has been awarded to Dr. Jonathan Hutchinson, F.R.S.

AT the concluding meeting of the International Conference on Hybridisation and Plant Breeding on Thursday last, Veitch gold memorial medals were presented to Mr. W. Bateson, F.R.S., the president of the conference, Prof. Johannsen, Prof. Wittmack, and Prof. Maurice de Vilmorin, and silver-gilt Banksian medals to Miss E. R. Saunders, lecturer on botany at Newnham College, and Mr. R. H. Biffen, for eminent services rendered to scientific and practical horticulture. Prof. de Vilmorin, as the representative of the Horticultural Society and the Botanical Society of France, invited the society to hold its next conference at Paris.

THE Bradshaw lecture will be delivered at the Royal College of Physicians, London, on November 6 by Dr. Sharkey, who will take as his subject "Rectal Alimentation"; the FitzPatrick lectures will be given by Dr. Norman Moore on November 8 and 13, and will deal with the "History of the Study of Clinical Medicine in the British Islands"; and the Horace Dobell lecture by Dr. F. W. Andrews, on November 15, will treat of the "Evolution of the Streptococci."

THE following courses of lectures have been arranged for by the Royal Sanitary Institute:—one on "Hygiene in its bearing on School Life," beginning on September 17, and a special course on "Food and Meat Inspection," commencing on November 12.

THE International Anti-Tuberculosis Conference will be held at the Hague from September 6–8 next, when the following questions will probably be discussed:—Ways of infection; specific therapeutics; compulsory notification; cost of sanatoria; dispensaries; tuberculosis in children; and education.

THE annual meeting of the American Röntgen Ray Society will take place at Niagara Falls, New York, on August 29, 30, and 31.

AN electrical manufacturers' exhibition is to be held at Bristol in November and December next. The object of the exhibition will be to afford to manufacturers an opportunity of bringing the latest improvements in their various specialities before the notice of electrical contractors and the public generally, and to demonstrate clearly the advantages of electricity for lighting, heating, and motor power purposes.

A DISASTROUS fire broke out in the buildings of the Milan Exhibition on Friday last, causing the destruction of the Italian and Hungarian decorative art sections and of a pavilion of the Italian architecture section. The damage is estimated at 160,000*l*.

THE recently issued annual Blue-book respecting the British Museum records a large falling off in the number of visits paid to the Bloomsbury Museum in 1905. In recent years the numbers have been steadily increasing, and in 1904 they reached the large total of 954,441. There has now been a reaction, with a loss of upwards of 140,000, the number for the year being 813,659. The visits paid to the Natural History Museum show, on the other hand, a considerable improvement; thus the total number of visitors last year was 566,313, an increase of 95,756 over the total in 1904 and of nearly 80,000 over that of any previous year. The number of visits recorded as having been made on Sunday afternoons was 70,084, as against 60,909 in 1904. The average daily attendance for all open days during the year was 1560·09; for weekdays only, 1600·73; and for Sunday afternoons, 1322·34. The total number of visits paid during the year to the department of zoology by students and other persons requiring assistance and information amounted to 11,811, as compared with 11,824 in 1904 and 11,627 in 1903.

As a result of the passage of the Bill allowing the production and utilisation of alcohol in America for industrial purposes, without the internal revenue tax, the U.S. Department of Agriculture has decided to publish a bulletin, from January 1 next, when this law is to take effect, placing before the public a collection of the best obtainable data on the use of alcohol in small engines. For this purpose Prof. Charles E. Lucke has been retained by the department as expert to conduct a protracted series of investigations in the laboratories of Columbia University. The bulletin, says the *Scientific American*, will contain all available information of the work done on the subject both at home and abroad. It is hoped that all those interested in this question will forward to Prof. Lucke at Columbia University any information of which they may be in possession, or inform him of the location of existing data. Possessors of patents covering inventions bearing upon the subject are invited to provide Prof. Lucke with copies of the same, and if possible to submit their apparatus intended for the utilisation of alcohol, such as vaporisers, carburetters, or complete engines. These will be tested in the most thorough manner, and the experiments will be conducted without any expense whatever to the public, save those entailed for the transportation of the apparatus. The reports of the tests will be published in the bulletin.

THE *Electrician* states that an ordinance has been published constituting wireless telegraphy in the Sudan a Government monopoly by providing that no person shall instal or make use of any apparatus for wireless telegraphy, or transmit or receive messages by means of any such apparatus within the Sudan except the Department of Telegraphs or a duly authorised officer or official of the Sudan Government, unless such person is in possession of a special licence in writing from the Governor-General.

AT the meeting of the Harvard College Chapter at Cambridge (Mass.) on June 28, the oration was delivered by Prof. E. C. Pickering, director of the college observatory. From the *Boston Evening Transcript* we learn that Prof. Pickering took as his subject "The Aims of an Astronomer," and dealt with it in vigorous style, pleading eloquently for the internationalisation of funds and aims. After describing the evolution of the individual astronomer from the time when his main object is to earn a living to the period when he arrives at the truer and broader aim of increasing the world's store of knowledge, Prof. Pickering outlined his international plan whereby the present overlapping of work and interests would be eliminated and the science of astronomy infinitely benefited. For instance, he suggests that rich men wishing to subsidise astronomical research should exercise as much discretion as they do in the businesses from which they derive their riches in order to place their gifts where the greatest need and the greatest facilities exist. This would entail an international advisory board to administer properly the accumulated fund without regard to nationality or personal interest. By such proceedings the young and ardent astronomer, the suitably situated observatory, and the men with ideas could be granted the financial help which they now so often lack, and with the assistance of which the progress of astronomical research could be greatly promoted.

THE acoustical properties of buildings form the subject of two papers, one by Mr. Wallace C. Sabine in the Proceedings of the American Academy of Arts and Sciences, xlii., 2 (June), and the other by M. Marage in the *Comptes rendus* bearing the date April 9. Mr. Sabine states that the absorbing power of a room, its furniture and cushions, and of the clothing of the audience, are all capable of numerical determination, and that the time of reverberation of a given sound is also a calculable quantity. An important feature of the paper consisted in a series of experiments undertaken to determine the reverberation best suited to piano music. M. Marage's paper deals with the corresponding conditions with regard to speech. There appears to be a unanimous consensus of musical opinion that a reverberation of about 1·1 seconds is calculated to secure the best effect with a piano, while for speech M. Marage fixes the coefficient at from 0·5 second to 1 second for all parts of the room and all vowels. A second part of Mr. Sabine's paper—which, by the way, is a sequel to a previous one published in 1900—deals with the effect of pitch on reverberation. It is to be wished that attention were more commonly given to the study of acoustical effect; then we might get rid of the boxed-in piano, covered with highly absorbing draperies and jangling ornaments, of the conventional drawing-room. The sounds which this instrument is able to emit under the violent treatment commonly applied to its keyboard are a mere travesty of music.

THE difficult problems in statistical mechanics associated with the kinetic theory of gases form the subject of a paper of thirty-five pages in the *Journal de Physique* for June, by Prof. H. Poincaré. The paper is largely a discussion of points suggested by the late Prof. Willard Gibbs. For simplification the author considers the case of a one-dimensional as well as that of a three-dimensional gas, and he is led to the distinction of two kinds of entropy, which he calls coarse and fine entropy (*entropie grossière, entropie fine*). Account is taken of rapid disturbances in which the gas has not time to assume a state of statistical equilibrium at every instant of the transformation. An allied subject is treated by Dr. W. Peddie in the Proceedings of the Royal Society of Edinburgh, xxvi., 3, in a paper on vibrating systems which are not subject to the Boltzmann-Maxwell law. Here again systems in one-dimension are considered, a kind of generalised Hooke's law of force being assumed in the test-case under discussion. The inference is drawn that equipartition of energy is not a general property of dynamical systems. It would not be unreasonable to infer that the Boltzmann-Maxwell distribution is characteristic of certain definable systems, and therefore is applicable to the explanation of definite phenomena only.

THE meteorological reporter to the Government of India has issued a memorandum (dated June 9) on the abnormal features of the weather of the past half-year, with a forecast of the probable character of the south-west monsoon rains of 1906. Similar forecasts were first made by H. F. Blanford, and were based on the limited information of snowfall reports and the general character of the weather in India immediately preceding the rains. Sir J. Eliot realised that Indian conditions alone were insufficient, and in 1894 introduced information from other sources. This work is another instance of the useful application of statistics in attempting to trace the meteorological relations of widely distant regions to which we recently referred. Dr. Walker remarks that "it is certain that the influence of abnormal features over any large region spreads in every direction, and will after some months affect the conditions at very great distances"; he also instances the discovery by Sir Norman and Dr. Lockyer that the oscillations of annual pressure in South America are closely related to those of the Indian Ocean, but inverse in character. Dr. Walker has added considerably to the data employed, and gives very full particulars of the considerations upon which his forecast is framed, the most important features being the heavy and late snowfall, associated with excessive rain both at Zanzibar and Seychelles. On the whole, he thinks that there is reason to expect that the total rainfall will not be appreciably smaller in amount than that of last year, which was considerably below the normal value.

HEREDITY and evolution occupy an important position in the July issue of *Biologisches Centralblatt*, Mr. H. de Vries communicating an article entitled "Altere und neue Selektionsmethode," while Dr. J. Gross discusses the relation between heredity and variation, more especially in connection with the Mendelian theory. The former is largely devoted to the methods of plant-culture adopted by Nilsson and by Rimpau. In the course of the latter the author directs attention to the fact that while albinism among mammals is frequently "recessive," in the case of hybrids between species of which one parent is normally white (such as the Polar bear and the Arctic fox) and the other dark-coloured the offspring are frequently intermediate in point of colouring between their parents. The movements of the spermatozoa of the parasitic nematode worms of the genus Ascaris form the subject of an article by Dr. H. Marcus, while Dr. F. Samuely brings to a close his account of recent researches into the chemistry of albumen and their bearing on physiology.

CAPTAIN W. S. PATTON, I.M.S., records the occurrence of a parasite in the white corpuscles of the blood of Indian palm squirrels (*Funambulus pennantii*) (Sc. Mem. Gov. of India, No. 24, 1906). The parasite, which in all probability belongs to the Hæmogregarinidæ, occurs as a long vermiform body, measuring 10 μ in length, lying in the substance of the large mononuclear leucocytes. The majority exhibit slow vermicular movements altering their position in the cells, sometimes lying close to the nucleus, sometimes at right-angles to the nucleus. The nucleus may be compressed or split by the parasite. In some cases free vermicules were seen in the plasma. The parasites were found in the peripheral blood, spleen, and liver. In the louse (an undescribed species of Hæmatopinus) infesting the animals vermicules were met with.

IN the last number of the *Journal of Anatomy and Physiology* (vol. xl., part iv.) Dr. Gaskell gives a final paper on his views of the origin of vertebrates, which he believes are derived from arthropods. In the present paper, a study of ammocœtes, the origin of the notochord is discussed, and the suggestion is made that it has originated as an accessory digestive tube. The remaining articles are mostly anatomical in character.

ACCORDING to the July issue of its Journal, the Marine Biological Association of the United Kingdom is extending the investigations which have already been instituted with regard to the distribution of the Channel fauna in the neighbourhood of Plymouth to deeper waters, and it is hoped during the present year to enlarge still further the area of survey. Special attention has been directed to improving the methods of rearing organisms in the laboratory, in regard to which a report is shortly promised. An investigation has also been commenced with regard to the nature of the food of mackerel and pilchard and other migratory fishes frequenting the mouth of the Channel in relation to seasonal changes.

IN his report for 1905, Dr. Benham, the curator, states that the Otago University Museum has been enriched by a valuable collection of eggs of New Zealand birds presented by Dr. Fulton, and also by the gift of a large series of ethnological objects from Mr. and Mrs. James Mills. The latter, which are chiefly weapons, are mostly Polynesian, and were collected some five-and-twenty years ago.

"THE Living and Fossil Species of Comptonia" is the title of one of the two articles in the July number of the *American Naturalist*. According to the author, Mr. E. W. Berry, the genus is represented at the present day only by a single species, which is a low shrub ranging from Nova Scotia to Manitoba, and southwards to Carolina and Tennessee, but the number of extinct forms which have been described is upwards of three score, with an almost cosmopolitan Tertiary distribution. In the second article Mr. C. S. Meads discusses the adaptive modifications of the occipital condyles in mammalian skulls. The basal connection between the two condyles in spiny anteaters is regarded as a direct reptilian inheritance. It is pointed out that there is a very marked difference between the carnivorous and ungulate type of condyles, the latter being much elongated inferiorly, so as to admit of great angulation of the head in relation to the vertebral column, and thereby, in the case of ruminants, presenting an armed front to the foe.

THE Tertiary lake-basin of Florissant, Colorado, receives a large share of attention in the third number of vol. iii. of the University of Colorado Studies, Mr. J. Henderson dealing with the basin itself, while Mr. T. D. A. Cockerell discusses the fossil fauna and flora of the Florissant shales. A paper on the existing flora of the district, by Dr. F. Ramaley, may be regarded as supplemental to the other two. The Florissant shales, which contain a very rich series of fossils, are apparently later than the well-known Green Rover shales, and may probably be assigned to the Miocene period. "The plants and insects are wonderfully preserved in fine volcanic sand or ash, deposited in layers which readily split apart, revealing the specimens, just as they fell, in prodigious numbers. Green leaves and even branchlets were torn from the trees, and insects perished wholesale in a catastrophe that must have equalled that of Martinique."

Two new memoirs of the Geological Survey of England and Wales have been received, "The Geology of the Country near Sidmouth and Lyme Regis," by H. B. Woodward and W. A. E. Ussher, and "The Water Supply of Suffolk from Underground Sources," by W. Whitaker, with contributions by Dr. H. F. Parsons, Dr. H. R. Mill, and Dr. J. C. Thresh. The former memoir is explanatory of sheets 326 and 340 of the new series, colour printed, geological maps (1 inch to the mile). It embraces a district that is famous no less for the eminent pioneer geologists who have worked in it than for its intrinsic geological interest. The cliff sections, so well exposed along the coast, are represented by numerous diagrams; there are also some small black-and-white maps and a few time-honoured representations of common fossils; the frontispiece is a reproduction of one of Sir A. Geikie's vigorous sketches, depicting the Axmouth or Bindon landslip. A short chapter on the local economic geology is done with more care than is usual in these "sheet explanations," and is quite adequate for the purpose. No striking advance appears to have been made with the difficult problem of the correlation of the lower New Red Sandstone series. The "Water Supply of Suffolk" is the fourth of the series of county memoirs dealing with this subject. It comprises a brief introduction to the geology, with remarks on the more notable borings, as that at Stutton, and others which record a remarkable thickness of Glacial drift. There is a sketch of the county rainfall with a coloured rainfall map by Dr. H. R. Mill, a series of detailed records of wells and borings, and a number of analyses of Suffolk waters. These water-supply memoirs should be of the greatest value to engineers, builders, and others. We note, for the first time, the free use of the American "geologic" in an English survey memoir; it is to be hoped that in future numbers of the series the practice of inserting maps showing the depth of water-bearing strata may be imported from the same quarter—this would be a much more useful innovation.

THE application of artificial manures to forest land has received some attention in Belgium and Germany, the results being sufficiently encouraging to induce Dr. Borthwick to bring the matter to the notice of the Royal Scottish Arboricultural Society. Besides showing an increase of growth, it has been found that trees on manured soil are stronger and less liable to disease. Dr. Borthwick's address is printed in the Transactions of the Society (vol. xix., part ii.), wherein there appear several papers by Dr. Nisbet, Mr. W. M. Stewart, and Mr. R. Galloway on the advisability and cost of establishing plantations in Great Britain, either as a cooperative undertaking or otherwise. A system is described of combating larch disease by thinning out the pure larch woods after sixteen or twenty years and planting up with other conifers or beech.

THE Department of Agriculture in the Federated Malay States was initiated in June, 1905, so that the report of the director, Mr. J. B. Carruthers, refers to half a year's work. Mr. Carruthers is continuing his experimental trials, previously started in Ceylon, of protective jungle belts to prevent the spread of fungal and insect pests. Reference is made to the more important products of the States, *e.g.* rubber, cocoanuts, sugar, and rice. At present the acreage of land planted with cocoanut palms is three times as great as that planted in rubber, but the value of the latter is already greater. On swampy lands it is suggested that nipah and sago palms will yield profitable results.

SIR DIETRICH BRANDIS contributes an account, with illustrations, of some bamboos collected in Martaban to the April and May numbers of the *Indian Forester*. Allusion is made to the transverse veins and the longitudinal bands of silica cells on bamboo leaves that are both well marked in *Pseudostachyum polymorphum*. The genera Oxytenanthera and Gigantochloa are characterised by the connate arrangement of the anthers, forming a transparent membranous tube. The rhizomes of a Phyllostachys and *Thyrostachys siamensis* are converted into walking-sticks and umbrella handles.

A NEW photographic paper has recently been put on the market by the Falla-Gray Photo Paper Co., Ltd., and samples have been submitted to us for trial. The special feature of the paper is that by some preparation of the emulsion it has been found possible to give a film which can be satisfactorily fixed by an immersion of only one minute in the hypo bath, and as satisfactorily washed in five minutes after fixing. It is claimed that this great saving of time is not obtained at any expense of the permanency of the prints. In actual working the paper is similar to the general type of gaslight paper, the image appearing quickly and rapidly acquiring full density. With the developer recommended, a rather strong combination of metol and hydroquinone, excellent toned greys and blacks appear to be easily obtained, while the semi-glossy surface is well adapted to give all the detail that may be required for reproduction purposes. The paper should prove useful for Press purposes, where fine gradation and speed of production are specially necessary, while to the ordinary worker it will be recommended by its full range of tones and adaptability to most kinds of negatives by variations of exposure.

THE eleventh "Annual" of the British School at Athens has been issued by Messrs. Macmillan and Co., Ltd; it describes the work accomplished during the session 1904–5. Dr. A. J. Evans, F.R.S., contributes a provisional report on the excavations during the year at the palace of Knossos and its dependencies; there are five articles on Laconia concerned respectively with the excavations near Angelona, the excavations, sculptures and inscriptions of Geraki, the excavations and inscriptions of Thalamae, a note on the 'Σρμαῖον the north-east frontier, and the Frankish sculptures at Parori and Geraki. The assistant-director of the school, Mr. M. N. Tod, describes inscriptions from Eumeneia, and there are in addition nearly a dozen other well-illustrated contributions, making up with the sixteen plates an admirable and interesting volume.

AN interesting pamphlet on the development of the Bristol Museum and Art Gallery has been written by Mr. W. R. Barker, chairman of the Museum and Art Gallery committee, and issued by Mr. Arrowsmith, of Bristol. In it is traced the institution from its inception (as the Bristol Library Society) in 1772 to the present day. The pamphlet, which is well worth perusal, is illustrated by some excellent process engravings.

THE Journal of the Royal Sanitary Institute for August contains the inaugural address delivered by Sir Edward Fry, president of the congress held last month; it contains also the lecture by Prof. C. Lloyd Morgan on "The Relation of Heredity to Physical Deterioration," and that on "The Wastage of Human Life" by W. Fleming Anderson.

THE July issue of the *Museums Journal* contains, in addition to its General Notes, the address on "The Education of a Curator," delivered at the Bristol conference of the Museums Association by Dr. W. E. Hoyle, the president of the conference.

A NEW book on the microscope, by Sir A. E. Wright, F.R.S., is announced for early publication by Messrs. Archibald Constable and Co., Ltd. The work will contain a complete vocabulary of technical terms relating to the microscope.

OUR ASTRONOMICAL COLUMN.

FINLAY'S COMET (1906*d*).—The results of a number of observations of Finlay's comet (1906*d*) are published in No. 4108 of the *Astronomische Nachrichten*.

At the Utrecht Observatory the comet was seen on July 21, and recorded as very faint; the observation showed that corrections of −12m. 58s. and $-1^{\circ}\ 51'$ were necessary to the ephemeris published by M. Fayet.

The magnitude of this object was found to be 9·0 when observed at Strassburg on July 17, its diameter being recorded as 12′.

In No. 4109 of the *Astronomische Nachrichten* M. L. Schulhof states that the ephemeris derived from his elements shows a greater error than he had foreseen, an error which a superficial revision of his calculations for the perturbations has failed to discover. The comet appears to have suffered a retardation which as yet is unexplained.

Applying, provisionally, the corrections shown to be necessary by the Strassburg observation, he has calculated another ephemeris, from which the following is taken:—

Ephemeris 12h. (M.T. Paris).

1906	α (app.) h. m. s.	δ (app.) ° ′	log Δ	$1 : r^2\Delta^2$
Aug. 8	2 47 36	+2 40	9·40344	13·72
10	3 5 35	+4 23	9·40744	13·78
12	3 23 6	+6 2	9·41390	13·67
14	3 40 2	+7 35	9·42253	13·41
16	3 56 17	+9 1	9·43301	13·03
18	4 11 49	+10 21	9·44499	12·56

OBSERVATION OF A BRIGHT METEOR.—A communication by Herr Ph. Fauth in No. 4109 of the *Astronomische Nachrichten* states that a bright meteor was observed at Landstuhl on July 16.

The time of observation was 11h. 39m. (local M.T.), and the object appeared in the N.N.W. Its brightness was greater than that of the full moon, and its path was between 12 Canum Venaticorum and γ Virginis. The duration of the light was about 1·5 seconds, and no detonation was noted.

DOUBLE-STAR MEASURES.—The results of the micrometer measures of double stars made with the 28-inch refractor at Greenwich during the year 1905 appear in No. 8, vol. lxvi., of the *Monthly Notices* (R.A.S.).

In addition to a large number of stars contained in the ordinary working list, and for which the name, position, position-angle, distance, magnitudes, and epoch of observation are given, a number of Struve stars which have been neglected, or for which periodical observations are required, were observed. Only the names of the latter are now published, the results of the measures being reserved for the *Greenwich observations* for 1905.

The measures now published are, in general, confined to stars of which the separation does not exceed 4″ or which show orbital movement.

In Nos. 4107–8 of the *Astronomische Nachrichten* Dr. G. van Biesbroeck publishes the results of the measures of 177 Struve stars made with the 12-inch refractor of the Heidelberg Astronomical Institute. The measures of twenty-nine comparison double stars are also given.

INTERNATIONAL CONFERENCE ON HYBRIDISATION AND PLANT-BREEDING.

THE Royal Horticultural Society held high festival in its new hall and elsewhere from July 30 to August 3. The occasion was the third conference on plant-breeding, previous gatherings having been held at Chiswick and in New York. Mr. William Bateson presided, and was so thoroughly imbued with his subject that the visitors found it difficult which to admire most, his grasp of difficult and complex problems, his able management, or his powers of endurance. The programme was a very long one, although some of the papers were, in the absence of their authors, taken as read. All the memoirs will be printed in full in the journal of the society. The speakers included, besides our own countrymen, Danes, Swedes, Germans, Austrians, French, and Americans.

"Mendelism" was naturally to the fore, and the numerous exhibits in illustration of the phenomena did more to secure general acceptance for the theory than did the elaborate disquisitions. Some of these, especially those of a mathematical character, evoked from the chairman the remark that we had reached the limits of our comprehension. In his introductory address Mr. Bateson gave a very interesting summary showing the advances that had been made since the first conference in 1898. The predominant note then was mystery—in 1906 we speak less of mystery and more of order.

Mr. Bateson suggests the adoption of the term "genetics" to indicate the nature of our researches into the phenomena of heredity and variation, in other words, the physiology of descent. He showed that we had already arrived at a clear conception of the true meaning of "pure-bred," pointing out that an individual is pure-bred when the two cells, male and female, from which it develops are alike in composition, containing identical elements or characters. Instead of regarding genetic purity as a vague state which may or may not be attainable by a long course of selection or fixation, we now know exactly what it is and how it is produced.

Similar explanations were given as to the significance of "reversion"; the reappearance of the ancient characters is brought about by the meeting together of distinct elements long parted, but how this is effected is still unexplained. Conversely, "variation" is often due to the separation or elimination of factors, and sometimes probably to the addition of new factors. Heredity is now known to be a regular phenomenon less or more amenable to experimental methods of research. When someone says, "But can't you breed a Derby winner or do something useful?" Mr. Bateson replies that "though in the attempt to discriminate among animals all good enough to win science may be as much at fault as common sense, yet it would not surprise me if science were to devise a way of breeding even racehorses which would not produce about a hundred 'wasters' for one fit to win—and yet I understand that common sense remains content with that rather modest attainment after two centuries and a half of steady trying." Mr. Bateson concluded by pointing out that the great advances in the application of science have generally become possible through discoveries made in the search for pure knowledge. In no other spirit can natural knowledge be more profitably pursued.

Other papers were contributed by Prof. Johannsen, of Copenhagen, whose views did not meet with universal acceptance, Messrs. Hurst, Darbishire, Yule, Dr. Wilson, of St. Andrews. Mr. de Barri Crawshay, Mr. Rolfe, and Prof. Pfitzer spoke on orchids; Mr. Chittenden and Dr. Tschermak dilated on questions of heredity. Prof. Rosenberg, of Stockholm, had a most important paper showing the behaviour of the chromosomes in hybrid plants. M. Noel Bernard spoke of the symbiosis existing between the roots of orchids and the hyphæ of certain fungi.

Miss Saunders, in a very lucid manner, explained the complex results she had obtained in crossing stocks, a paper the comprehension of which was much facilitated by the numerous specimens exhibited in the hall. Mr. Biffen contributed a remarkable paper on the application of Mendel's laws to the improvement of cultivated wheats, and various communications from raisers of carnations, potatoes, bulbs, roses, amaryllids, and other plants were read. The entire programme, with very few exceptions, was worked through under trying conditions of heat and street noises, and those who participated in the hard work honestly earned the recreation that was furnished them by garden-parties at Burford and Gunnersbury, to say nothing of the banquets offered to the foreign guests and other visitors by the Royal Horticultural Society and the Horticultural Club. The success of the conference was marked, and congratulations may be tendered to all who took part in its organisation.

MAN AND THE GLACIAL PERIOD.[1]

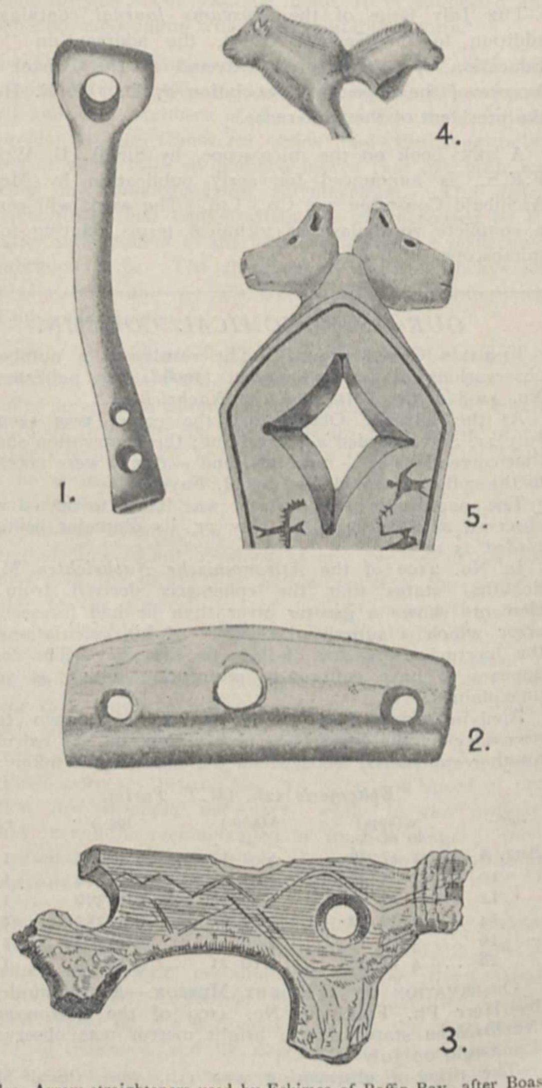
THE correlation of the successive occupation of Europe by various races of mankind with the successive events of the Glacial period has been greatly facilitated by the successful investigations of Prof. Albrecht Penck into the Quaternary history of the eastern Alps. Four well-defined terraces can be traced up the valleys of this region, each of them taking its origin in a terminal moraine. They represent the deposits of rivers issuing from the front of the ice during a glacial episode. Between the terraces the valleys show evidence of deepening by erosion during periods which correspond to genial intervals, the last of which, in order of time, is represented by the breccia of Hötting, when the temperature at Innsbruck, as shown by the included leaves and bracts of *Rhododendron ponticum*, was 3° C. higher than the average at the present day.

The earliest remains of the human family are afforded by *Pithecanthropus erectus* of Upper Pliocene age; the skull of this creature, while singularly simian in form, is shown to be human by its capacity (850 c.c.). Evidence supposed to indicate an even earlier existence of man-like species is afforded by the so-called "eoliths," but these it is now scarcely necessary to consider seriously, especially after the observations recently made on the eolithic forms which occur as a by-product in the manufacture of cement at Mantes. Probably 99 per cent. of the supposed implements obtained from the plateau gravels of southern England are of a doubtful character, but there is a small remainder, comprising forms distinguished by a notch, almost semi-circular in outline, which so closely resemble the scrapers once used among the Tasmanians for making their wooden spears that it seems most natural to regard them as of human origin.

The Tasmanians were the most unprogressive race in the world, and probably the oldest within the Australian region; their cranial capacity was 1160 c.c., and they were ulotrichous. It would hence appear that the cleavage between the Ulotrichi and the rest of the human species must have occurred at a very remote period.

The Chelléan stage of culture is represented by stone implements, which occur in the third fluvio-glacial terrace of southern France at the foot of the Pyrenees, and in possibly corresponding gravels in the valley of the Thames. The numerous skulls of Chelléan age which have been met with in cave deposits (Neanderthal, Spy, Krapina) agree in all essential features, and evidently belonged to a single race (*Homo primigenius* of Schwalbe), now most nearly represented by the Australians. In cranial capacity there is a close agreement between the recent and extinct races (1250 c.c.).

The Solutrian stage follows upon the Chelléan, and implements representing it are found in the löss of the Danube, which occurs between the third and fourth fluvio-glacial terraces, and thus occupies an horizon corresponding to that of the Höttinger breccia. The Solutrian, or löss man, as the Germans sometimes call him, lived in a warm or genial climate. To the artists of this race are to be ascribed the drawings and paintings left upon the walls of numerous caves in France and Spain, which recall by their spirit and technique the work of the Bushmen in South Africa. The associated figurines carved in various material present two remarkable anatomical features (steatopygy and elongated labia minora) which are peculiar to South African races, so that, even without the evidence afforded by the Grimaldi skeletons in the Grotte des Enfants, Mentone, we might safely regard the Solutrian race as ancestral to the Bushmen or some allied



1 and 2. Arrow straighteners used by Eskimos of Baffin Bay, after Boas. 3. Arrow straightener of Magdalenian age, from the Kesslerloch, near Thayngen, after Merk, from Hoernes. 4. Head of a Magdalenian arrow straightener, after Lartet. 5. Head of an Eskimo arrow straightener, after Dawkins.

[1] An abstract of three lectures delivered at the Royal Institution on May 24, 31, June 7, by Prof. Sollas, F.R.S.

race. Stow, in his excellent account of the South African races, has furnished the key to much of Solutrian history, and it is of particular interest to observe that this author was led by independent evidence to conclude that the original home of the Bushmen lay far to the north of the area they occupied at the time we first became acquainted with them. The cranial capacity of the Bushmen was 1330 c.c.; that of the Grimaldi skeletons has not yet been made known.

The Magdalenian race, or the reindeer hunters, the last of the definitely Palæolithic tribes, evidently lived under somewhat severe conditions of climate. A study of their implements and mode of life certainly suggests, as Prof. Boyd Dawkins first pointed out, some connection with the Eskimos, but this is a view which has not commended itself to the majority of investigators. The so-called "batons de commandement" may be selected as affording the crux of the problem; these have been compared by Prof. Dawkins with the Eskimo arrow straighteners, an explanation rejected by Hoernes and others on the ground that the Magdalenian people were unacquainted with the use of the bow. This, however, is a pure assumption, unsupported by facts. A stronger objection may be found in the shape of the perforation which characterises the Eskimo straightener as represented by Prof. Dawkins; this is lozenge-shaped, as it is in all the examples I have seen preserved in our museums; in the "baton," on the other hand, the form is invariably circular. Some of my archæological friends have gone so far as to assert that this form is incompatible with use as an arrow straightener, though I have myself made perforated "batons" out of deer's horn which serve to straighten a crooked stick very effectually. But, what is more to the point, Dr. Boas has figured recently an arrow straightener actually used by the Eskimos of Baffin Bay, which not only resembles many "batons de commandement" in general form, but more particularly in the shape of the aperture, since it is drilled with a round hole. These two implements, the arrow straightener of the Eskimos and the "baton" of Magdalenian man, are in this case so nearly identical that no manner of doubt can exist as to the truth of Prof. Dawkins's explanation. Additional interest is thus acquired by a curious resemblance in detail which characterises the arrow straighteners of the two races, otherwise very different both in form of the perforation and in certain artistic qualities; this is to be found in the carved end, which sometimes represents two heads placed back to back, an unusual design, repeated, curiously enough, among a tribe of American Indians in their "topos" or hair-pins, which are similarly terminated by two heads (llamas') *adossé*. These facts, taken in conjunction with numerous other resemblances in detail between the implements at present used by the Eskimos and those of Magdalenian man, cannot fail to suggest some ethnic connection.

As regards the skeletal remains of the period, attention may first be directed to those of the Cro-Magnon type, including the skeleton of the seventh interment in the Grotte des Enfants; the skulls of this type, while resembling those of the Eskimos in some respects, especially in the narrowness of the nose, differ widely in others, such as the length of the face and the height of the orbits; the limb bones indicate a race of tall stature (1800 mm. or 1900 mm.), very different in this respect to the short Eskimos (1646 mm.). In the skeleton of La Chancelade these differences disappear; the skull is remarkably Eskimo-like, the stature deficient (1500 mm.). The osteological evidence would seem to point to the contemporaneous existence of two allied races during the Magdalenian age, one now represented by the Eskimos and the other by neighbouring North American tribes, both possibly inhabiting a large part of Europe and Asia, whence they overflowed into North America either by the Icelandic or the Alaskan route, perhaps by both. The existing Eskimo cult has to a large extent been evolved since the race entered North America. The distribution of Magdalenian remains suggests that the occupation of Europe occurred during the closing phases of the last glacial episode.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The committee for the study of special diseases announces that Dr. R. C. Brown, of Preston, Lancashire, has promised the sum of 150*l.* per annum for two years for a pathological scholarship in connection with the investigations being carried out by the committee on rheumatoid arthritis and allied diseases. This scholarship will be known as the R. C. Brown Scholarship in Special Pathology, and will be open to all recently qualified men. The scholar will be required to work under the direction of the Huddersfield lecturer in special pathology at Cambridge, and to assist in the research the committee have undertaken on the pathology and bacteriology of the above diseases.

The Frank Smart studentship in botany will be awarded during the present month. The studentship (the yearly value of which is about 100*l.*) is ordinarily tenable for two years, and the student is in special cases eligible for reappointment for a third year. The successful candidate must devote himself to research in botany under the direction of the professor of botany, who shall determine the conditions under which the research is to be conducted and the place or places in which it is to be carried on. Applications must reach the Vice-Chancellor, Trinity Hall Lodge, on or before Saturday, August 25.

PROF. UHLENHUTH, of Greifswald, has been appointed director of the newly established department of bacteriology in connection with the Imperial Bureau of Health, Berlin.

DR. G. D. HARRIS, of Cornell University, has been appointed to the chair of geology in the Louisiana State University; he will also direct the Geological Survey of Louisiana.

PROF. E. A. MINCHIN, professor of protozoology to the University of London, will deliver his inaugural lecture on "The Scope and Problems of Protozoology" on November 15.

MISS ETHEL HURLBATT, principal of Bedford College for Women, London, has accepted the post of warden of the Royal Victoria College, McGill University, Montreal. Her successor will shortly be appointed, and will, it is hoped, go into residence at the beginning of the Lent term.

MR. R. L. WILLS has been appointed by the Kent Education Committee director of technical instruction in the Chatham, Rochester, and Gillingham district, and Mr. J. Quick has been appointed by the same committee director of technical instruction in the Folkestone, Ashford, and Hythe district.

ON Saturday last Prof. T. Clifford Allbutt, F.R.S., and Prof. H. H. Turner, F.R.S., had the degree of D.Sc. conferred upon them by the University of Leeds; the degrees in connection with the British Association meeting and the celebration of the jubilee of the coal-tar industry, to which attention was directed in our last number, were also conferred.

THANKS to the aid afforded by the Drapers' Company, the work of the statistical laboratory at University College, London, under Prof. Karl Pearson, has been considerably extended. The laboratory, which possesses a large collection of statistical models and diagrams and of mechanical integrators and calculators, provides a complete course of training in the theory and practice of statistics, and instruction is given in exhibition calculation (mechanical and arithmetical) and the use of statistical quantities.

THE Senate of the University of London has accepted from Mr. Martin White two further donations, one to provide a salary of 200*l.* a year for Dr. Edward Westermarck, university lecturer in sociology, for a further period of five years, the other an additional sum of 700*l.* for the establishment for five years of two scholarships a year each of the annual value of 35*l.* and tenable for two years. In connection with Mr. White's benefaction, special courses will be delivered during the session 1906–7 on ethnology, by Dr. A. C. Haddon, F.R.S., and on psychology, by Dr. J. W. Slaughter.

According to *Science*, the investigation at Cornell University of problems in fresh-water biology the year through is made possible by a recent provision for a division of limnology in the department of invertebrate zoology in the University. Dr. James G. Needham, of Lake Forest College, has been appointed assistant professor of limnology to take charge of that work. He will enter upon his duties at Ithaca in February of next year. A site for a biological field station has just been selected on the Renwick Lagoon at the head of Cayuga Lake. The necessary station building and equipment will be provided in the spring.

The calendar of Tokyo Imperial University for 1905–6, a copy of which has just been received, shows that the total number of students enrolled in September, 1905, was 4517 as compared with 3771 in 1903. These students were divided among the constituent colleges as follows:—University Hall, 680; College of Law, 1545; College of Medicine, 641; College of Engineering, 549; College of Literature, 511; College of Science, 122; and College of Agriculture, 469. The number of students at the College of Science is small, probably because all scientific work of an applied kind seems to be apportioned to the colleges of engineering and agriculture, where such subjects as applied chemistry, mining and metallurgy, and agricultural chemistry are studied. The list of original scientific papers published by professors and students of the University is an imposing one, and fills more than forty pages of the calendar.

A copy of the prospectus of the agricultural department of Armstrong College, Newcastle-upon-Tyne, for the session 1906–7 has been received. Complete courses of work are provided in all departments of agriculture and forestry. The department is subsidised by the Board of Agriculture and by the education committees of the four northern county councils. The Northumberland County Council Experimental Station is worked in connection with the department under the supervision of Prof. D. A. Gilchrist. A special laboratory and the entire use of a byre for ten cows are available, at the Durham County Council Dairy Station, for daily research work. By an arrangement with H.M. Office of Woods, the Chopwell Woods, which extend to about 900 acres, are now placed under the control of the department, and are of great value in connection with the courses in forestry. Intending students will thus see that the college possesses every facility for the practical study of agricultural science.

SOCIETIES AND ACADEMIES.

London.

Geological Society, June 27.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—Interference-phenomena in the Alps: Dr. Maria M. **Ogilvie Gordon.** The present paper, so far as it deals with the general structure of the Alps, was completed in April, 1905, but the author has since endeavoured to strengthen her line of argument by taking as a type the series of structural changes undergone in the largely igneous mountain-massive of Bufaure in the dolomites. After describing in detail the geology of the Bufaure Massive, the structural relation of the Western Alps and the Engadine to one another and to the whole mountain-system are discussed. From the arrangement of overthrusts, as well as from the distribution of the igneous intrusions in the Western Alps and in the Engadine, it is concluded that these were areas where leading cross-faults intersected the east-and-west Central Alpine band, and shows how the coalescence of these cross-faults with E.N.E.–W.S.W. faults on the north side and W.N.W.–E.S.E. faults on the south side defined two leading fault-curves, the one passing through the Engadine, the other passing through the Western Alps. The cross-segment comprising the Rhine-Ticino district between the Western Alps and the Engadine is regarded as anticlinal in character, segments having been down-thrown from it both towards the west and east, and overthrust masses have crept E. and S.E. from the Western Alps and westward from the Engadine. The relation of the French Jura Mountains to the Alpine system is then discussed, and it is pointed out that the Swiss-French plain flanking the Western Alps presents the same essential features of structure in relation to the Western Alps on its east side and the French Jura Mountains on its west as those elucidated for the Rhine-Ticino cross-segment. The strike-curve round the west formed by the Jura Mountains and the ranges of Dauphiné is interpreted as the peripheral plicational system in the Alps, showing that the region between the Hungarian basin and the mountain-groups of Central France has been under the influence of the westward thrust. The general principle of structure is the sagging of crust-blocks by means of normal faults towards bands or localities of crust-weakness or subsidence, and the reverse or overthrust-movements which may take place from within these bands or localities. The paper affords evidence of differential rates of movement in different parts of a thrust-mass or fault-block undergoing horizontal displacement, both in respect of the laterally-adjacent parts of a thrust-mass and also of the subjacent layers. The maps and sections show that the actual deformations which characterise a thrust-mass have a different direction of strike on either side of an axial band of maximum horizontal displacement. Several examples in the dolomites are described where there has apparently been a local reversal of the regional westward movement. While each individual case demands special examination, an explanation that satisfies certain cases is provided. At localities where the base of the thrust-mass is open to inflows of igneous rock, the igneous material may ascend and be carried onward with the gliding mass. After consolidation of such igneous inflows, they present resisting bodies within the thrust-mass, which, in the same way as any massive developments of sedimentary material, impede the advance of rock-material in the same direction as before. The tendency is for the material of the thrust-mass to be plicated and faulted as it is driven against a resisting body, widening out in a direction parallel with the resisting mass, and piling up the material to such an extent that local reversal of the direction of overlapping is produced.—The influence of pressure and porosity on the motion of subsurface water: W. R. **Baldwin-Wiseman.** The author commences the paper with a brief historical summary of the researches which have been conducted since 1830 on the motion and behaviour of underground water. In discussing the influence of the porosity of a rock on the rate of flow of water through it, he describes the variations in porosity which may occur in restricted areas of the same rock, due to superincumbent pressure, faulting, and the intrusion of dykes. He describes experiments on the rate of desiccation and soakage of rocks. A lengthy series of laboratory experiments, conducted with specially devised apparatus to afford a constant pressure and to eliminate all errors due to lateral flow, are explained, and it is demonstrated that there is not a uniform relation between flow and pressure in rocks over a considerable range of pressure. Various attempts at determining the range of the cone of depletion in strata are passed in review, and a method based upon an experimental determination of the variation of internal pressure in a rock-mass when charged with water and subjected to a considerable difference of pressure on the two faces is outlined. In the concluding portion of the paper data collected during various hydrological surveys are discussed, and the influence of surface-configuration and stratigraphical sequence on the subsurface water-contours are pointed out.

Dublin.

Royal Irish Academy, June 25.—Dr. F. A. Tarleton, president, in the chair.—Note on the action of emulsine on β-glycosides: Prof. Hugh **Ryan** and G. **Ebrill.** This paper shows that emulsine hydrolyses the galactoside of α-naphthol in aqueous solution, but is inactive towards the arabinosides of cresol, β-naphthol, and carvacrol, as well as the tetracetyl derivatives of the glucosides of β-naphthol and cresol.—The composition of a nitrogen mineral water at St. Edmundsbury, Lucan, co. Dublin: Dr. W. E. **Adeney.** The mineral water which forms the subject of this paper flows from a spring which is situated in the demesne of St. Edmundsbury, Lucan. The water is supersaturated with nitrogen, and as it rises to the surface of the spring large bubbles of that gas mixed with small quantities of carbon dioxide are constantly evolved, giving it the appearance somewhat of ebullition; hence the name of the "Boiling Well" by which it is marked on the Ordnance maps. The dissolved gases were found to be as follows, expressed in volumes at 0° C., and 760 mm. bar., per 1000 volumes of the water:—carbon dioxide, 140·77; oxygen, 0·0; nitrogen, 27·13. The water contains about ninety grains of mineral matter per gallon. The chief constituents are:—calcium bicarbonate, 35·2 grains; sodium chloride, 41·24 grains; magnesium chloride, 9·4 grains; and magnesium sulphate, 3·24 grains, per gallon. It also contains small quantities of ferrous bicarbonate, potassium chloride, and traces of lithium chloride and of barium sulphate. It is probable that the excess of nitrogen which this water holds in solution was derived from the fermentative decomposition of nitrates; 1·8 parts nitric nitrogen per 100,000 parts of the water would, on decomposition, yield 14 c.c. nitrogen, at 0° C., and 760 mm. bar., which represents about the quantity in excess of the gas in solution. The fact that after several days of strong frost, and at a time when the temperature of the air was 32° F., that of the water, as it rose to the surface of the spring, was 60°·5 F., shows that the water must rise from a considerable depth below the surface of the ground, and this suggests an explanation as to how the water holds so large an excess of nitrogen in solution. A careful examination was also made of the water to ascertain whether it contained any matters which would render it unfit to be drunk, but with negative results.

EDINBURGH.

Royal Society, July 2.—Prof. Crum Brown, vice-president, in the chair.—The use of soluble Prussian blue in investigating the reducing power of animal tissue: Dr. D. Fraser **Harris.** The method of experiment was to inject the blood vessels of either decerebrate cats and rabbits or the isolated surviving kidney or liver of pig or sheep. In the latter cases the blue of the potassio-ferric-ferrocyanide is in the capillaries reduced to the pale green or colourless compound, the di-potassio-ferrous-ferrocyanide —a vital reduction expressed, *not* by a deoxidation, but by change of trivalent iron into divalent iron. Irrigation with H_2O_2 restored the blue colour. In the experiments on the kidney, when the pressure of injection rose to 100 mm. of mercury, a colourless, gelatinous artificial urine dropped from the ureter, and the pelvis of the kidney was filled with colourless gelatin; this leuco material at once became blue on irrigation with H_2O_2. Various considerations showed that the green or leuco condition resulted neither from the action of the alkaline salts of blood and tissues nor from putrefaction, but proved the existence within the blood of "reducing substances." The leuco compound ten years after formation within capillaries can still be, by the H_2O_2, restored to the blue condition. The least perfect reduction is in the great vessels, the most perfect in the thin-walled capillaries, *i.e.* in those vessels which are supplying material for anabolism to the living cells endowed with a high reducing capacity.—The viscosity of solutions, part i.: C. **Ranken** and Dr. W. W. **Taylor.** The paper contained an account of the apparatus, and also the measurements of aqueous solutions of electrolytes and non-electrolytes at various temperatures and concentrations. Of the substances examined, mercuric cyanide is the only one with a temperature coefficient smaller than that of water. Dilute solutions of carbamide at low temperatures have "negative relative viscosity," being probably the first example of a non-electrolyte in water which is known to exhibit it.—Two lecture experiments in illustration of the theory of ionisation: Dr. W. W. **Taylor.** (1) To show that the ionisation of an acid is diminished by addition of salts of an acid; addition of dilute nitric acid or of strong solution of potassium nitrate does not coagulate albumen; together they do so immediately. (2) To show that a weak acid turns out a strong acid from its salts; acetic acid solution or strong solution of potassium nitrate does not coagulate albumen; together they do so. This can be shown not to be due to potassium acetate.

July 13.—Dr. R. H. Traquair, vice-president, in the chair.—Obituary notice of S. P. Langley: Dr. W. **Peddie.** —The recent epidemic of trypanosomiasis in Mauritius; its cause and progress: Dr. Alex. **Edington** and Dr. J. M. **Coutts.** The authors believe that the infection did not come from India with a cargo of cattle, as has been stated, but that it had been already in the island in a latent form. This belief is further strengthened by information recently obtained that a case of trypanosomiasis actually existed on the adjacent French island of Réunion in August, 1901, which antedated the earliest date in Mauritius. Cattle which had been made immune to the trypanosome were found to be still susceptible to the *Trypanosoma brucei*—the parasite of the tsetse-fly, which is thus proved to be specifically distinct. The parasites totally disappear in the blood of immunised cattle. In goats the infection is evinced by progressive emaciation and death after about two months; but although their blood is virulent and produces trypanosomes in susceptible animals, no trypanosomes could be detected in the blood fluids or tissues of the goats. According to the report for 1904 of the director of the Health Department of Mauritius, the epidemic is slowly but surely diminishing. The importation of mules, which are very susceptible to the disease, tends more than anything else to maintain the disease in an active form.—Note on the smolt to grilse stage of the salmon, with exhibition of a marked fish recaptured: W. L. **Calderwood.** In 1905 the Tay Fisheries Company marked about 6500 smolts by the attachment of a small piece of silver wire to the dorsal fin. On June 1, 1906, the first grilse marked with a wire was taken in the Tay. Since then four other fish had been recaptured. The one exhibited was 24 inches long; fully a year before, when marked with the wire, it was about 5 inches long. Its growth during its residence in the salt water was estimated at from three to six ounces per month.—The effect of precipitation films on the conductivity of electrolytes, part i.: W. S. **Millar** and Dr. W. W. **Taylor.** The paper contained an account of results obtained by use of the alternating current and telephone method with films of aluminium hydroxide, chromic hydroxide, and cupric ferrocyanide. The solutions compared were the chlorides, bromides, and sulphates of potassium, sodium, and ammonium; sodium ammonium tartrate, and sodium ammonium racemate.—The theory of alternants in the historical order of development up to 1860, and the theory of circulants in the historical order of development up to 1860: Dr. Thomas **Muir.**—The length of a pair of tangents to a conic: Prof. **Anglin.**

PARIS.

Academy of Sciences, July 25.—M. H. Poincaré in the chair.—The president announced the death of M. Brouardel.—The toxic action and localisation of the radium emanation: Ch. **Bouchard** and V. **Balthazard.** The presence in the peritoneum of the guinea-pig of 2 grams of barium sulphate containing about 5 mgr. of radium sulphate proved fatal to the animal. In a control experiment with the same quantity of barium sulphate free from radium, the animal suffered no inconvenience. The distribution of the radium emanation in the various organs of the animal after death was determined by an electrical method. The suprarenal capsules showed the largest proportion of the emanation, the lungs, skin, liver, and kidneys showing decreasing amounts. The author points out that from the chemical inertness of the emanation this selective action of the organs of the body is unexpected.—The results of two deep borings in Picardy: J. **Gosselet.** The boring at Saigneville was carried to a depth of 425·95 metres, the Devonian being encountered at a depth of 408 metres. The strata met with are compared with those encountered in the boring at Péronne, the latter having a depth of 500 metres.—The extension of vectorial algebra with the aid of the theory of binary forms, with applications to the theory of elasticity: Émile **Waelsch.** —A class of integral series: Michel **Pétrovitch.**— Lagrange's projection applied to the map of European

Russia: N. **de Zingor.**—The mobility of the ions produced by the Nernst lamp: L. **Bloch.**—The experimental study of telegraphic transmission: M. **Devaux-Charbonnel.**—The relation existing between electrical resistance and the viscosity of electrolytic solutions: P. **Massoulier.** The conductivity of solutions of potassium chloride in glycerol has been measured for varying concentrations of glycerol. The resistance was not found to be strictly proportional to the viscosity, but there is obviously a relation between the two magnitudes, since while the viscosity varied from 1 to 5·6, the product of conductivity and viscosity only changed from 1 to 1·3. Similar results were obtained on measuring the conductivity and viscosity of potassium chloride in sugar solutions.—The influence of pressure and form of discharge on the formation of ozone: A. **Chassy.** At pressures below 6 cm. no ozone is formed, no matter how long the experiment is prolonged. This effect would appear to be due to a change in the nature of the discharge at this pressure.—Contribution to the study of ultramarine: C. **Chabrié** and F. **Levallois.** The prolonged action of an aqueous solution of silver nitrate at 140° C. upon ultramarine gives sulphuric acid and silver nitrite, together with nitric oxide.—Zirconium silicide ($ZrSi_2$) and titanium silicide ($TiSi_2$): Otto **Hönigschmid.** The reduction of zirconium oxide and the double fluorides of zirconium and titanium by the alumino-thermal method in presence of a large excess of silicon gives the silicides $TiSi_2$ and $ZrSi_2$. —The alloys of lead and calcium: L. **Hackspill.** The best method of preparing these alloys is the electrolysis of fused calcium salts with a molten lead kathode. Alloys containing from 7 per cent. to 21 per cent. of calcium were heated in a vacuum to about 1000° C.; lead distilled off, and the alloy remaining had the composition Pb_3Ca_2 in each case.—Kathode phosphorescence spectra of terbium and dysprosium diluted with lime: G. **Urbain.** —Radio-active lead extracted from pitchblende: Jean **Danysz,** jun.—The constitution of hordenine: E. **Léger.** Hordenine gives picric acid when treated with nitric acid, and trimethylamine on the dry distillation of its iodomethylate. The formula $(OH)C_6H_4.CH_2.CH_2.N(CH_3)_2$ is suggested as the most probable.—The action of phenylmagnesium bromide on the esters of the dialkylamidobenzoyl-benzoic acids: J. **Pérard.**—The introduction of the dinaphthopyryl and xanthyl radicals into electronegative molecules: R. **Fosse** and A. **Robyn.**—The diamino-acids derived from ovalbumen: L. **Hugounenq** and J. **Galimard.** Egg-albumin has furnished 2·14 per cent. of arginine and 2·15 per cent. of lysine.—The mixed crystals of barium chloride and bromide: Jean **Herbette.**—The production of a new elementary species of maize by traumatism: L. **Blaringhem.**—The disease of wine known as "la graisse": E. **Kayser** and E. **Manceau.** —New observations on the retrocerebral apparatus of rotifers: P. Marais **de Beauchamp.**—A new method of obtaining crystals of hæmatin in the medico-legal diagnosis of blood spots: MM. **Sarda** and **Caffart.**—The Gault and Genomanian of the Seybouse basin: J. **Blayac.**—The liquefaction of volcanic carbonic acid in Auvergne. The poison spring of Montpensier: Ph. **Glangeaud.**—The resistivity of mineral waters, their coefficient of variation with temperature, and the differentiation of natural mineral waters from similar waters made artificially: D. **Negreano.**—The structure of the Fusilinideæ: Henri **Douvillé.**—The formation of ground ice: J. **de Schokalsky.** A detailed account of observations on the formation of ground ice in Lake Ladoga, near St. Petersburg.

CAPE TOWN.

South African Philosophical Society, June 27.—Dr. J. D. F. Gilchrist in the chair.—Opisthobranchiata of South Africa: Prof. **Berg.** Forty new species are described, of which several represent new genera. Both tectibranchs and nudibranchs are well represented. Among the former are eight new species of Aplysia. The difference between the fauna of the east and west coast is marked in these marine animals, the region west of the Cape Peninsula having forms of northern character; the region to the east of the Cape of Good Hope has more of a tropical Indian character.—Dr. R. **Broom** communicated five papers:—(1) The early development of the appendicular skeleton of the ostrich, with remarks on the origin of birds. In the early embryo there are three well-developed toes and two others rudimentary. In the pelvis the pubis and ischium are directed downwards and united by pro-cartilage. In the wing there are evidences of four digits. The author holds that birds are descended from bipedal reptiles intermediate between the Pterosaurs and the carnivorous Dinosaurs. (2) Note on the lacertilian shoulder girdle. It is held that all the various cartilaginous and bony bars found in front of the shoulder girdle are merely parts of the true scapula and coracoid. (3) Some little-known bones in the mammalian skull. A number of bones typically present in the reptilian skull, but not generally recognised as occurring among mammals, are shown to be present occasionally. (4) A new cynodont reptile from the Molteno beds of Aliwal North. A description is given of a new cynodont, the first reptile that has been discovered in the Molteno beds. (5) A new rhynchocephalian reptile from the Upper Beaufort beds of South Africa. A description of a lower jaw of a small reptile allied to Homœosaurus. This is the oldest true rhynchocephalian known.—Notes on South African cycads: Prof. H. H. W. **Pearson.** Field observations upon *Encephalartos Friderici-Guilielmi*, Lehm., *E. Villosus*, Lem., *E. Altensteinii*, Lehm., and a species of Stangeria. Evidence in support of the insect pollination of *E. Villosus* is adduced. In *E. Friderici-Guilielmi* and *E. Altensteinii* the cones are laterally placed, and the growth of the stem is therefore monopodial. The importance of subterranean branching as a means of vegetative reproduction in Stangeria and in *E. Friderici-Guilielmi* is discussed.

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