THURSDAY, SEPTEMBER 30, 1909.

APPRECIATIONS OF CARL VON LINNÉ.

Carl von Linné's Bedeutung als Naturforscher und Arzt. Schilderungen herausgegeben von der Königl. Schwedischen Akademie der Wissenschaften anlässlich der 200-jährigen Wiederkehr des Geburtstages Linné's. Pp. iv+168; 48; 43; 188; 86, 2 pl.; 42. (Jena: G. Fischer, 1909.) Price 20 marks.

THIS volume is a German version of that issued in May, 1907, by the Royal Swedish Academy of Science, and consists of six appreciations of the great Swedish naturalist.

The first of these, by Emeritus Prof. Otto E. A. Hjelt, was written at the request of the Academy, and is a revised edition of a former work prepared for the celebration of the quatercentenary of Upsala University in 1877, embodying various improvements through recent investigation into Linnean matters, due to the devotion of the late Dr. E. Ährling and Prof. T. M. Fries. In common with the other essays, this is separately paged, and may be procured apart from its accompanying discourses.

Linné's remarkable services to botany and zoology have thrown somewhat into the shade his acquirements as a practising physician and professor of medicine. This essay will do much to draw attention to this side of Linné's activities. It must not be forgotten that he was rescued from a suggested apprenticeship to a tailor or shoemaker, by the sagacity of his early teacher, Rothman, who assured Nils Linnæus that his son showed great aptitude for medicine. It was for this that Linné entered the University of Lund, and afterwards migrated to Upsala for further improvement; he took his degree of M.D., to earn a livelihood, and he practised in Stockholm after his return to Sweden. His first chair at Upsala was of medicine, and though soon afterwards he exchanged it for that of botany, he continued to keep in touch with it during his career, and left manuscripts showing his unabated interest, in spite of his exertions in other directions. A list of his medical writings at the end of this essay contains eighty-six titles.

This is followed by "Carl von Linné und die Lehre von der Wirbelthieren," of Prof. Einar Lönnberg, in which a *résumé* is given of Linné's predecessors in zoology, from Conrad Gesner, Rondelet, Aldrovandi, and others, to Ray and Willoughby, and contrasting the order brought in by methodical arrangement under Classes, Orders, and Genera.

The third essay, "Carl von Linné als Entomolog," is by Dr. Chr. Aurivillius, and is here separately given; in the original Swedish edition, Linné was considered as a zoologist, in a joint memoir with the previous author, but in this issue the part of each writer is set out separately. Following the same line of thought as in the foregoing essay, Dr. Aurivillius points out that the collections formerly belonging to Queen Lovisa Ulrika at Drottinngholm and of King Adolf Fredrik at Ulriksdal, which had been arranged and catalogued by Linné, have been in the keeping of the University of Upsala since 1803.

Dr. C. A. M. Lindman is responsible for the next memoir, "C. v. L. als botanischer Forscher und Schriftsteller," and is the longest of the series. Beginning with Linné's early training and first catalogues of local plants, it deals with that wonderful series of books which were printed in Amsterdam, the "Systema Naturæ," "Genera plantarum," "Flora lapponica," "Hortus Cliffortianus," &c., especially drawing attention to such parts of Linné's botanical teaching which are apt to be overlooked, such as his attempts at a natural system, and observations in morphology and physiology of plants; of these, many are to be found in his dissertations and travels, rarely looked at now. Indeed, Linné's books are chiefly referred to at the present day from the systematic point of view. The fact that his busy mind had occupied itself on problems which even now are unsolved is lost sight of, because his observations must be sought for in their original Latin or Swedish dress. The latter portion especially of Dr. Lindman's work should be carefully read, and will heighten our wonder at the enormous amount of work accomplished by the occupant of the Chair of Botany at Upsala.

Linné regarded as a geologist forms the next part of this volume, and is due to Prof. Nathorst; it is illustrated with two plates, and ten figures in the text. Both as petrologist and palæontologist the merits of Linné are set out, and his keen insight into geological causes are dwelt upon. Linné had but little opportunity as a field geologist; his travels were practically bounded by his official journeys to Gotland, Westgotland, and Skåne, and yet his observations merit careful reading in the light of modern science.

A similar appreciation is given by Prof. Sjögren in the last section, "Carl von Linné als Mineralog." The Linnean collection of minerals was sold by Dr. J. E. Smith in 1796, when about to remove from Chelsea to Norwich, and its present condition and place are unknown. But it is enough to gather from the various statements in the writings of Linné to put before us the views of the great naturalist in honour of whom these essays were composed.

The chief difference noticed between the original and the present edition is the omission of the reprint of Linné's "Clavis medicinæ," which formed an appendix of ninety pages to Prof. Hjelt's memoir.

B. D. J.

INDIA-RUBBER MANUFACTURE.

The Manufacture of Rubber Goods. A Practical Handbook for the Use of Manufacturers, Chemists, and Others. By Adolf Heil and Dr. W. Esch. English Edition by E. W. Lewis. Pp. viii+236. (London: C. Griffin and Co., Ltd., 1909.) Price 10*s*. 6*d*. net.

IT is now several years since the late Dr. Weber's treatise upon "The Chemistry of India Rubber" was published. The book was reviewed in these columns at the time, and has become a standard work upon the scientific principles involved in the production of rubber. A companion volume upon the practical manufacture of rubber articles was contemplated by the author, but his decease prevented its production; and the present work is to be regarded as a substitute. It is a translation of Heil and Esch's "Handbuch der Gummiwarenfabrikation," adapted for English usage in respect of the machinery generally employed in this country.

Non-technical readers may be reminded that crude rubber as imported contains a number of impurities—water, woody tissue, sand, and other mineral matter. Moreover, it is unvulcanised, and to fit it for diverse uses various "filling" substances must be incorporated with it. The process of manufacture consists, therefore, in the purification of the raw material; the mixing of this with ingredients which will impart the required colour, durability, or other special property to the article; the fashioning of this plastic mixture into tyre, tube, or whatever finished article is desired; and lastly, the vulcanisation of the object with sulphur, or chloride of sulphur, whereby the rubber becomes non-adhesive, harder, and more durable.

The authors give the plan and arrangement of a factory for the carrying out of these operations in what they consider to be the most advantageous manner. They direct special attention to the necessity for excluding dust in the making-up of rubber goods, since leaky seams are liable to develop in goods if particles of dust are allowed to settle on the edges of the article during the joining process. Another point to which they direct attention is the necessity, after the rubber has been washed free from admixed impurities, of drying it in a rational way. Far too little regard is had to this important detail. The large surface-area exposed favours atmospheric oxidation of the moist, warm rubber, and the time of exposure should therefore be as short as practicable. On the other hand, if the material is imperfectly dried, goods made from it are liable to rapid deterioration. To dry it thoroughly, quickly, and safely is the desideratum; and the authors describe modern drying-rooms and centrifugal plant adapted to this purpose. While not recommending any one method as the best in all circumstances, they discuss the general principles involved, and plead for an intelligent application of them.

The necessity for avoiding undue "working" or kneading of the dried rubber is also insisted upon. Not only does it increase the expense, but the quality suffers deterioration thereby. True, "rubber substance" is regarded as a mixture of polymerised hydrocarbons, and too much kneading results in a presumed depolymerisation of a portion of the material, with consequent injury to the texture.

A number of examples are given illustrating the composition of "mixings" for making different kinds of rubber articles; and the machinery for working and calendering the mixtures is described at some length.

As regards vulcanisation, it is a remarkable fact that the processes still used are carried out essentially in the same way as when first introduced, some seventy years ago, by Goodyear, Hancock, and Parkes. The details, of course, differ with the different factories; and the empirical methods evolved are guarded as trade secrets. In fact, so perfectly has long experience developed the rule-of-thumb indications that the authors think scientific investigation can hardly result in any noteworthy revolution in the methods of manufacture. It may be so; but this is not quite the spirit in which progress is made. A few years ago indigo-planters would have said much the same thing.

Many illustrations accompany the text, which is generally lucid, though occasionally with a leaning to Teutonic stolidity. Except in this respect, the translator has eliminated any lingual indication of the origin of the book, which can be recommended as a very practical and useful work. C. S.

VECTOR ANALYSIS.

Vector Analysis: an Introduction to Vector-methods and their Various Applications to Physics and Mathematics. By Dr. J. G. Coffin. Pp. xix+248. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 10*s*. 6*d*. net.

THIS "Introduction to Vector-methods and their Various Applications to Physics and Mathematics" is an exposition of the late Willard Gibbs' vector analysis. The author in his preface warns us that "no attempt at mathematical rigor is made"—which perhaps explains the opening sentence of chapter i.: "A vector is any quantity having direction as well as magnitude." What of finite rotations? Are they not to be considered quantities having direction and magnitude? In an appendix the author compares notations, not always quite accurately. He believes Willard Gibbs' notation to be the simplest and most symmetrical of any of the existing kinds. Burali-Forti and Marcolongo, who believe they have devised the perfect notation, object to Willard Gibbs's "dot" in the scalar product, using a "cross" instead. As regards the question of symmetry, the truth is that the vector product is not symmetrical, for in Gibbs's notation $\mathbf{a}\times\mathbf{b}=-\mathbf{b}\times\mathbf{a}$. As a matter of fact each vector analyst can always find sufficiently self-pleasing arguments in favour of his pet notation.

Notation apart, the book is well put together, and lays stress on many important applications in dynamics, elasticity, hydrodynamics, electricity, and magnetism. The differential operator ∇, in its Gibbsian phase, is developed in considerable detail. But will non-Hamiltonian vector analysts never realise how much they lose by working with what is not, after all, the real Hamiltonian operator? By discarding the associative law in vector products they lose the flexibility of the real ∇. Pages of definitions would be saved by a simple return to Hamilton and Tait; and not only so, but the mind of the student would be freed from the task of committing to memory the laws of the equivalent operators as used by Gibbs, Heaviside, Gans, Jahnke, Bücherer, Föppl, Burali-Forti and Marcolongo, &c. In the exercises at the end of chapter v. we notice two mistakes. In exercise (4) we are told that $\nabla.(\mathbf{a}\times\mathbf{r})=2a$, where a is the length of the vector $\mathbf{a}$. In quaternions this is $S\nabla V\alpha\rho$. But $\nabla V\alpha\rho=2\alpha$, a *vector*, which can have no scalar part. Again, in Exercise (13) we have by definition

$$e^{\mathbf{a}} = 1 + \mathbf{a} + \frac{\mathbf{a}^2}{1.2} + \frac{\mathbf{a}^3}{1.2.3} + \ldots,$$

where

$$\mathbf{a}^2 = \mathbf{a}.\mathbf{a},\ \mathbf{a}^3 = \mathbf{a}\mathbf{a}.\mathbf{a},\ \mathbf{a}^4 = \mathbf{a}.\mathbf{a}\mathbf{a}\ \mathbf{a},$$

and we are to prove that

$$e^{\mathbf{a}} = \cos a + \mathbf{a}_1 \sin a,$$

where a is the length of $\mathbf{a}$, and $\mathbf{a}_1$ is the unit vector along $\mathbf{a}$. Now according to Gibbs $\mathbf{a}.\mathbf{a} = +a^2$, so that all the terms of the assumed expansion must be positive. How then can they give the *sine* and *cosine*? The statements are true *only* if we use the Hamiltonian vector whose square is *minus* the square of its length. The linear vector function is introduced for the discussion of the kinetics of a rigid body. This is purely Hamiltonian, and is very good so far as it goes. The investigation, however, seems to lack here and there the strength and spontaneity of Tait's classical discussion.

RETAINING WALLS AND ROAD BRIDGES.

(1) *Graphical Determination of Earth Slopes, Retaining Walls, and Dams.* By Prof. C. Prelini. Pp. ix+129. (London: A. Constable and Co., Ltd., 1908.) Price 8*s*. net.

(2) *The Design of Highway Bridges, and the Calculation of Stresses in Bridge Trusses.* By Prof. M. S. Ketchum. Pp. xxi+544. (New York: The Engineering News Publishing Co.; London: A. Constable and Co., Ltd., 1908.) Price 16*s*. net.

(1) THIS book brings together for the use of the engineering student in a handy form for reference the various graphical methods due to Culmann, Rebhann, and others, for solving problems connected with earth pressures.

The first chapter treats of the stability of earth slopes; the cohesive force in a bank of earth is determined by graphical methods, and hence is deduced the most probable plane of sliding; by means of the parabola of cohesion the various slopes of equilibrium for various heights of bank are determined, and its application to practice is then discussed; the considerable economy in excavating deep trenches with slopes correctly designed is proved by worked out examples.

In the second chapter the design of retaining walls is taken up; the author points out that all the various theories which have been employed can be divided into two groups, (*a*) those depending on the theory of the sliding prism, (*b*) those depending on analytical theory. A graphical solution, due to Rebhann, of the sliding prism type is then given; this method is then applied to a series of practical cases, both for retaining walls when surcharged, and when free of surcharge. The variation of pressure with height of wall, and position of the centre of pressure are dealt with, and also the effect of cohesion on the pressure against retaining walls, and the pressure of passive resistance of the earth in the case of abutments which are pushed outwards by arches.

In the next chapter there is an analytical demonstration of Rebhann's theory, and brief statements of the formulæ of Rankine and Weyrauch. In a series of three tables the author gives the values of the earth pressure against walls of different heights as deduced by these three formulæ, and the results agree so well that it is evident that any one of the three methods is equally trustworthy from the practical point of view.

The results obtained in the preceding chapters are applied in chapter iv. to the design of various types of retaining walls; and the important problem of the determination of the necessary thickness at the base of a retaining wall in order that it may be stable under earth pressure is fully discussed for each type of wall.

The last chapter of the book is devoted to masonry dams, which, as the author points out, are simply a particular case of retaining wall, with the material sustained practically frictionless; it is shown that the most economical profile, theoretically, is a triangular one, but in practice this is an impossible section. The modification needed in order that the dam may have a certain thickness at the top is then discussed, and the pentagonal profile deduced. It is shown that this theoretical profile is the basal form of all modern high dams. The book should prove especially useful to civil engineering students during their final college year.

(2) While many text-books have been devoted to the design of railway bridges, but little attention has been hitherto given to the equally important question of the design of road bridges, and, although the work of calculating the stresses in the different members is the same for both types, there are, owing to the very different requirements to be met, radical differences in the design of the two classes of bridge. This book, therefore, meets a distinct want, and it will be especially useful to the young designer, in view of the fact that the author has given special attention to the problem of the design of the substructure, which is usually quite neglected in books on bridge design. An entire chapter has been devoted to the design of floor beams, floors, shoes, and pedestals, and other similar details, and it is in regard to such matters that the young engineer most commonly finds the need of help and guidance.

The ninth chapter will prove of considerable use, not only to the student, but also to the teacher; as the author points out, in order to obtain a thorough knowledge of the calculation of stresses in bridge trusses, it is essential that the student should work through numerous problems—altogether twenty-four problems are worked out in detail in this section of the book, and a second similar one has been added to each of the twenty-four problems as a further exercise for the student to solve with the help afforded by the worked-out example; some of the solutions are obtained graphically, others by algebraic methods. Another valuable section is that devoted to influence diagrams, or influence lines, which are required in studying the variation of the effect of a moving load or system of loads, on a truss.

Special attention has been given to the design of high truss steel bridges, and to plate girder bridges, and this section of the book is well illustrated with reproductions of working drawings, which, in spite of the necessary small scale, are perfectly clear and distinct in all the essential details. The stresses in, and the design of, solid masonry arches and culverts form the subject of two chapters, and, though there is nothing specially novel in the treatment adopted, these sections of the book will be welcome to the draughtsman who is engaged in this branch of bridge design, especially as the author has given some useful notes on the theory of reinforced concrete.

In part iii. of the book there is a full critical investigation of an existing structure—the weights, costs, and efficiencies of the members of a Pratt highway bridge of 160 feet span are fully worked out, and the errors in design pointed out, and the modifications which would improve the design are suggested. There is no doubt that such an investigation is bound to make students familiar with bridge details, and we would commend this method to the notice of engineering teachers. T. H. B.

OUR BOOK SHELF.

Die Strahlen der positiven Elektrizität. By Prof. E. Gehrcke. Pp. xi+124. (Leipzig: S. Hirzel, 1909.) Price 4.50 marks.

AT a moment when scientific thought is being concentrated on the consideration of the nature of positive electricity, we can only welcome the appearance of a book which aims at bringing together, in the short compass of a hundred pages, all the principal facts bearing on the subject. This Prof. Gehrcke has done, and he has done it well, for, with the exception of a few slight omissions, he has put before his reader all that is essential with regard to positive rays. But we could wish that more than this had been done, for it is a little disappointing to find the results of experiments given, often with little, if anything, to indicate the theoretical deductions which can be drawn from them. Indeed, not infrequently the opinions of different investigators as to the interpretation of the results of experiments are recorded without any comment as to the relative merits of rival theories. No doubt it was the intention of the author to keep the work within definite limits, but it seems that much has been sacrificed merely for the sake of brevity. In no part of the book is this more apparent than in the portion devoted to radio-activity and the nature of the α rays. Here descriptions are often so short that it is questionable whether anyone not already fully acquainted with the subject will be able to follow the reasoning.

In the part dealing with radio-activity there are a few inaccuracies which call for comment. On p. 90 the author states that it is usually supposed that one α particle is given off from each atom during any radio-active process involving the emission of such particles. In view of the work of Bronson, who showed, for example, that an atom of thorium emanation, in breaking up, gives off four times as many α particles as an atom of thorium B or C, this is clearly not the case. Again, the table on p. 89 contains some mistakes. The volatilisation point of radium A, given as 1000° C., is too high, and that of radium C, as 1100° C., is too low. The volatilisation point of radium B is given as 20° C., instead of 600° C. That radium B can escape, at ordinary temperatures, from a surface coated with active deposit is correct, but the phenomenon is not due to any true volatility of the substance at ordinary temperatures, and has been explained on quite different lines.

Das Seelenleben der Tiere. By Dr. P. Ohm. Pp. 117. (Stuttgart: Neue Weltanschauung, 1909.)

THIS little book is the fourth of a series called "Weltanschauungs-Fragen," and apparently intended to include contributions to the monistic philosophy of Haeckel. Consequently, Dr. Ohm brings forward the two principal theories of animal intelligence—one that it is totally different in kind from human, and the other that it is the product of evolution, and differs only in degree, but is essentially of the same nature. After a brief historical introduction to the subject, and noticing the opinions held by various authors from Plato to Wasmann, Darwin, and Harold Höfding, Dr. Ohm speaks of the dawning intelligence indicated in Protista, sponges, Medusæ, Hydra, molluscs, &c., and then inserts a chapter on instinct to controvert the view advocated by Wasmann that it is a perfect and divine inspiration, quite different from reason. Here he deals especially with the manifestations and imperfections of the intelligence of insects, especially ants and bees.

Another chapter is devoted to the "Seelenleben" ("soul-life," or, more correctly, intelligence) of insects and spiders, with special reference to their eyes, antennæ, sense of direction, &c., and a figure is given of the Indian tree-ant (*Œcophylla smaragdina*) using one of its own larvæ to spin threads. An illustration is also given of the large garden diadem spider and its web. Another chapter follows, on the senses, habits, and intelligence of vertebrate animals, and the book concludes with a comparison between human and animal intelligence; and the author regards the faculty of speech as the essential difference between them. A short bibliography is appended.

Dr. Ohm has written a thoughtful little book, and has dealt with a difficult subject fairly and moderately. His work will be read with interest by students interested in the important questions with which it deals; but everyone is so much influenced by preconceived ideas, on one side or another, that it is almost impossible to form an unbiassed opinion about them. W. F. K.

Comment Former un Esprit. By Dr. Toulouse. Deuxième Édition. Pp. x+260. (Paris: Librairie Hachette et Cie., 1908.)

THIS book is the reply to a request for ten lessons to professional teachers and parents which should embody what Dr. Toulouse's experience as a psychologist and a medical man has taught him to think essential to "the cultivation of an intelligence." He starts from a position with which critics of educational institutions on this side of the Channel have made us familiar; "we teach everything in school to-day except how to think and how to act." His remedy is also familiar—education should aim at teaching us not so much to know as how to apply knowledge to the regulation of the important affairs of life. To achieve this end it must train us, in accordance with sound principles of "method" (in the Cartesian sense), to observe, to judge, to feel, to act. The author's discussion of these methodical principles is broad-minded and suggestive, but it is too brief and schematic to be of much direct service to the teacher in the class-room or the parent in the home. His recommendations have much more value when they either express the practical wisdom of a man who has managed his life successfully or deal with specific topics on which his experience as a medical psychologist gives him authority. Under the latter heading attention may be directed to a vigorous argument for the frank instruction of boys and girls in "the phenomena of life."

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.]*

Visibility of Halley's Comet.

THE discovery of Halley's comet at a time so far preceding the date of perihelion passage adds another proof of the great capacity of the photographic method. The interesting point to many observers is as to when the comet will become visible to them as a telescopic object. This must, of course, depend in a large measure upon the diameter of their glasses and on their powers of vision. After the present moon has left the sky, say during the second week in October, the comet ought to have increased in light sufficiently for it to be observed in a 12-inch telescope. The calculated magnitude of the comet will be 14½ on October 15, and its distance from the earth about 230 millions of miles. Its apparent position will then be five degrees west of γ Geminorum, and near 72 Orionis. On October 16 the comet will be just two degrees south of 71 Orionis (mag. 5·5), and ought to be visible as a very faint nebulosity, especially if the night is good. The transparency of the air has an important influence on the perception and aspect of faint comets and nebulæ, for a really suitable sky will enable objects to be glimpsed which are utterly invisible on bad nights when there is diffused light, thin cloud, mist, or fog prevalent. The comet will be visible in an excellent position nearly all night during most of the winter, but will continue small and faint until it blazes out next April.

W. F. DENNING.

The Presence of Hæmoglobin in Invertebrate Blood.

MAY I make use of your columns to correct a statement in my article on Crustacea in vol. iv. of the "Cambridge Natural History," which I am afraid may seriously mislead the reader? Referring to the alleged presence of hæmoglobin in the blood of Branchipus and Daphnia, I have stated in a footnote on p. 30 that the fact that the red blood of Lernanthropus has been proved not to contain hæmoglobin throws doubt on the reality of its presence in the other two animals. At the time of writing I was not aware that the authority on which the presence of hæmoglobin in Branchipus and Daphnia rested, and I was inclined to impugn, was Sir Ray Lankester, who, in the late 'sixties and early 'seventies, published a series of researches which laid the foundation of a comparative knowledge of the distribution of hæmoglobin and similar respiratory pigments in the animal kingdom (see especially Proc. Roy. Soc., vol. xxi., December, 1872, p. 70). After reading these articles it is clear to me that Sir Ray Lankester's statement as to the presence of hæmoglobin in the blood of Branchipus and Daphnia, resting as it does on careful microspectroscopic examination, is quite unaffected by what may or may not be the case in Lernanthropus, so that I can only withdraw my footnote with many apologies to him and to readers of the "Cambridge Natural History." With regard to Lernanthropus and its allies, small crustacea parasitic on fish and mussels, which possess a closed vascular system containing a red fluid, there is still some doubt. Van Beneden, who discovered Lernanthropus in 1880, states (*Zoologischer Anzeiger*, Bd. iii., p. 35) that he examined the blood spectroscopically, and found the oxyhæmoglobin lines.

More recently Dr. Steuer (*Arbeiten Zool. Inst. Wien*, vol. xv., p. 14, 1903) sent numerous specimens of an allied form, Mytilicola, to Prof. R. von Zeynek in Vienna, who came to the conclusion that the blood did not contain hæmoglobin, since (1) with glacial acetic acid and sodium chloride no hæmin crystals were obtained; (2) after reduction with potassium cyanide and ammonium sulphide, the characteristic reduced hæmoglobin lines were not formed; (3) there was no hæmochromogen reaction.

Curiously enough, we are not told whether the simple examination of the blood gives the oxyhæmoglobin lines, as Van Beneden stated, or not, so that we are left in doubt whether Van Beneden was altogether in error or the red substance in the blood of Lernanthropus possesses one of the properties of hæmoglobin but not the others. The matter being in this unsatisfactory state, it is very desirable that someone, to whom the opportunity is offered, should re-investigate the blood of Lernanthropus.

New College, Oxford. GEOFFREY SMITH.

MAGNETIC STORM OF SEPTEMBER 25.

DR. CHREE, F.R.S., has sent us the following communication on the above:—

The magnetic storm of September 25 exhibited the rapid oscillatory movements that are usually associated with the appearance of aurora. As recorded at Kew, the storm commenced suddenly at about 11.43 a.m. During the next nine hours there was an almost uninterrupted succession of large oscillatory movements in the magnetic curves, especially those of declination and horizontal force. The storm was of comparatively short duration, no movements of any great size being recorded after 8.30 p.m. on September 25, and by 1 a.m. on September 26 little trace of disturbance was left. When the storm was at its height the oscillatory movements were so rapid that the record left on the photographic paper was frequently too faint to show minute details, and the limits of registration were at times exceeded.

At the commencement there would appear to have been an exceedingly rapid oscillatory movement of the declination needle, after which the needle moved to the east continuously for about 15 minutes. After the first 12 minutes, during which a movement of 72′ was recorded, the trace got off the sheet, so that the full extent of the easterly drift is not shown. After a few minutes' absence the trace reappeared, but, after some oscillatory movements of the needle, the trace got off the sheet again on the same side as before at about 12.12 p.m., and remained off on this occasion for nearly 40 minutes. During the whole of this time the needle pointed at least 70′—at times, probably, a good deal more—to the east of its normal position. After coming on the sheet about 12.52, the trace exhibited some minor oscillations superposed on a rapid drift across the sheet. The entire width, representing 2° 7′, was crossed in less than half an hour, and the trace at about 1.20 p.m. got off the sheet on the opposite side. The needle then pointed about 1° to the west of its normal position. Between 1.20 p.m. and 8.30 p.m. there were a number of large oscillations, movements of 40′, 60′, or more, now east, now west, taking place in the course of a few minutes. The largest of the rapid oscillations clearly shown took place between about 8.7 and 8.22 p.m., a westerly movement of 98′ being followed by an easterly movement of 84′. The disturbance shown by the horizontal-force curve was no less remarkable. The commencing movement at 11.43 a.m. went beyond the lower limit of registration, a fall of 430 γ taking place in about 10 minutes. At this time the trace was off the sheet for only about 5 minutes. After reappearing it showed large oscillations. By 12.53 p.m. it had crossed the sheet to the other side, the change of force during one period of 13 minutes being no less than 625 γ. The trace was off the sheet continuously from 3.55 to 5.10 p.m., the horizontal force during the whole of this time exceeding its normal value by more than 300 γ. Except when off the sheet, the trace showed continuous large oscillatory movements during the whole afternoon. The largest clearly shown was partly synchronous with the large declination oscillation near 8 p.m. already described; it consisted of a rise of 520 γ and fall of 710 γ, all in the course of 17 minutes.

The declination range, 2° 7′, and the horizontal-force range, 740 γ, actually recorded, represent merely the full width of the photographic paper. How much these ranges were exceeded it is impossible to say, but, judging by the look of the curves, the excess was probably considerable. The vertical-force trace got off the sheet only on one side, and this element would appear to have been less disturbed than the other two. Still, as the trace was off the sheet continuously for nearly an hour after 3.35 p.m., the chances are that the true range exceeded somewhat largely the range 530 γ actually recorded. The duration of the storm was comparatively short, but whilst it lasted it exhibited an energy which has been very seldom rivalled at Kew. The oscillatory movements were quite as rapid as those of October 31, 1903, and the range of the elements has probably not been exceeded during the last twenty years, not even during the great storm of February 13, 1892.

Magnetic storms such as the present inevitably create an interest in the explanations that have been advanced to account for the phenomenon. The theories of Arrhenius and of Nordmann, the theories and researches of Birkeland, and the deductions made by Maunder from the Greenwich disturbances all point to the sun as the ultimate source, and to some form of discharge—ions, electrons, or such like carriers of electricity—as the immediate vehicle. The electrical nature of aurora is difficult to dispute, and the fact that storms like the present appear to be invariably associated with aurora visible far outside the polar regions unquestionably supports in some ways theories such as those of Birkeland or Arrhenius.

When we come, however, to details, difficulties present themselves. If magnetic storms are directly due to the electrical currents which render the upper atmosphere luminous, how comes it to pass that the visual phenomena of aurora are so constantly changing, whilst even in the most conspicuously variable of magnetic storms the larger movements of the magnets take usually 5, 10, or 20 minutes to accomplish, the force appearing to alter at a nearly uniform rate for minutes on end? The relatively gradual nature of the magnetic change is a true phenomenon—as clearly indicated by the short-period magnets of the Eschenhagen pattern, as in the larger Kew magnets with periods of 10 seconds or more. There is, again, the very remarkable fact that when we go to high latitudes, where aurora and magnetic disturbance are both almost daily occurrences, the association of the two phenomena becomes much more difficult, if not impossible, to recognise. The absence of visible aurora during active magnetic disturbances may be reasonably accounted for during the Arctic summer, when the sun is above the horizon, but it is a different matter when we find the magnets rather quieter than usual during the occurrence of a bright aurora. Unless we are to assume a fundamental difference of type between auroras presenting the same spectroscopic lines, or a variety of sources for different magnetic storms, there is a difficulty which is not easily surmounted. The only explanation that has occurred to me is the possibility that the visual phenomena may represent merely intense local concentration of electrical current, and that the main portion of the discharge frequently makes no appeal to the eye, and is of a much more steady and persistent character. Another difficulty in regarding the phenomena of magnetic storms as entirely and directly due to the action of electrical currents associated with aurora is that it is a frequent occurrence—as on the present occasion—for the horizontal force to be considerably depressed below the normal value when the storm has apparently ceased and for some considerable time thereafter. It is possible, of course, that the external currents have partly demagnetised the earth, or at least modified its distribution of magnetism, and that there are recuperative tendencies tending to cause reversion to what is for the time being a more stable distribution; but if this be the true explanation, the demagnetising action and the recuperative tendencies are presumably in action during the course of the storm, and profoundly modify the magnetic phenomena. To many minds subscription to some theory may be a necessity for intellectual comfort; but in the case of magnetic storms reservation of judgment appears at present the more scientific attitude.

In addition to the foregoing we have received the following communication from Prof. A. Fowler, of the Imperial College of Science and Technology, South Kensington:—The possible occurrence of a magnetic storm and auroral display on September 24 or 25 was suggested by observations of the large spot which was then on the sun's disc. On September 24 the spot was a little west of the central meridian—which appears to be the most favourable position in relation to magnetic disturbances—and spectroscopic observations showed that it was of the same disturbed type as the spot associated with the great magnetic storm of October 31, 1903 (NATURE, vol. lxix., p. 6).

On Friday evening (September 24) the sky was overcast, and it did not then occur to me to test the possible presence of aurora by the spectroscope. On Saturday evening, however, although the sky was at first completely clouded over, the spectroscope gave unmistakable evidence that an auroral display was in progress. From 6.40 to about 7.30 (the sun set at 5.52), the whole sky was filled with a feeble light, with brighter patches here and there, and the characteristic green line of the auroral spectrum was seen in every direction. The greatest intensity was at first near the zenith, but the line was easily visible over the entire sky, and was even seen in the light reflected by a pocket handkerchief. This condition continued with diminished brightness until near 8 p.m. Between 8 and 9 o'clock the display was very feeble, but shortly after 9 the auroral line was again fairly distinct in a faintly luminous belt about 10° above the northern horizon. After 9.30 no evidence of aurora was obtained, although the sky was then partially clear.

The general distribution of the green line over the heavens in clearer skies has been occasionally noted by Ångström and others, but I have not yet found any previous record of such a wide diffusion of the auroral light when the sky was completely clouded. If wholly above the clouds, the aurora must have been of extraordinary brightness in order to produce this effect.

Besides the green line, there were three fainter nebulous lines or bands in the green and blue, which have been frequently mentioned by previous observers. A careful search was made for the red line which appears in "crimson" auroræ, but its presence was not even suspected.

As to the sun-spot, there was a brilliant reversal of the C line of hydrogen over one of the umbræ when I observed it at 12.20 p.m. on September 24, and on opening the slit it was clear that this appearance was produced by a very bright overlying prominence. Reversals of the chromospheric lines b_3 and 1474 K were also suspected, but the observations were stopped by clouds. According to Tacchini and Lockyer, it is the prominence, rather than the spot, which should be considered as related to the magnetic disturbance.

AVIATION.

THE successful aviation week recently concluded at Rheims should do much to popularise aviation, if that subject is not sufficiently popular already. The large number of newspapers and periodicals devoted to aërial navigation is, however, sufficient evidence of the amount of public interest which centres round the new form of locomotion. At a railway bookstall at Tarbes, in the Pyrenees, a few weeks back, the present writer saw no fewer than five different papers devoted to flying machines. Possibly the number of such journals is equal to, even greater than, or at any rate comparable with, the number of successful flights that have been performed; it certainly appears as if the frequency with which a new journal comes out is not small in proportion to the frequency of aëronautical successes. Indeed, at the present rate, the assigning of new titles to these journals will soon take the form of a problem in permutations and combinations.

When it is attempted to draw scientific conclusions from these successful flights there is not, after all, so very much to be said. The difference between a machine that will fly one mile and a machine that will fly a hundred miles is mainly that the latter must be able to carry a heavier load in the form of petrol or other fuel than the former. In the case of high flights the same remarks apply, though the construction of a machine which is capable of ascending or safely descending at a considerable angle to the horizon presents many points of scientific interest which, no doubt, will receive the attention they deserve sooner or later, unbeknown to the average newspaper reader. In saying that when aviation takes the form of record-breaking it ceases to be a science and becomes a sport, we are, of course, not taking into account all the work of an experimental character in the construction and perfection of motors, propellers, and aëroplanes which has to be gone through behind the scenes before the sport can be indulged in. We have, however, failed to find that any very definite and striking new result has been proved by the recent triumphs.

It would seem, in fact, as if writers on the subject were directing their attention to the early history of aërial navigation to make up for the fact that there is very little to write about in a mere statement of records. Under the title of *Ila*, a weekly journal is appearing in connection with the International Aëronautical Exhibition at Frankfurt, of which the historical section is an important feature. It is interesting to revive acquaintance with the early, and in many cases fantastic, devices of Barthélemy Lourenço de Gusman, Besnier, Jacob Degen, Blanchard, the *Minerva* of Robertson, with its suspended ship and cabins, and an old cartoon of an omnibus and horses hanging from a balloon. As for Lourenço, a special number (Illustrierte Aëronautische Mitteilungen xiii, 17, *Ila* iii.) contains references to his exploits in view of August 8 of this year being the 200th anniversary of his supposed flight. The article by Mr. B. Wilhelm is prefaced by a short editorial note by Capt. H. W. L. Moedebeck, and seems to support the view that Lourenço actually went so far as to make a small model of a fire-balloon rise in the air in presence of the King of Portugal. Of pictures of Lourenço's grotesque and fantastic design we have two in the number in question, but in No. 10 of *Ila* it is pointed out that if Gusman really did fly, his ship must certainly have looked quite different.

Another article dealing with the general history of aërial navigation, both past and present, forms the subject of a special number of *La Nature*, issued on August 21 in connection with the Rheims meeting of the following week. A useful feature is the series of illustrations, each showing in one figure a collection of the principal types of airships and aëroplanes, in much the same way that the early history of the subject is summarised in the interesting old "Tableau d'Aviation" of fame. Of these we reproduce the two illustrations of the most recent aëroplanes. The article concludes with a calendar of "the great dates of aviation," which is here given, with addition of the Rheims records :—

Date	Aeronaut	Place	Distance and Duration
Oct. 14, 1897	Ader	Satory ...	Flight of 300 metres.
Sept. & Oct. 1905	Wright Bros.	Kitty Hawk	Flights of 17 to 38 km.
Nov. 12, 1906	Santos Dumont ...	Bagatelle ...	220 m. in a straight line.
Jan. 13, 1908	H. Farman	Issy	Kilometre in closed circuit.
July 6, 1908	H. Farman	Issy	Prize for ¼ hour.
Sept. 9, 1908	O. Wright...	Fort Meyer.	63·975 km. in 1h. 3m. 15s.
Oct. 10, 1908	W. Wright	Mans	1h. 9m. 45s., two persons.
Oct. 30, 1908	H. Farman	Bouy to Rheims ...	First actual journey, 27 km.
Oct. 31, 1908	Blériot ...	Toury to Artenay & back ...	First circular trip.
Dec. 31, 1908	W. Wright	Pau	123 km. in 2h. 18m. 33·6s.
June 5, 1909	Latham ...	Camp de Châlons ...	1h. 7m. 35s. on monoplane.
July 18, 1909	Paulhan ...	Douai... ...	150 metres altitude on biplane.
July 25, 1909	Blériot ...	Sangatte to Dover ...	Channel flight, 37 m.
Aug. 4, 1909	R. Sommer	C. de Châlons	2h. 10m. on biplane.
Aug. 7, 1909	R. Sommer	,, ,,	2h. 27m., time record
Aug. 23, 1909	Curtiss ...	,, ,,	10 km. in 8m. 37·6s. (speed).
Aug. 24, 1909	Blériot ...	,, ,,	10 km. in 8m. 4·4s. ,,
Aug. 25, 1909	Paulhan ...	,, ,,	131 km. in 2h. 43m. 24·8s.
Aug. 26, 1909	Latham ...	,, ,,	154·5 km. in 2h. 13m. 9·6s.
Aug. 27, 1909	Farman ...	,, ,,	180 km. in 3h. 4m. 56·4s.
Aug. 28, 1909	Latham and Farman	,, ,,	Altitude 120–130 m.

When the newspapers state that one portion of the course has come to be called "the valley of death," from the numerous wrecks that every day strew its fields, and when we refer to the accidents to Paulhan, Fournier, Blériot, and still later to the death of Lefèbvre and the accidents to Lieut. Calderara, to Bossi, and to Le Blanc, it will be seen that aëroplane triumphs are being bought at the expense of many thousands of pounds spent in rebuilding completely smashed-up machines, not to mention the risk to life and limb.

Of course, a considerable proportion of these accidents are undoubtedly accidents in the true sense of the word, but when we read, as we have done over and over again, that machines have suddenly stopped dead from no explicable cause, and then suddenly plunged to the ground, the idea of longitudinal instability at once suggests itself, and the obvious remedy is that aviators should wait until this subject has at least been thrashed out mathematically, or should devote a fraction of the sum they spend on repairs of broken parts to furnishing the assistance which would enable the theoretical investigations to be pushed forward without delay instead of being hung up for months at a time owing to pressure of other work.

Such a course would have been by far the shortest, cheapest, and best way of disposing of one of the important difficulties connected with aviation. But what chance of success would a mathematician have if he made an appeal of this kind? The world is full of people who have made, or imagine they have made, epoch-making discoveries, and who only require funds for their development. Their effusions find their way into every journal that does not adopt the most strict censorship over the scientific value of its contributions. The time has passed when any value can be attached to projects for aërial navigation which are not supported by either theory or experiment, yet such projects still succeed in appearing in print, and naturally ninety-nine people out of every hundred mistake the chaff for the grain. In the Journal of the Franklin Institute for July, for instance, Mr. Russell Thayer propounds the idea that all you have to do is to attach a gyroscope to a dirigible balloon and provide it with a sail in order to make it abandon its path of least resistance, drifting with the wind, and plough through the air in a different direction. Even the heading of the paper contains the sentence "The lever in space without a fulcrum on the earth!"

We leave readers of NATURE to form their own opinions of this recent contribution to a journal professing to be "devoted to science and the mechanic arts." But if Mr. Russell Thayer will turn to *Ila*, No. 10, p. 174, he will see that his idea of an airship supported by balloons and driven by sails was anticipated in the year 1670 by the Jesuit priest Francesco Lana, of Brescia, whose design possesses the additional merit of dispensing with the gyroscope!

Returning to the serious side of the problem, it suggested of enabling an aviator to observe the resistance, and consequently to ascertain the relative velocity of his machine. Captain Renard concludes his "conferences" on aviation in the *Bulletin de la Société d'Encouragement* for June. From Mr. Octave Chanute we have received by a recent mail papers on "The Evolution of the Two-surface Machine," and "Soaring Flight" (American *Aëronautics,* September and October, 1908, April, 1909), which remind us of the useful pioneer work in which Mr. Chanute was engaged, particularly before the Wright brothers took the subject so much in hand. In the *Revue scientifique* for August 14, Capt. Paul Renard writes on "The Antoinette Aëroplane and High Flights." Prof. Houssay, as a zoologist, writes, in the *Revue générale des Sciences,* xx., 14, on the stabilisation of fishes by fins and other appendages, and points out a certain analogy with the stabilisation of dirigibles. Photography by carrier pigeons is discussed in *Ila* for July 10, which also contains illustrations, which should interest philatelists, of letters sent by balloon post during the siege of Paris in 1870, and now exhibited at Frankfurt.

In view of the immense amount of popular enthusiasm aroused by aëroplanes, long before they have reached the stage at which they are likely to be used as a common means of transport, it is somewhat interesting to think that an invention has appeared almost unnoticed which is accessible to everyone, and is capable of affording quite as much genuine enjoyment to those who use it as the aëroplane, at a fraction of the cost. The piano-player was heralded by no flourish of trumpets, it received no attention in the Press, save in the makers' advertisements, and there is no journal devoted to its interests. Yet from a scientific point of view it possesses many remarkable—almost marvellous—properties, which afford abundant material for research. But if such researches were undertaken, no one would publish or read them. All the fashion is for aëroplanes.

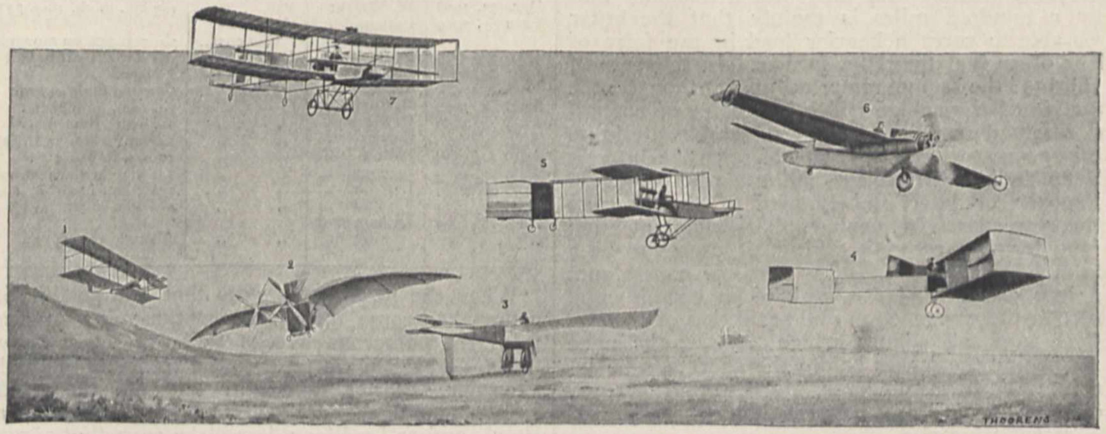


FIG. 1.—1. Wright glider (1900–3). 2. Ader (1890–7). 3. First Blériot monoplane (1906). 4. Santos Dumont's machine which made the first officially recorded flight (1906). 5. Farman's biplane which made the first circuit of a kilometre (January 13, 1908). 6. Robert Esnault Pelterie monoplane (1907–8). 7. Delagrange biplane (1908).

is impossible to glance at the two illustrations accompanying this article without forming the general impression that in many of the types figured the longitudinal stability is defective and the lateral stability *nil,* or worse than *nil.* It is merely the danger of making statements which are unsupported by the most circumstantial evidence that prevents us from expressing a very strong and emphatic view regarding pretty well every machine in the collection. The one fact which appears definitely established is that aëroplanes which are unstable, both longitudinally and laterally, can perform flights of indefinite length in the hands of skilled aviators, and this result will receive its full and proper explanation in the prospective mathematical theory. Indeed, for those who can appreciate them, mathematical researches on stability are much more fascinating than flights on aëroplanes.

A few further papers are deserving of mention. In the number of *La Nature* referred to, an apparatus called "wrightmeter" is suggested, invented by M. Dalloz for the stated purpose of determining the coefficient of resistance of air. As this resistance is measured on a *sphere,* this does not go very far in determining the resistances commonly occurring in aërodynamics, the more useful application being that

G. H. BRYAN.

Since the above article was in proof, the science of aviation has sustained a sad loss by the death of Captain Ferber. Although Captain Ferber's name has not come prominently before the public as a record-breaker, this perhaps is in some measure due to the scientific spirit in which he studied aviation. Captain Ferber commanded the Alpine Battery at Nice from 1900 to 1904, and during that time became interested in aviation. His first models, like the old-fashioned quadrilateral boy's kite, had aëroplanes of considerable longitudinal dimensions, but on becoming acquainted with the gliding experiments of Chanute, Herring, and the Wright Brothers, he was not long in adopting the two-surfaced rectangular type. Captain Ferber materially developed our theories of longitudinal stability, and he also gave a mathematical investigation, probably the first, of lateral stability. In view of the last statement, and the fact that Ferber's machines were furnished with special triangular sails in order to render them laterally stable, it seems somewhat rash to suggest that his fatal accident was due to the precautions being inadequate; yet it is just possible we may find that such was the case; if so, it is remarkable that Ferber should fail when others who have taken less adequate precautions have succeeded. Before his death Captain Ferber attributed the accident to flying too low, so that the machine struck the ground when it heeled over. Captain Ferber was the author of a number of papers and articles dealing with aviation, and also a keen balloonist.

G. H. B.

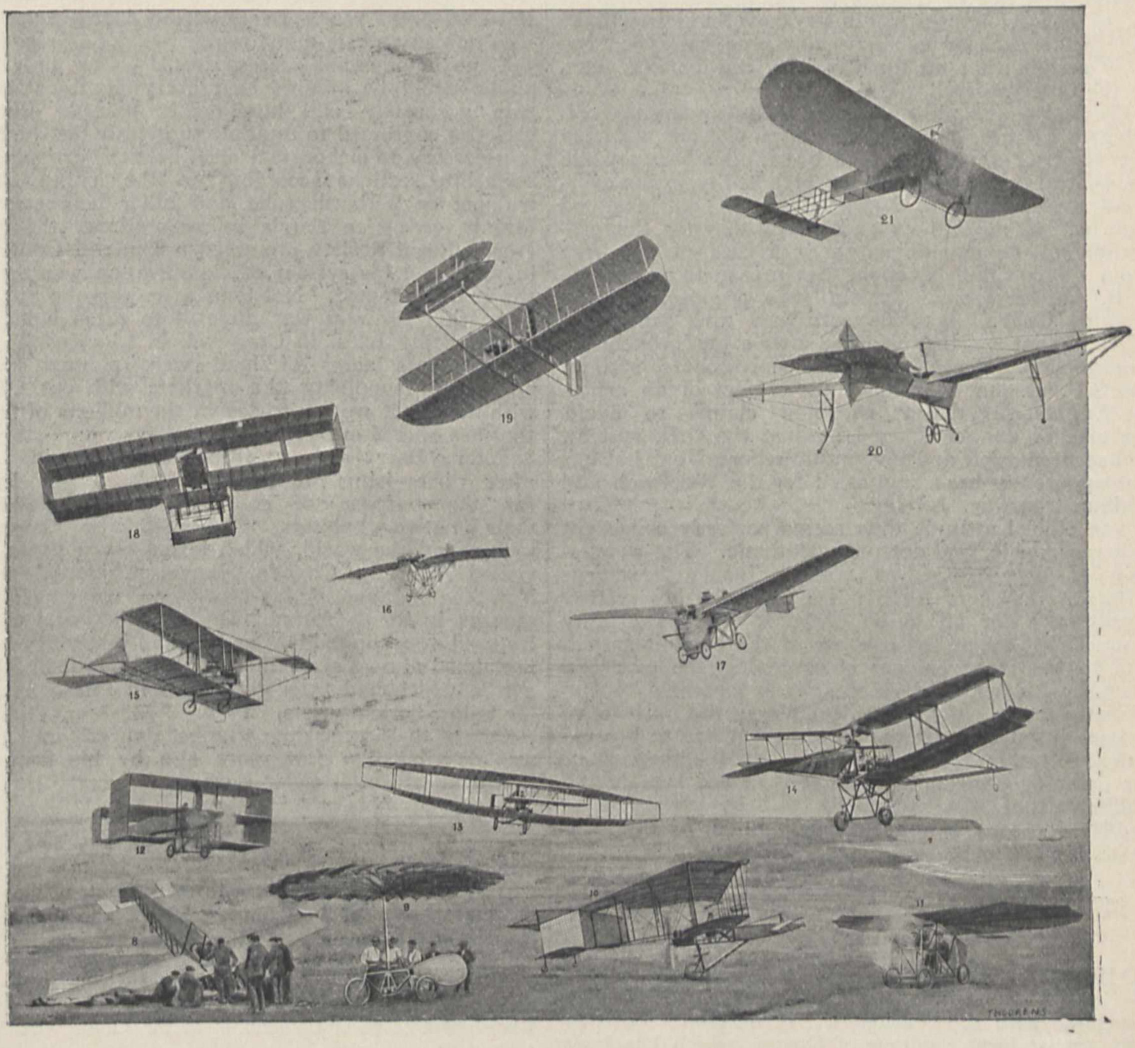


FIG. 2.—8. Blériot monoplane after accident. 9. Luyties American helicopter. 10. Bonnet Labrauche biplane. 11. Vuia helicopter. 12. Goupy triplane. 13. Curtiss's American biplane. 14. Zeus aëroplane. 15. Ferber biplane. 16. Santos Dumont's Demoiselle. 17. Gastambide Mangin biplane. 18. Farman's biplane which travelled from Bouy to Rheims (October 30, 1908). 19. Wright's machine which made the record flight with two passengers (1h. 9m. 45s.). 20. The Antoinette V., which made the record for monoplanes (1h. 7m. 35s.) and attempted to cross the Channel. 21. The Blériot XI., which crossed the Channel on July 25, 1909.

THE ROYAL OBSERVATORY AND ELECTRIC TRAMWAYS.

FROM statements recently appearing in the public Press, many people have been led to regard the Astronomer Royal as an uncompromising opponent of tramway electrification; but as it is perfectly well known that Greenwich is very well supplied with electric trams, it must be quite evident that this impression cannot be correct.

It is specifically alleged that:—

(1) The extension of the overhead trolley system from the Arsenal gates to the Woolwich Free Ferry is blocked by the refusal of official sanction.

(2) The same official sanction is withheld from all schemes for the authorised electric tramway from Woolwich to Eltham.

The facts we have been able to ascertain are as follows, premising that the Admiralty, and not the Astronomer Royal, is officially responsible for safeguarding the efficiency of the observatory records, and that the Board of Trade has to provide for adequate protection of the observatory for the magnetic portion of the work.

(1) The proposal appears to have been brought up suddenly, without previous warning, towards the latter part of August, at a time when, as is well known, many Government officials are expected to be away on leave, and, consequently, delay is almost certain. It appears also that as soon as the question was gone into by those concerned, it was decided to consent to the proposal on the strict understanding that any further step in the conversion of the existing horse-tramway between East Greenwich and Woolwich should be by extension of the conduit system eastwards, and not of the trolley system westwards. It is, of course, impossible to say how long it will be before this decision can have any practical effect, but it is certain that no further delay can be attributed to the observatory.

(2) As regards the authorised tramway from Woolwich to Eltham, we find that many Eltham residents are strongly opposed to the overhead system, while the official position is not one of hostility to the overhead system *per se*, but of insisting on insulated returns, any system which ensures this for the protection of Greenwich magnetic records being free from this official objection. As a case in point, the G.B. surface-contact system was proposed by the County Council several years ago and sanctioned officially, but was then dropped after some inconclusive experiments. Recently a new surface-contact system, the S.P. system, was made the subject of an article in *Engineering*, May 28, and claims to avoid the risk of danger alleged against the G.B. system. It has been tried and favourably reported on, but has not apparently been suggested for the Woolwich and Eltham tramway.

The official attitude thus seems perfectly consistent and reasonable, and not unsympathetic. The suggestion of overhead wires without insulated returns within a radius of three miles from the observatory ought once for all to be dropped. If the County Council objects to the expense of the conduit system and to the inconvenience of equipping the overhead system with insulated returns, it is for them to find a satisfactory alternative. Unless the protective clauses insisted on by the Government are to become a dead letter, it is futile to try to blame the observatory for delay or obstruction, and it is in the last degree unlikely that the Admiralty will be persuaded to stultify its own action and contention by allowing these clauses to be overridden.

PETER BARR.

THE name of this eminent horticulturist, whose death we announced last week, will ever be associated with the development of narcissi. Born in 1826, in the former village of Govan, which has long since been absorbed in the city of Glasgow, he was the son of a mill-owner who found recreation from weaving in the cultivation of tulips and other florists' flowers. The son appears to have inherited a strong love for floriculture, for he soon tired of the looms, and obtained employment in various seed businesses, until in 1861 he commenced business, with a partner, on the site of the present premises of Messrs. Barr and Sons, King Street, Covent Garden, under the title of Barr and Sugden. Barr then directed his attention to practical floriculture, experimenting with hellebores (Christmas roses), tulips, lilies, and pæonies. For these purposes he found it necessary to take up a piece of ground at Tooting, where he conducted trials which interested the leading florists of the day. He next scoured the country over for narcissi, meeting with considerable success in his quest. Two amateurs had already formed wonderful collections of these flowers which, unknown to the general public, they had cultivated for nearly a quarter of a century. These were Mr. W. Backhouse, of Darlington, and Mr. Edward Leeds, of Manchester. Barr made up his mind that if he could only obtain possession of these collections he would have all the best of existing daffodils in his own possession. By dint of perseverance and enterprise he succeeded in this, and the collections were removed to Tooting, where for years afterwards new seedling varieties flowered every year. Every variety worth cultivating was named and its name registered, for he recognised that no commercial success would follow unless the public could be assured that every plant catalogued was accurately and intelligently named. But the varieties continued to multiply so greatly that he found it necessary to elaborate a classification, grouping the sorts into sections according to the length of the trumpet or perianth tube and other characteristics. Mainly owing to Barr's representations, the Royal Horticultural Society promoted a Daffodil Conference in 1884, and his system of classification was then, in the main, adopted. Not long after this the attention of market growers was directed to these bulbs, and in the Scilly Isles, in Cornwall, in Lincolnshire, and other places acres of land were planted for the purpose of supplying the markets with cut blooms, with the result we see to-day in the millions of flowers that are offered everywhere for sale.

Peter Barr retired from business in 1896, after botanising in various places in Europe for the purpose of collecting rare daffodils in their native habitats. In 1898 he began a tour round the world, which lasted seven years. He visited America, Canada, Japan, China, Australia, New Zealand, and, on his way home, spent twenty-one months in South Africa. During this world tour he lectured on daffodils, and was interviewed and acclaimed almost everywhere as the "Daffodil King," a title which had been given him in this country by his fellow-floriculturists.

One of the finest white trumpet daffodils ever raised was distributed a few years ago by his firm, and it was named after Peter Barr.

NOTES.

WE learn from the *Times*, with deep regret, of the death, on Sunday last, of Prof. Anton Dohrn, the founder and director of the Zoological Station at Naples.

SIR THOMAS ELLIOTT, Secretary to the Board of Agriculture and Fisheries, has been nominated by the French Government to be a Companion of the Order "du Mérite Agricole."

IN view of the retirement, to which reference has been made in these columns already, of Prof. J. Cleland, F.R.S., from the chair of anatomy, and of Prof. Jack from the chair of mathematics, at the end of the present month, there has been set on foot, on the initiative of the business committee of the general council of the University of Glasgow, a movement for making appropriate recognition of their long and distinguished services. Circulars have been issued to the whole body of university graduates and to members of other learned bodies with which Profs. Cleland and Jack have been connected. In the circulars it is stated that the form of recognition will, to a large extent, depend on the amounts subscribed, but it is thought that it might fitly include the provision of some fund for the advancement of anatomical and anthropological science in the case of Prof. Cleland, and of mathematical science in the case of Prof. Jack, and the presentation to the University of portraits or busts by an eminent artist. Representative committees have been formed to administer each fund, and the preliminary lists of subscriptions show that the movement has already met with a hearty response. Men of science and others desiring to take part in the recognition and to contribute to either fund are invited to communicate with the honorary secretary and treasurer, Mr. Archibald Craig, clerk of the University general council, 149 West George Street, Glasgow.

THE Antarctic vessel *Nimrod*, now moored in the Thames off the Temple Pier, was opened yesterday for the inspection of the public by the Lord Mayor of London.

SHOCKS of earthquake on the morning of September 22 are reported from the Bouches-du-Rhône, Rognes, Reggio di Calabria, Messina, and Athens, but in no case does much damage appear to have been done.

IT is stated by the British Antarctic Expedition, 1910, that arrangements have been made for the purchase of the *Terra Nova* for the projected expedition of next year. The vessel, which is a whaler, was built in 1884. In 1903 she was purchased by the Admiralty as relief ship for the *Discovery* expedition. The year 1905 saw her in the service of the North Polar expedition, on a visit to Franz Josef Land. The size and strength of the ship make her a fitting receptacle for the extensive equipment which it is necessary she should carry for the full success of the plans of the expedition. After being duly inspected on behalf of the expedition in Newfoundland she will sail for England and, it is hoped, reach the Thames about the end of October or early in November. The officers and crew for the expedition have now been selected.

THE presidential address of Mr. W. Noble Twelvetrees will be delivered to the Civil and Mechanical Engineers' Society at Caxton Hall, Westminster, on Thursday, October 7.

ACCORDING to a *Times* correspondent a group of French, German, and Belgian patrons of aviation are offering a prize of 10,000*l.* to be awarded to the aviator who rises, with a fixed point as centre, to a height of 250 metres, flies a thousand metres from this altitude in a horizontal direction, and finally, returning, soars for a quarter of an hour at a height of 20 metres over the point of departure. An alternative feat is to make a flight from Brussels to Paris or from Brussels to Cologne, without a stop, at a speed of 60 kilometres an hour.

IT is stated in *Tropical Life* that an International Cotton and Fibre Exhibition will be held in London in 1912, and that in conjunction with it there will be an important conference for the purpose of considering the cotton and fibre questions in their various aspects. A section of the exhibition will be devoted to other fibres, animal, vegetable, and mineral.

ACCORDING to a Reuter message from Rome, the Juba, in Benadir, has formed a new mouth. Some months ago a violent typhoon broke through the spit of land separating the sea from that part of the river which runs parallel with the coast, and the action of the sea and the current combined have since made a new mouth 450 yards in breadth and formed a long lagoon which, with little expense, can be converted into a serviceable harbour. The same message states that the Italian Resident, Captain Ferrari, has found that the Webbi Shebeli does not, as was supposed, lose itself in marshes in the Ballis country, but is an affluent of the Juba, into which it runs some 120 miles from the latter's mouths.

THE *Electrician* states that a gift has been made to the American Institute of Electrical Engineers by the Western Electric Company of a valuable collection of patent specifications. The specifications range from May 30, 1871, to December, 1908, and number approximately 100,000.

AMONG the popular lectures shortly to be delivered at the Royal Victoria Hall, Waterloo Bridge Road, are the following:—on October 5, "Marconi's Transatlantic Wireless Telegraphy," by Prof. W. Lynd; on October 19, "The Great Earthquake in Jamaica," by Dr. Vaughan Cornish; on October 26, "New Guinea," by Mr. J. E. Liddiard.

THE annual exhibition of the Royal Photographic Society, at the New Gallery, Regent Street, will remain open until the end of October. It is divided into four principal sections—pictorial, scientific and technical, professional work, and trade exhibits of apparatus and materials. The scientific student will find matters of interest in every section, including even the pictorial, for, as the society has reverted to its old custom of stating the method of production, the pictorial photographs may be looked upon, if so desired, as specimens of the various processes. The section specially devoted to scientific and technical subjects is this year of a wider interest than usual. The greater number of exhibits represent the character and habits of various living creatures, from the largest to the smallest, and in this department is included special collections of work by the Zoological Photographic Club and by a number of German naturalists, the latter having been collected by R. Voightländer, of Leipzig. The astronomical photographs include recent plates from Greenwich, Stonyhurst College, and the Heidelberg Observatory. Among those who show spectrum photographs we notice the names of Prof. Zeeman, Prof. H. Kayser, A. Fowler, and C. H. Fabry and H. Buisson. Dr. C. L. Leonard contributes Röntgen-ray photographs that show peristaltic waves in the stomach and intestines. Experiments on the resolving power and other properties of photographic plates are shown by C. E. K. Mees and E. K. Hunter. Photomicrography, telephotography, and balloon photography are well represented, and there are a few interesting exhibits that refer to the methods of process work. Of colour photography, although there are many specimens, the only progress indicated is in the direction of the perfecting of the newer plates, more particularly the Thames plate. The regular disposition of the three colours in this plate renders it specially adaptable to reproduction by different methods. We would point out that many photographs of great interest are mounted as lantern-slides, and that these are shown on a stand by themselves, away from the general collection of scientific and technical exhibits.

RAINY, cool, and unsettled weather has prevailed throughout September, and although the rainfall in the aggregate has not generally been excessive, there have been few days without rain, except during the third week of the month. The total measurement of rain is in excess of the average in London by about 0·3 inch, and rain fell on nineteen days. The day temperatures have continued remarkably low for the time of year, and at the London reporting station of the Meteorological Office, in St. James's Park, the sheltered thermometer has not once touched 70°. At Greenwich there was only one day with 70° or above, the highest reading being 71°, on September 6. There has not been so cold a September since 1897, and as recently as 1907 there were fifteen days during the month with a temperature of 70° or above. Our weather over the British Islands has been chiefly under the influence of cyclonic disturbances, which have arrived with considerable frequency from off the Atlantic.

IN the September number of the *American Naturalist* Dr. R. F. Scharff reviews the evidence in favour of an early Tertiary land-connection between North and South America. He believes in the existence during early Tertiary times of a strip of land connecting western North America with Chile, when Central America and northern South America were submerged. Such a connection, it is urged, is supported by many lines of evidence, and would serve to explain the occurrence of Eocene armadillos in North America and the affinity between the Canadian porcupine (Erethizon) and the Santa Crucian Stiromys.

IN addition to their great abundance, the star-fishes of Alaska and British Columbia are remarkable, according to a paper by Prof. A. E. Verrill in the September issue of the *American Naturalist*, for the redundancy in the number of their rays, this being specially noticeable in the family Asteriidæ, the members of which, despite many exceptions, are generally five-rayed in other parts of the world. "Besides the species that normally have an increased number of rays, or vary indefinitely, there are others which have, more or less rarely, a smaller or larger number as monstrosities. . . . Various other monstrous variations occur somewhat frequently, such as forked rays, supernumerary rays arising from the dorsal surface, &c."

THE second part of the first volume of the Records of the Canterbury Museum (New Zealand) contains an account of the scientific results of a trawling expedition undertaken by the New Zealand Government in 1907. The expedition seems to have been organised entirely from the commercial point of view, and the facilities afforded for scientific investigation were by no means so great as they might have been. It is therefore not surprising that the scientific results are somewhat meagre. This is the more unfortunate, as we still know comparatively little about the marine biology of the waters around the New Zealand coast. The investigations, chiefly of local naturalists, have made us very fully acquainted with the terrestrial fauna of the Dominion, and much has been done in the way of shore-collecting; but systematic marine biological research is, as a rule, beyond the reach of private individuals, and it is here that an enlightened Government might be fairly expected to take an opportunity for encouraging the advancement of science.

PROTOZOOLOGY is very much in evidence in vol. liii., part iv., of the *Quarterly Journal of Microscopical Science*, which contains no fewer than five papers on this subject. Miss Muriel Robertson describes the life-cycle of a new trypanosome from Ceylon, of which the principal host is the soft tortoise, *Emyda vittata*, and the intermediate host a leech of the genus Glossiphonia. Mr. C. Clifford Dobell describes the processes of physiological degeneration and death in *Entamoeba ranarum*. Dr. McCarrison places on record his observations on the Amœba in the intestines of persons suffering from goitre in Gilgit; Dr. Row describes the development of the parasite of oriental sore in cultures; and Prof. Minchin discusses the structure of *Trypanosoma lewisi* in relation to microscopical technique. Several of these papers are remarkable for the beauty of the coloured plates which accompany them, and the same is true of a short paper by Messrs. Muir and Kershaw describing, under the name *Peripatus ceramensis*, a new species of Peripatus from Ceram, the first to be recorded from the Moluccas. In the same number Mr. Joseph Mangan describes the entry of zooxanthellæ into the ovum of Millepora, and gives some particulars concerning the medusæ.

THE report on forest administration in Southern Nigeria for 1907 contains an account of a tour through the west provinces, described by Mr. H. N. Thompson, the conservator of forests. Two fine forest tracts were explored at Ijaye and Ilesha, both of which are situated in the dry-zone vegetation. The first-named is called after an ancient town which was destroyed about sixty years ago, and since that time part of the forest has grown up. Here there were found to be mahogany trees with a girth measurement exceeding 10 feet, which implies a much more rapid rate of growth than is betokened by ring counts. The same conclusion is derived from the dimensions of trees planted in the botanical gardens, wherefore Mr. Thompson advances the opinion that probably the mahogany trees show three or four well-marked zones of growth each year, corresponding to the four definite seasons.

THE reasons for deterioration that follow upon self-fertilisation or inbreeding of the maize plant have been investigated by Dr. G. H. Shull, who puts forward in the publication of the American Breeders' Association (vols. iv. and v.) certain conclusions based on the results of experimental cultivation. Plants selected according to the number of rows of grain in the ear were allowed to self-fertilise, when two strains became evident. For reasons which are given, it is considered that the individuals in a maize field are generally very complex hybrids, and that these strains are elementary species or biotypes, so that, according to the author's premises, self-fertilisation tends to isolate elementary forms, producing a homozygous condition, *i.e.* pure forms. Crosses between the two strains led to a distinct increase in the yield, whence the following method of propagation is suggested. Pure races of maize are to be obtained by self-fertilisation, and the crosses made between these pure races provide seed corn for the field crop.

BOTANICAL teachers making use of lantern-slides may be glad to know of a new series of slides produced by Messrs. F. E. Becker and Co., Hatton Wall, London, from original photomicrographic negatives prepared by Mr. C. W. Greaves. A first series of fifty slides is announced, of which several relate to sections of anomalous dicotyledonous stems, others to the anatomy of stem, leaf, and root of angiosperms and the pine; a few represent cryptogamic and fossil sections. The phanerogamic specimens examined are clear and well defined, being taken from good microscopic sections, and the section of a Fucus conceptacle is excellent in general contour and detail.

AN abstract of the report of the director of the Bombay Bacteriological Laboratory for 1908 appears in the *British Medical Journal*, from which we learn that the issue of anti-plague vaccine was little short of that of the preceding year, when the disease was severely and widely prevalent, the number of doses dispatched being 533,315 against 620,923. Experiments were carried out regarding the efficiency of rat and rat-flea destroyers, but they were not satisfactory or conclusive. The general bacteriological work was of a varied description. Special inquiry was made regarding an outbreak of malaria in the fort and dock area of Bombay; the investigation is still in progress. An outbreak of relapsing fever in the Kolaka district was also made the subject of special study. The laboratory rendered assistance and advice regarding questions relating to plague and other infective diseases, and courses of instruction were arranged for hospital assistants and others with reference to plague inoculation and bacteriological work.

MR. C. CARUS-WILSON has printed a paper, read by him before the Geological Society of London, on the pitting of flint surfaces. He directs attention to the frequently polygonal and rudely hexagonal character of the outer ends of the pits found on flints in a certain stage of decomposition, and to the considerable amount of water that may be absorbed by the external layers of such flints. But he shows much uncertainty of view as to the mode of origin of the pits; the suggestion made in the text that their polygonal outlines are connected with the crystalline form of the absorbed water as it froze seems, to say the least, fantastic. In a footnote, however, the author compares these outlines with the shrinkage-cracks of such rocks as basalt, and regards the ice merely as the agent that split off the lost portions of the flint. Would it not be simpler to regard the rudely polygonal outlines as resulting from the intersection of successively formed and adjacent cup-like surfaces of fracture?

WE have received the report of the chief inspector of mines in Mysore for the year 1907–8, which opens with the statement that there was a large diminution in the number of applications for mining licenses as compared with the previous year; the statistics of licenses granted show, on the other hand, an increase from 101 in 1906 to 242 in 1907. The gold production showed a decrease of 5·84 per cent. as against a decrease of 8·67 per cent. in 1906, the comparison in each case being with the previous year; it amounted to a value of 2,041,129*l.* in 1907, and the total value of bullion produced from the commencement of mining operations in 1882 to the end of June, 1908, was 28,598,155*l.* Air blasts seem still to be frequent, but there was a decrease in the number of accidents. Statistics are given of the production of manganese and chrome, 82,835 tons and 11,197 tons respectively, but as regards other minerals it is reported that the statistics have been handed over to the curator of the Geological Museum for report as to whether it is possible to extract any useful information from them.

THE Proceedings of the Royal Society of Edinburgh (vol. xxix., p. 602) contains a paper, by Mr. E. M. Wedderburn, on the deep-water oscillations recently described by Prof. Pettersson (NATURE, August 12, p. 197). Working on a suggestion made by Sir John Murray, Mr. Wedderburn adduces evidence to show that the oscillations observed in the Skagerak are analogous to those which have been observed by the Scottish Lake Survey, and that they really show the presence, not of a long-period tide, but of a temperature seiche, having its node at the mouth of the Skagerak and its loop at the point of observation.

A PRELIMINARY summary report on coast changes in east Yorkshire, by Mr. T. Sheppard, of The Museum, Hull, forms a contribution to the investigation of the larger question of changes on the east-coast region of England during the historical period, undertaken by the research department of the Royal Geographical Society. Mr. Sheppard, after pointing out that the coast line between Bridlington and Spurn Point is of special interest because, while on the one hand enormous tracts of land have disappeared within historic times, on the other large areas have been formed, embanked, and cultivated, divides his district into five sections, the Holderness coast from Bridlington to Kilnsea, Spurn Point, the North Humber shore, the South Humber shore, and the Humber itself. Each district is treated from the point of view of geological evidence, historical evidence, and actual measurement. The general results indicate a wastage of the thirty miles of cliff between Bridlington and Spurn at a rate of about 7 feet per annum, and a growth on the Spurn during recent years of 17 feet per annum southward, with a net increase of 9 feet per annum in the width of the point. To the west of the Humber are large areas of land, now partly cultivated and productive, which were formerly watery wastes.

AN important paper on evaporation in Egypt and the Sudan, by Mr. B. F. E. Keeling, is published by the Survey Department of Egypt. The author first deals with the results of comparisons of various types of evaporimeters used in Egypt at different times. Those now in use are mostly of the Piche and Wild patterns, exposed in double-louvred screens; their readings are apparently comparable in different climates, if similarly exposed, where the mean wind velocities are not widely different. A table is given showing the mean daily evaporation at stations in the Nile Valley; in Egypt and the North Sudan it is greater in the summer, while in the rainy areas it is at a maximum in the dry winter season, as is to be expected. One section of the report deals with the evaporation from open expanses of water. In the neighbourhood of Cairo the mean amount was 4·2 mm. per day (winter 3 mm., summer 5·3 mm.); on Lake Victoria it is estimated at 3 mm. per day. In the last section some remarks are made on the relation of evaporation to other meteorological factors; the mean daily curve of evaporation at Helwan closely follows the curve of saturation deficit.

IN the September issue of *Man* Prof. Flinders Petrie describes a find of string nets of the seventeenth Egyptian dynasty which are practically unique. They were found associated with an untouched burial near Thebes. This is, perhaps, the most varied and rich collection of funeral remains which has ever been brought from Egypt. It will be preserved as an entire group in the Royal Scottish Museum, Edinburgh. The corpse was enclosed in a single coffin painted with wings in blue and gold. On the neck was a splendid golden collar; on each arm a gold armlet; round the waist an electrum girdle, copied from a Nubian pattern, made of seeds and leather. The whole collection of jewellery weighs half a pound avoirdupois—the largest group of gold-work which has ever left Egypt. The string nets associated with these remains, of which Prof. Petrie gives photographs, illustrate the remarkable skill in string-working attained by the Egyptians of that era. He also announces the discovery, at Memphis, of the great palace of King Apries (about 580 B.C.). Scale armour, bronzes, a remarkable silver plaque with a gold figure of Hathor, and a great carved portal, now in ruins, are part of the discoveries at this site.

IN the September issue of *Man* Dr. C. G. Seligmann describes what is known as the Bandar cult among the Kandyan Sinhalese. It is a form of ancestor worship, Bandar being the title applied to the canonised spirits of eminent persons to whom, soon after their death, offerings are presented in order to induce them to protect the worshipper from evil and to grant him good fortune. One of the most important of these spirits is Kosgama Bandar, who takes his name from the village in which he lived in the eighteenth century or earlier. He seems to have rebelled against the King of Kandy, by whom he was captured and executed. He and similar spirits exercise authority under the control of Skanda, one of the four guardian deities of Ceylon. Dr. Seligmann prints, with a translation, a curious invocation addressed to this spirit.

FASCICULES 1 and 2 of the *Bulletin des Séances de la Société français de Physique* for 1909 contain thirteen memoirs, several of which have already been noticed in these columns. Amongst those not previously dealt with may be mentioned that by M. G. Delvalez, on the Hall effect in liquids. According to the electronic theory of conduction of electricity, this effect should be extremely small, while experiment appeared to show that it was a million times greater than the theoretical value. M. Delvalez has succeeded in showing that these observed effects were due to the convection currents in the liquid, set up because it is a mobile conductor carrying current through a magnetic field. The motion generates an electromotive force, which has been measured as the Hall effect. By using an alternating electromotive force to produce his main current, and arranging to balance the Hall electromotive force against the fall of potential down an induction free resistance traversed by the main current, he has shown that the effect is very small, certainly less than one three-thousandth of the value previously observed.

THE use of platinum felt, as suggested by Monroe in 1888, in place of asbestos as a filtering medium is recommended by Mr. W. O. Snelling in a paper in the Journal of the American Chemical Society (vol. xxxi., pp. 456–461). In addition to its insolubility in almost all the ordinary chemical agents, it has the advantage of extraordinary porosity, combined with the power of retaining completely and easily such finely divided precipitates as barium sulphate and calcium oxalate; a series of tests showed that the filtration was six times more rapid than with an asbestos filter containing one-third the quantity of asbestos. The precipitate can be dissolved off, and the felt used again and again; moreover, a damaged filter can readily be patched by the adding of chloroplatinic acid and igniting. The use of the "Monroe crucible" for atomic-weight determinations is especially advocated. Another issue of the same journal contains a paper by Mr. J. T. Stoddard on rapid electro-analysis with stationary electrodes (*ibid.*, pp. 385–390), in which it is claimed that by using a kathode of gauze or of mercury, a stationary anode, and a heavy current, complete decomposition of the metal can be effected as rapidly as with a rotating electrode; under these conditions the liberation of gas, and the convection currents consequent on the heating of the liquid, appear to provide sufficiently for the agitation of the fluid without recourse to mechanical methods.

THE *Philippine Journal of Science* for March contains a third paper by Raymond F. Bacon on the Philippine terpenes and essential oils, and a paper by Mr. H. D. Gibbs on the oxidation of phenol. The latter author has taken advantage of the tropical sunshine to study the red coloration which is developed by phenol when exposed to air and light, and has carried out the investigation with remarkable care and thoroughness. He shows that the phenol becomes coloured in presence of oxygen, but not of hydrogen, nitrogen, and carbon dioxide. The action is caused by oxidation, quinol, quinone, catechol, and carbon dioxide being produced; the principal coloured compounds are probably quinone condensation products, the red colour being attributed to phenoquinone. The oxidation is not appreciable in the dark at room-temperatures, but becomes measurable at 100°, and fairly rapid at the boiling point of phenol. In sunlight the rate of coloration is rapid, and increases with the temperature; it is affected by the ultraviolet absorption of the glass, by atmospheric conditions, and by the altitude of the sun. Ozone is very reactive; it gives the same products as oxygen, and in addition glyoxylic acid has been detected. Anisol, the methyl ether of phenol, gives no coloration either by the action of ozone or of oxygen and sunlight.

MESSRS. E. B. ATKINSON AND CO., of Hull, forward us an improved pattern of Soxhlet's apparatus for the extraction of oils and fats. The new form is fitted with a glass stop-cock on the syphon tube. By regulating the overflow, the thimble can be kept full of the solvent during the extraction, instead of being alternately filled and emptied. Also, by closing the stop-cock at the end of an operation, the solvent can be retained in the upper part of the apparatus; this allows the flask containing the extracted fat to be almost freed from the solvent, so that it can be placed straightway in the drying-oven. A bulb on the upper part of the side-tube facilitates the passage of the vaporised solvent if liquid should collect there. The new pattern thus appears to have distinct advantages over the older form.

THE use of the Walschaerts valve gear on American locomotives has been greatly extended since its introduction into the States a few years ago. The advantages of this gear render it very suitable for the large engines employed in America, and its success has led to experiments with others of a similar type. Several railways are now trying the Pilliod motion, a gear made by the Pilliod Company of Chicago, and described in the *Engineer* for September 3. In this gear, as in the Walschaerts, the motion is derived partly from a return crank on the main crank-pin and partly from the crosshead. The moving parts are the same for any class of engine, and weigh about 1000 lb. There is no load on the reversing lever, which can be unlatched and moved in any condition with the regulator either open or closed. The motion is expected to effect a considerable saving in fuel and in maintenance and repairs. The release is late; thus with cut-off at 25 per cent. the release is at 85 per cent.; the Walschaerts gear, with a similar cut-off, releases at about 65 per cent. of the stroke. Special adaptability for high speeds is claimed.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN OCTOBER:—

Oct. 6. 11h. 59m. to 12h. 34m. Moon occults κ Geminorum (mag. 3·7).
8. 10h. 37m. Minimum of Algol (β Persei).
11. 7h. 26m. ,, ,,
12. 23h. Venus in conjunction with δ Scorpii (star 0° 7′ S.).
13. 6h. Saturn in opposition to the Sun.
17. 17h. Venus in conjunction with the Moon (Venus 2° 17′ S.).
18–24. Epoch of October meteoric shower (Orionids, Radiant 92° + 15°).
20. Saturn. Major axis of outer ring = 46·15″, Minor axis = 9·21″.
27. 8h. Saturn in conjunction with the Moon (Saturn 1° 17′ N.).
,, 19h. Mercury at greatest elongation west.
31. 9h. 8m. Minimum of Algol (β Persei).

OBSERVATIONS OF HALLEY'S COMET, 1909*c*.—Photographs showing Halley's comet were obtained at the Greenwich Observatory, with the 30-inch reflector, on September 9, two days before it was discovered by Prof. Wolf. Owing to the proximity of the moon the two exposures were limited to thirty minutes and twenty-five minutes respectively, and the very faint cometary images were not identified until after the receipt of the telegram announcing the discovery at Heidelberg. The positions determined gave corrections of +24s. and −4′ to the ephemeris published in No. 4330 of the *Astronomische Nachrichten*.

In a supplement to No. 4356 of the *Astronomische Nachrichten*, where the above observations are recorded, Prof. Wolf states that the comet is already a fairly bright object, of about the sixteenth magnitude, appearing as a nebulous mass of 8″–10″ diameter having a central condensation.

Photographs were also secured by Mr. Knox Shaw at the Helwan Observatory on September 13 and 15, and by Dr. H. D. Curtis, with the Crossley reflector at the Lick Observatory, on September 12, 13, and 14.

ANOTHER LARGE SUN-SPOT.—During last week another large sun-spot was to be seen on the solar disc. It was first observed, at South Kensington, on September 18 near to the limb and a few degrees south of the sun's equator. Developments took place until on Saturday last, when just past the central meridian, it consisted of one large nucleus and several smaller ones, and was visible to the naked eye. It is perhaps worthy of note that a magnetic storm, of sufficient magnitude to interfere seriously with the transmission of telegrams, took place on Saturday.

OBSERVATIONS OF MARS.—In a telegram to the Kiel Centralstelle (Circular No. 112), Prof. Lowell announces that the Martian antarctic canals are disappearing, and that the general pallor of the various features continues. He also states that the Solis Lacus is double.

Regarding the naked-eye appearance of the planet, Mr. J. H. Elgie recently directed attention to the apparent nearness of Mars as compared with the neighbouring stars of Pegasus. He suggests that this sense of nearness might be due to the propinquity of a wooded ridge over which the planet was rising, the Pegasus stars being well above the ridge, and therefore beyond this influence. At the same time, the brilliant irradiation of the planet seems quite sufficient to account for a phenomenon which must appeal to anyone seeing the planet on a clear evening.

OBSERVATIONS OF SATURN.—A telegram from Prof. Lowell to the Kiel Centralstelle, published in Circular No. 113, announces that a dark medial streak has been observed on Saturn's equator, and that there is an appearance of lacings similar to those seen on Jupiter. Further, an intense white spot, in saturnian latitude 50° S., was detected by Mr. Slipher and transitted at 14h. 5m. (Washington time) on September 23.

THE FUTURE OF ASTRONOMY.—In an address delivered at the Case School of Applied Science, Cleveland (U.S.A.), in May, Prof. E. C. Pickering took as his subject the future development of astronomy, paying special attention to the methods whereby the limited financial resources and *personnel* may be used with the greatest advantage to the science. After a review of the several past epochs of astronomy, and some rather amusing remarks as to how monetary gifts are made and used at present, he outlined the general scheme, to which he has previously referred on various occasions, and the principle of which underlies the splendid organisation of resources built up at the Harvard College Observatory. The central feature of the scheme is one large, and perforce international, observatory employing, say, 200 or 300 assistants, and maintaining three stations. Of the latter, one would be in latitude about 30° N., and another the same distance south; western America is suggested as a suitable *locale* for the former, South Africa for the latter, and each would be selected wholly for its climatic conditions, which premises fairly great altitudes and desert regions. Each observing station would have instruments of the largest size, such as the 7-foot reflector previously suggested for South Africa, and would do practically no reductions or measuring. These would be carried out at the third station, situated where living and labour are cheap, where the photographs, &c., would be stored. Such an organisation would exist for the benefit of all serious astronomers; anyone wishing to engage on any piece of work would simply requisition the raw material, *e.g.* sets of special photographs, from the central bureau. If not in stock, the required photographs would be secured at the earliest convenient opportunity. By thus centralising and organising astronomical resources, Prof. Pickering claims that the science would benefit immensely, because the waste at present resulting from overlapping, or from being forced to use inadequate raw material, would thereby be eliminated (*Popular Science Monthly*, vol. lxxv., No. 2).

THE INSTITUTE OF METALS.

THE publication of the first volume of the Journal of the Institute of Metals marks the completion of a full year's work. The institute has been formed to advance and disseminate knowledge in connection with the manufacture and properties of the non-ferrous metals and alloys. The members are fortunate in having for first president Sir Wm. White, who delivered an excellent address, in the course of which he dealt in a very able manner as well with the delicate subject of "trade secrets" as with the important one of the relationships between manufacturers and users of metals, although his oft-reiterated special pleading for the National Physical Laboratory during the meetings must have been rather wearying to the other important workers represented.

The paper by Mr. J. T. Milton, chief engineer of Lloyd's, on some points of interest concerning copper and copper alloys, is mainly about troubles experienced by users, and is valuable for members of all types; but the statement on p. 68 that the temperature of pouring the white metal into bearings is left to the ordinary workman is not the case in at least one of the great Sheffield-Clyde firms, as for many years this has been done with the aid of a suitable pyrometer, and probably is so still. The paper drew a very long and good discussion, in which Prof. Gowland's remarks that ancient bronzes were very impure, so that their hardness could not be due to exceptional purity, and that by careful hammering modern bronzes can be made as hard as ancient, were of interest to those who are often being met by the statement that the method of hardening bronze tools is a lost art.

The mechanism of annealing in the case of certain copper alloys, by Messrs. G. D. Bengough and O. F. Hudson, is of a very theoretical nature as a whole, but gives several practical hints on the treatment of brass. Mr. J. T. W. Echevarri's paper, on aluminium and some of its uses, is most interesting, although his reasons for its efficacy in preventing blow-holes in steel (p. 130)—that it combines with the gases and produces an innocuous slag—would hardly be accepted. In the discussion the president remarked that not only had aluminium proved unsatisfactory for shipbuilding because of serious corrosion (p. 156), but that, though suitable aluminium alloys might yet be obtained, they had to be discovered. Notes on phosphor-bronze, by Mr. A. Philip, is thoroughly practical, and contains several tables of tests with corresponding analyses, with a full discussion as to the most suitable compositions and tests for different purposes.

In metallographic investigations of alloys Mr. W. Rosenhain gives a good critical summary of methods, but, unfortunately, attempts to bolster up the discredited differential method of taking cooling curves. On p. 213 he recommends that "the slowest possible rate of cooling should be adopted in cooling-curve experiments"; but long experience teaches that the rate of cooling must be chosen according to the nature of the alloy and the objects of the investigation. In Dr. Desch's paper, on inter-metallic compounds, surely the complicated "broken solidus curve MBNPQRESTUG" for an institute of metals might have been better chosen from a real example than an imaginary one, so that such members as waded through it all would have a reward of facts as well as principles. Dr. Shepherd in the discussion endeavoured to explain to the members what the present writer has tried to impress on several investigators, namely, that though a pyrometer be capable of great accuracy, it does not follow that the phenomena are observed to the same degree of accuracy, and also that though the phase rule is a guide, it must be remembered that it was deduced for ideal conditions, and takes no account of the time factor or of the rate of diffusion or viscosity. Dr. Shepherd favours the use of heating curves, but his remark that "in the case of transformations in the solid phase he had found no satisfactory results with cooling curves" must sound strange to investigators on steel—the pioneers in this type of work—the well-known Ar1, Ar2, Ar3 being all points on cooling curves. For demonstration purposes cooling curves are generally taken because more convenient, but for a complete investigation both heating and cooling curves must be studied. Had this not been done, the important effect on suitable hardening temperatures for steel of the difference between Ar1 and Ac1 would still be left not fully explained. The remarkable irreversibility in certain nickel-iron alloys of the A2 point, the only one reversible in ordinary mild steel, demands the consideration of both curves.

Mr. W. H. A. Robertson's paper, on plant used in the manufacture of tubes, is of a practical and descriptive nature.

The last paper of all, the relation between science and practice and its bearing on the utility of the Institute of Metals, by Sir Gerard A. Muntz, Bart., treats of a subject probably the most important of the series for a first volume. It is a short paper written by invitation of the president, but it gives formal expression to a general feeling, much in evidence in personal conversation with all grades of workers connected with the metal trades, that information is needed in a form not too academic, expressed in language that the intelligent who are not mere theoretical specialists can understand. When the practical man, who must produce results, compares the air of omniscience assumed by some purely theoretical metallurgists with the smallness of the help they seem able to give him in his work, he is apt to be discouraged and to have thoughts about metallurgical science that he ought not to be led to think. The science underlying metallurgy is not yet sufficiently understood to do entirely without the extremely useful empirical conclusions of intelligent practical men, and hence elaborate generalisations, often on inadequate bases (the "raw science" of Mr. Rosenhain), can generally only be suggestive of methods of attack on matters of difficulty in works, and one must take all available help from practice to command success. Long personal experience in connection with delightful and somewhat successful investigations of this nature, made in conjunction with those actually engaged in works, serves only continually to strengthen this view. The Institute of Metals, to be worthy of its name, must welcome any paper on purely scientific original work connected with non-ferrous metals if convinced that the results are trustworthy, however remote their practical utility may seem; but it must also consider the immediate needs of the great majority of its members by encouraging papers of a practical scientific nature, expressed in language that may be understood by the most intelligent members who are actually engaged in works practice.

A. McWILLIAM.

THE BRITISH ASSOCIATION AT WINNIPEG.

SECTION K.

BOTANY.

OPENING ADDRESS BY LIEUT.-COLONEL DAVID PRAIN, C.I.E., LL.D., F.R.S., PRESIDENT OF THE SECTION.

Sutor ne supra crepidam judicaret, probably an old saying when Pliny wrote, is still a safe guide. The limitations of life and of knowledge are different, and human effort is thereby so conditioned that progress depends on specialisation in study. Specialisation lessens the temptation to forget this caution; but the force of the proverb is not weakened. It also conveys a behest, and compliance with this behest helps to counteract the narrowed outlook which specialisation sometimes encourages.

Those whose studies are confined to some limited field often welcome a sketch of the aims and methods of work with which they are not familiar. Such a sketch may be held to have served its purpose if the subject discussed, and its relationship to cognate studies, be rendered intelligible.

No apology, therefore, is made for the subject now taken up, even if it be sometimes hinted that this subject —Systematic Botany—is inimical to originality, the antithesis of scientific, and outside the limits of botany proper. These views depend on half-truths and arbitrary connotations. They do not affect the fact that the primary purpose of systematic study is to advance natural knowledge. The systematic worker, in furthering this object, does not halt to consider whether his work be applied rather than original, technical rather than scientific.

As a matter of history, the scope of systematic study practically coincides with what botany once implied; as a matter of fact, it corresponds to what zoology implies now. The accident that man, on his physical side, is like the beasts that perish has led to the recognition of animal physiology and anatomy as independent sciences. Owing to the absence of any such fortuitous circumstance vegetable anatomy and physiology remain under the ancestral roof. These off-shoots of botany are as vigorous as their zoological counterparts. They may be entitled to think that systematic methods are old-fashioned, and it may be desirable that they should set up separate establishments or form alliances with the corresponding off-shoots of zoology. But nothing in all this justifies the eviction of systematic botany from the family home.

The statement that systematic methods are old-fashioned may be accepted without conceding that these methods are out of date. Systematic work, while sharing in the general advance in knowledge, has been able, amid far-reaching changes, to maintain continuity of method in the pursuit of its double purpose. This has been a benefit to botany as a whole when crucial discoveries or illuminating theories have, in other fields, led to a re-orientation of view requiring the use of fresh tablets for the record of new results.

Disintegration and re-adjustment due to altered outlook are familiar processes. Histology, parting company with organography to serve physiology, is now an independent study, one of the branches of which occasionally declines to accept any doctrine unconfirmed by cytological methods. The study of problems relating to nutrition and reproduction has been considered the especial task of physiology. Now, the chemist at times claims the problems of nutrition as part of his field, and we look for advances in our knowledge of reproductive problems to the cytologist and the student of genetics. These instances are adduced from without because relative exemption from distintegration is a distinctive feature of systematic study. The two-sided task of the systematist is to provide a census of the known forms of plant life and to explain the relationships of these forms to each other. The work on one side is mainly descriptive, on the other mainly taxonomic, but the two are so interdependent, and their operations so intimately blended, that it is difficult to treat them apart. Re-orientation in botanical study has led to seismic disturbances in the taxonomic field, but the materials supplied by descriptive work have remained unaffected, and therefore have been ready for use in the repair or reconstruction of shattered "systems."

The exemption from radical change in method, which marks systematic work, is due to those characteristics that expose it to the charges of discouraging originality and of calling only for technical skill. It also largely explains why systematic study, especially on the descriptive side, is not attractive to minds disposed towards experimental inquiry. The labour involved is as exacting, accurate record and balanced judgment are as necessary, in descriptive as in experimental research. "A skill that is not to be acquired by random study at spare moments" is as essential in descriptive as in other work, while the relief that variation in method affords is precluded. Increased experience, here as elsewhere, leads to more satisfactory results, but without, in this case, mitigating the toil of securing them. The testing of theories, often an inspiring task in experimental research, in the descriptive field retards progress. But if in descriptive work imagination and the spirit of adventure are undesirable, these qualities are not inhibited by systematic study as a whole. Imagination is legitimate and useful in the taxonomic field, and in another line of activity—the acquisition of the material on which descriptive work is based—the spirit of adventure is essential to success.

The untravelled descriptive worker is not without consolations. His work is as necessary to botany as that of the cartographer to geography, or the grammarian to literature. His results are means to the ends that others have in view. If these results often appeal to coming rather than to contemporary workers, the descriptive writer is at least largely spared the doubtful benefit of immediate appreciation. He can pursue his studies unaffected by any considerations save those of adding to the sum of human knowledge and of bringing a necessary task appreciably nearer completion. In descriptive study it is the work rather than the personality of the worker that tells. Yet the work is not without human interest, because systematic writings rarely fail to reflect the character of the writers. The intimate knowledge of descriptive treatises, which floristic or monographic study entails, usually leads to mental estimates of the actual authors. The evidence on which these estimates depend is unwittingly given and unconsciously appreciated. But its value is not thereby diminished, and estimates so formed may prove useful checks on contemporary judgments.

The descriptive worker as a rule makes his work "the primary business of his life, which he studies and practises as if nothing else in the world mattered." But he does not hold aloof from those engaged in other lines of botanical activity. His evidence is mainly obtained from organography and organogeny; but, just because his results are for the use of others, the descriptive botanist has to keep abreast of all that is done in every branch of his science. New weapons are constantly being forged, and not in morphological workshops only; with these and their uses the descriptive worker must be familiar, for the need to employ them may arise at any moment. If he does not always abandon old friends for new, this is not because the systematist is unaware of their existence, or unprepared to apply new methods. The descriptive worker employs his tools as a craftsman; like other craftsmen, he finds that tools do not always fulfil the hopes of their designers. In descriptive work, too, as elsewhere, a steam hammer is not required to break every nut; the staff and sling may be arms as effective as those of the hoplite. There are occasions when the descriptive writer does appear to hold aloof by declining to accept proffered evidence. But his motive is not arrogant; it is only altruistic. If he is to avoid the risk of causing those who depend on his results to reason in a circle, the descriptive writer must obtain these results, if not without extraneous aid, at least without help from those for whose immediate use they are provided.

Taxonomic study is pursued in an environment which differs from that surrounding descriptive work. The descriptive student can hardly see the wood for its trees. The taxonomic student works in more open country, and can look on the wood as a whole. He has, too, the benefit of companionship. The palæobotanist meets him, with all the lore of mine and quarry, as one ready to exchange counsel; other workers attend to give or gather information.

The community of interest which unites the systematic worker, chiefly concerned with existing plant-types, and the palæobotanist, primarily interested in types now extinct, is strengthened by the bond which identity of purpose supplies. But the two are differently circumstanced; the systematic worker is ordinarily better acquainted with the characters than with the relationships of his types; the palæobotanist usually knows more of the relationships of his types than he does, or ever may do, of their characters. The material of the palæobotanist rarely lets him rely on ordinary descriptive methods in defining his plants; he has to depend largely on anatomical evidence, which supplements and confirms, but hardly replaces, the data of organography. On the taxonomic side the palæobotanist is restricted to phylogenetic methods; here again he is handicapped, though less than on the descriptive side, by the fragmentary character of his specimens. The palæobotanist hardly does more than the phylogenist, hardly as much as the anatomist, towards advancing the object all have in common.

The same community of interest unites in their labours the organographic systematist and the morphologist whose interests are phylogenetic. Here, however, though the task of the two be complementary, the mode of attack is so different as almost to mask their identity of purpose. The comparative morphologist studies the planes of cleavage indicated by salient differences in structure and development. The system he evolves is composed of the entities, sometimes more or less subjective, that combinations of characters suggest. The method in intention, and largely in effect, passes from the general to the more particular, though the process is tempered by the fact that the characters used are derived from such types as exhibit them. The organographic systematist, after summing up the characters which mark individual types, aggregates these according to their kinds. Having estimated the features that characterise individual kinds, he aggregates these according to their families. Families are thereafter aggregated in higher groups, and these groups are subjected to further aggregation. The system thus evolved is composed of those entities, always in theory objective, that successive aggregations indicate, and the process is one of constantly widening generalisation.

The comparative morphologist, though glad when his results can be practically applied, follows truth for its own sake. His work is thus on a higher plane than that of the organographic systematist, whose aggregations are primarily utilitarian. But the work of the latter is not less valuable because its scientific character is incidental. Were our knowledge of plant-types exhaustive, a generally accepted artificial arrangement of these would be as useful to the applied botanist as a professedly natural one. But our knowledge is incomplete, and the accession and intercalation of new types renders any artificial, and most attempts at a natural, system sooner or later unworkable. The more closely an arrangement approximates to the natural system, the less can the intercalation of new forms affect its stability. The more stable a system is, the more easily will its details be remembered and the more useful will it prove in practical reference work. Here, therefore, for once, self-interest and love of truth go hand in hand.

Since the organographic systematist learns their characters from his groups, while the comparative morphologist defines groups by the characters he selects, their results, were knowledge complete, should be identical, and this identity should prove their accuracy. But knowledge is finite, and these results are not always uniform. The want of uniformity is, however, often exaggerated because the reasons are not always appreciated.

One cause is the difference in personal equation, which affects alike the worker who deals with things and him who considers attributes. It would be contrary to expectation were every phylogenist to assign the same value to each character, or every systematist to apply the same limitation to each type or group of types. The divergence of view on the part of two observers may show a small initial angle; it may nevertheless lead them to positions far apart. But while divergence of view is the most obvious explanation of the want of uniformity apparent in systematic results, it is the least effective cause. This inherent tendency to differ manifests itself in contrary directions; in the long run individual variations are apt to cancel each other.

The nature of the work counts for more than the predisposition of the worker. The aggregations on organographic lines, which were the main guides to the composition of the higher groups until phylogenetic study was seriously undertaken, do not assist the comparative morphologist. The characters on which phylogenetic conclusions may be based increase in value in proportion to the width of their incidence, so that the greater their value for phylogenetic purposes the less do they aid the descriptive worker in discriminating between one plant-type and another. Often they are characters which for practical reasons the descriptive worker must avoid. Organography, then, may not give evidence as to characters whereof cognisance cannot be taken, while for another reason the comparative morphologist may not use characters derived from descriptive sources. The object of the phylogenist is to take his share in advancing our knowledge of taxonomy; to seek from the systematist the evidence on which his results are based would be to vitiate the reasoning of both. All that the phylogenist can ask the descriptive worker to do is to supply the units that require classification.

The comparative morphologist, relying mainly on anatomical and embryological evidence, at first had a hope that his method of study might enable him to supply his own units and thereby render further taxonomic work based on organography unnecessary. This hope remains unfulfilled, and the phylogenist, as a rule, limits his efforts to a narrower field. The organographic systematist realises that in the present state of our knowledge the study of the incidence of selected characters gives more satisfactory results as regards the composition of the higher phyla than repeated aggregation can attain, while the comparative morphologist recognises that, as matters stand, the approximations of organography in respect of types and kinds are more satisfactory than any he can yet offer. Since, however, the progress in one case is outwards, in the other the reverse, a zone of contact is inevitable. This zone, in which the influence of both methods of study is felt, is occupied by those groups immediately higher in value than the natural families of plants, and it is here that discrepancies in the results attained chiefly manifest themselves. These discrepancies take the form of unavoidable differences of opinion as regards the composition of collections of natural families. If a family A possesses ten characters of ordinal import, whereof it shares eight with a family B and only two with a family C, while the characters combined in A are, as regards B and C, mutually exclusive, the organographic systematist is ordinarily induced to group A and B together and to exclude C from that particular aggregation of families. If, on the other hand, the phylogenist finds that the two characters common to the families A and C are met with in other families, D, E, F, he will ordinarily be led to place A, C, D, E, F in the same higher group from which the family B, notwithstanding its greater general agreement with A than any of the others, must be excluded. This source of discrepancy is, however, less potent than might be expected. When the evidence advanced by either is very strong, the other worker readily accepts it; in doubtful cases mutual accommodation takes place, the one worker limiting his groups, the other applying his criteria with less rigidity.

The healthy disregard for formal consistency which admits of adjustments to further practical ends does not, however, alter the fact that a system thus attained can only approximate to the natural arrangement at which both workers aim. Gaps in knowledge may be bridged with histological or teratological aid, or safely crossed with the help of some sudden intuition or happy speculation. But the existence of anomalous types and groups serves as a reminder that much has yet to be learned with regard to living types, while the widest gap in our knowledge of these is a fissure as compared with the chasms that confront the palæontologist. In this the taxonomist of either type finds the incentive to further effort.

The automatic adjustment of differences due to idiosyncrasy, and the mutual accommodation of those arising from method of work, still leave considerable want of harmony in taxonomic results to be accounted for. What appear to be rival systems of classification compete for recognition. As each such system professes to be the nearest attainable approximation to the natural arrangement, the evidence of a state of dissension and confusion in the taxonomic field appears to those unfamiliar with systematic work to be incontrovertible. Dissension may be admitted; confusion there is none. Pictures of the same subject by different artists may be very unlike, yet equally true; what appear to be rival systems are only manifestations of one.

It is not difficult to form a conception of this system; it is less easy to share the conception with others. Let us imagine a closed space approximately spherical in shape, its surface studded with symbols that mark the relative positions of existing plant-types. Let us imagine the lines of descent of all these types to have been definitely traced and effectively mapped. We find, starting from near the centre of our sphere, a radiating system of lines; we find these lines to be subject to repeated dichotomy and embranchment which may take place at any point; we find the resultant lines departing from the original direction at any angle and in any plane; we find the *nodus* of any individual dichotomy or embranchment capable of serving as the focus of origin for a subsidiary system comparable in everything except age with the centre of our sphere, and conceivably exceeding in the multiplicity of its ramifications the primary system itself. Some only of our lines reach the symbols that stud our spherical surface, though every symbol is the terminal of some such line. Here a terminal is fairly isolated, and the line it limits goes far towards the centre with little or no dichotomy or embranchment. Elsewhere our terminals are closely set, the lines they limit running inwards in company until some proximate *nodus* is reached. Moreover, within our sphere, in the abrupt terminals of various lines we can dimly trace the vestiges of other spheres, not always concentric with our present sphere, once studded with symbols marking the existence of types now extinct. Imagine further the centre of our hypothetical space as not necessarily a primary centre, but merely the *nodus* of some dichotomy or embranchment in a system of which ours is but a residuary fragment.

As we are practically limited to superficial delineation, an intelligible picture of our system is more than the science of perspective and the art of chiaroscuro can be asked to provide. What is unattainable on the flat is still more impossible in sequence. Serial presentation involves a point of departure; convenience, predilection, hazard, may dictate what this shall be, and determine the sequence adopted. The result is not a variety of systems, but a series of variants of one system. Considering how complex the problem is, the number of variants is remarkably small. In any case the differences met with are inconsequent; they do not affect the facts, and the facts alone really count. The trained taxonomist knows that no serial disposition can indicate, even vaguely, the relative position and import of all these facts. Plane presentation, though more adequate than serial by a dimension, falls short of accuracy; the surface on which the bulk of the facts may be displayed can have no lateral boundary. Even if its presentation on a globe be attempted, the diagram must be incomplete; many of the points to be shown lie beneath the surface. Convention might overcome the difficulty involved in the indication of extinct types, but the diagram would still fail by a dimension to demonstrate the descent of the forms superficially represented.

Intercourse with the phylogenist, while directly influencing the relationship of the organographic systematist to taxonomy, has indirectly modified his attitude towards the diagnosis and limitation of plant-types. Taxonomic study based on evidence other than descriptive has stimulated histological research and fired the anatomist with an ambition to replace by his methods those of organography. It is certainly not for want of industry or care that the success of the phylogenist in the taxonomic field has not also attended the diagnostic work of the anatomist. This failure to replace organographic by anatomical methods is due to the fact that the qualities which make histological evidence useful in generalisation lessen its value in discrimination. That anatomical characters may be of great use even in diagnosis has been less fully appreciated than it might by those habituated to organographic methods. On the other hand, anatomists who have not benefited by an apprenticeship in descriptive study at times overlook the fact that the value of histological evidence in diagnostic work is indirect. Codification of the scattered results of systematic anatomy has now shown the descriptive worker how useful histological methods are when skilfully and properly used, and has at the same time made it apparent to the anatomist that, in respect of grades lower than ordinal, his methods are more fitted for proof than for demonstration. Their alliance is now cordial and complete.

While descriptive and anatomical study conjointly make for accurate discrimination, opinion and circumstance combine to prevent uniform delimitation of plant-forms or "species," and no conceivable compromise can overcome this difficulty. With the term "species" is bound up a double controversy—what idea the word conveys, and what entity the word connotes. Into the first we need not enter; we must assume that our ideas are sufficiently uniform to render the term intelligible. The second we cannot take up here; we must accept the position as we find it, and note, in a spirit of detachment, how in actual practice the systematic botanist does delimit his "species." In doing this we have to discriminate between the effect which observed facts produce on different minds, and that which different mental states produce on the records of facts. The results obtained may be essentially identical though arrived at in different ways; as, however, the results are not always uniform, the existence and effect of these two factors must be carefully noted.

It is rather unusual to find that workers whose powers of observation are equal take precisely the same view of every member of a group of nearly allied forms. One, from predisposition or accident, is influenced rather by the characters whereby the forms differ; another is more impressed by those wherein they agree. In monographic work especially the same worker may find himself alternately more alive to the affinities and more struck by the discrepancies among related forms. At one time he feels that his difficulties may be best solved by recognising all these forms as distinct, at another he inclines to the view that they may be but states of one protean species. Where the capacity for detecting differences is naturally strong, the disposition is towards segregation; where there is a keen eye for affinities, the reverse. The facts in both cases are the same; their influence on minds in which the faculty of observation, though equally developed, has a natural bias in a particular direction may thus be different.

This inherent variation in mental quality, of which the observer may personally be unaware, and over which he may have incomplete control, is not, however, so potent a factor as a difference in mental attitude, usually the result of training or tradition. The existence of two distinct attitudes on the part of authors towards their "species" is common knowledge. In the absence of more suitable terms we may speak of them as the "parental" and the "judicial." To the parental worker his species are children, whose appeals, even when *ad misericordiam*, are sympathetically received. To the judicial worker his species are claimants, whose pretentions must be dispassionately weighed. The former treats the recognition of a species as a privilege, the exercise of which reflects honour. The latter views this task as a duty, the performance of which involves responsibility. With amply characterised forms the mental attitude is inconsequent, but when critical forms are reviewed it is all-important. Here the benefit of a doubt is the practical basis of final decision. This benefit in the case of the parentally disposed worker may lead to the recognition of a slenderly endowed species; in the case of the judicially inclined, to the incorporation of an admittedly critical form in some already described species, the conception of which may thereby be unduly modified.

These attitudes do not in practice divide descriptive workers into two definite classes. Some writers display one attitude at one period, the other at another period of their career. Occasionally the two alternate more than once in a writer's history. Cases are known in which one attitude is consistently adopted towards species of one natural family, the other towards species of a different family.

When want of uniformity in delimitation is due to the varying effect of the same facts on different observers there is no room for either praise or blame. Capacity for appreciating affinities is complementary to that for discrimination. The fact that now one, now the other tendency is more highly developed makes for general progress. Workers in whom the two may be more evenly balanced can strike a mean between the discordant results of colleagues more highly endowed than they are in either direction. But those who possess a capacity for compromise do not mistake this for righteousness; they are apt to wish themselves more gifted with the opposing qualities of those whose work they assess.

When cases in which want of uniformity in delimitation due to difference in mental attitude on the part of independent workers are considered, we again find that praise and blame are inappropriate. If both attitudes have defects to be guarded against, both have merits that deserve cultivation. The defects are patent and rarely overlooked; the careful systematist, more critical of his results than anyone else can be, is alive to the risks which attend stereotyped treatment, and on his guard against the excesses to which this may lead. It is more often forgotten that both attitudes have their uses, and that each should be exhibited at appropriate times. Here, however, no middle way is possible: the mean between the two attitudes has the qualities of a base alloy. It is the attitude of indifference, fatal to scientific progress, and productive of results that are useless in technical research.

The ideal arrangement in monographic study is the collaboration of two workers, one highly endowed with the discriminating, the other with the aggregating faculty. But for the statement of their joint results both must adopt the judicial attitude. On the other hand, in floristic work, in isolated systematic contributions, and in all descriptive work undertaken on behalf of economic research, the better because the more useful results are supplied by workers in whom capacity and attitude combine to induce the recognition rather than the reduction of easily characterised forms.

In the present state of our knowledge uniformity in the delimitation of what are termed "species" is unattainable. We are in no danger of forgetting this fact; what we do sometimes overlook is that, circumstanced as we are, such uniformity is undesirable. The wish to be consistent is laudable; when it becomes a craving it blunts the sense of proportion and may lead to verbal agreement being mistaken for actual uniformity. The thoughtful systematist, when he considers this question without prepossession, finds that forms which in one collocation need only be accorded a subordinate position must, under other conditions, receive separate recognition.

The normal effect on specific limitation of the causes that militate against uniformity is easily understood, and the resulting discrepancies can be allowed for in statistical statements. There are, however, cases where the capacity for appreciating differential characters or points of agreement is so highly developed as to obscure or even inhibit the complementary capacity. The effects are then ultra-normal; nicety of discrimination exceeds the "fine cutting" allowable in floristic work; aggregation exceeds the limits useful in monography. No common measure is applicable to the results, and the ordinary systematist, who has definite and practical objects in view, expresses his impatient disapproval in unmistakable terms. The work of those addicted to one habit he characterises as "hair-splitting"; that of those who adopt the other he speaks of as "lumping." The industry displayed in elaborating monographs which attribute a thousand species to genera wherein the normal systematist can hardly find a score must often be effort misplaced. The same remark applies to the excessive aggregation that substitutes for a series of quite intelligible forms an intricate hierarchy of subspecies, varieties, subvarieties, and races. Orgies of reduction are moreover open to an objection from which debauches of differentiation are free. Discrimination can only be effected as the result of study; the finer the discrimination, the closer this study must be. Reduction offers fatal facilities for slovenly work, over which it throws the cloak of an erudition that may be specious. When dealing with excessive differentiation the normal systematist is on solid ground; when following extreme reduction he may become entangled in a morass. Yet workers of both classes only exhibit the defects, for ordinary purposes, of striking merits, and there are occasions when the results that each obtains may be of value to science.

Its mnemonic quality renders taxonomic work practically useful. Its application in economic research does the same for specific determination. Economic workers are chiefly interested in useful or harmful species; to others they would be indifferent were these not liable to be mistaken for such as are of direct interest. The identification of economic species and their discrimination from neutral allies is not always simple, because species that are useful or noxious are often those least perfectly known. The qualities that render them important frequently first attract attention; these may be associated with particular organs or tissues, and samples of these parts alone may be available. Ordinarily, when material is incomplete, critical examination has to be postponed. In economic work, however, this may not be possible, and the systematist, just as in dealing with archæological or fossil remains, may here have to make the most of samples and fragments in lieu of specimens. Cultural help and anatomical evidence sometimes lead to approximate conclusions; often, however, as with neutral species, definite determination must await the communication by the field botanist of adequate material. Even then a difficulty, comparable with that frequently met with in archæological and palæobotanical study, may be encountered. As archæological or fossil material may, owing to the conditions to which it has been subjected, look unlike corresponding fresh material of the same or similar plants, so may trade samples, owing to special treatment, bear little outward resemblance to the same organs and tissues when fresh.

When material of economic plants is ample another difficulty may be encountered. Domesticated species often undergo perplexing variation. In studying this variation the systematist may have to seek linguistic and archæological help, and be led into ethnological and historical by-paths. In classifying the forms that such domesticated plants assume he gladly avails himself of aid from those whose capacity for detecting affinities is unusually developed. But even with extraneous assistance the systematist, in this field, sometimes fails to attain final results. He can, however, always pave the way for the student of genetics, whose work involves the study of the "species" as such. As regards forms of economic importance which neither organography nor anatomy can characterise, but which the chemist or biologist can discriminate, physiological methods are required to explain the genesis or elision of qualities evoked or expunged under particular conditions.

A highly developed capacity for aggregation, if properly controlled, is also useful in the study of plant distribution from a physiographical standpoint. The systematist shows his sympathy with phytogeographical needs in two very practical ways. He declines, out of consideration for the geographical botanist, to deal with inadequate material, and for the same reason he refuses, in monographic studies, to be influenced by geographical evidence. The monographer is conscious that if he pronounces two nearly related forms distinct, merely because they inhabit two different areas, he is digging a pit into which the phytogeographer may fall when the latter has to decide for or against a relationship between the floras of these two tracts. But the fact that, with existing knowledge, uniform delimitation of species is impossible, seriously weakens the value of normal systematic results for phytogeographical purposes. The units termed "species" that are most useful in floristic and economic study are often too finely cut to serve distributional ends. When all existing plant-types have been treated on monographic lines the results may with relative safety be used by the phytogeographer, since errors due to personal equation may be regarded as self-eliminating. As matters now stand, however, the geographical botanist obtains his evidence partly from monographs, partly from floras, and is apt to be misled. Yet even in floristic work the systematist sees that the "species" which it is his duty to recognise often arrange themselves in groups of nearly allied forms. These groups, which need not be entitled to sectional rank, while very variable as regards the number of species they contain, are more uniform than species in respect of their mutual relationships. They are therefore more useful than species as units for phytogeographical purposes. In defining these groups the faculty for aggregation is essential, and those in whom this faculty is highly developed may here be profitably employed, even when their discriminating powers show a certain amount of atrophy.

The cases, by no means rare, of workers who, with a comparatively poor eye for species, display great talent in their treatment of genera, afford indirect but striking proof that the faculty for aggregation may be more highly developed than its complement, and that the dominance of this faculty may ensure useful results. But the *a priori* expectation that in dealing with families this dominance should be still more valuable is not borne out by experience, for in this case it is recognised that aggregation has probably been pushed too far. This error has not been attributable to the faculty for aggregation so much as to the evidence at its disposal; the corrective has largely been supplied by the use of anatomical methods as supplementary to organographic data.

The physiologist in studying processes is not always obliged to take account of the identity of the plants which are their theatres of action. He has at hand many readily accessible and stereotyped subjects the identity of which is a matter of common knowledge, and as his experience increases he learns that he may sometimes neglect the identity even of these. If he asks the systematist to determine some type on which his attention is especially focussed, the physiologist only does this in order that he may be in a position to repeat all the conditions of an experiment required to verify or modify a conclusion. A passive attitude towards systematic study has thus been created in the mind of the physiologist; this passivity has been intensified by the fact that the direct help which the physiologist can render to systematic study is limited. Physiological criteria are indeed directly applied for diagnostic purposes in one narrow field, where organography and anatomy are synonymous and inadequate. But if it be true that the diagnostic characters on which the bacteriologist relies belong to some non-corpuscular concomitant of his organism, this attempt to apply physiological characters to systematic ends has failed. In many cases physiological characters do influence taxonomic study. Differences in the alternation of generations, specialised habits connected with nutrition, peculiarities as regards response to stimulation, variation in the matter of protective endowments, admit of application in systematic work, and are constantly so applied in the characterisation of every taxonomic grade. But the evidence as to these characters reaches the systematist through secondary channels, so that the help which physiology renders is indirect, and the passivity of the physiologist remains unaffected.

This passivity has at last been shaken by the development of the study of plant distribution from a physiological standpoint. The practical value of this study has been affected by the employment of a terminology needlessly cumbrous for a subject that lends itself readily to simple statement, and by the neglect to explain the status, or verify the identity, of the units included in its plant associations. A reaction against the use of cryptic terms has now set in, and the physiological passivity which has led workers in this field to ignore systematic canons when identifying the units discussed shows signs of disappearing. The œcologist, it is true, must classify his units in accordance with characters that differ essentially from those on which reliance can be placed by the systematist. But the characters made use of must be possessed by his units, and the œcologist now realises that, in effecting his purpose, he is as immediately dependent on descriptive results as the economic worker or the geographical botanist, and that, if his work is to endure, his determinations must be as precise as those of the monographer, his limitations as uniform as those of the phytogeographer. The needs of the œcologist are, however, peculiar, and his units must be standardised accordingly. Œcological units are not the groups of species, uniform as to relationship, which the geographical botanist requires; nor are they the pragmatical "species" of floristic and economic work. They are the states, now fewer, now more numerous, that these floristic "species" assume in response to various influences; and œcological associations can only be appreciated and explained when all such states have been accurately defined and uniformly delimited. In accomplishing this task the faculty for detecting differences is the first essential, and the physiologist has here provided a field of study wherein workers, whose tendency to nicety of discrimination unfits them for normal systematic study, may find ample scope for their peculiar talent, and accomplish work of real and lasting value.

We find, then, that the taxonomy of the wider and more general groups is now mainly based on phylogenetic study, and is largely scientific in character and application. The taxonomy of the narrower and more particular groups, based on organographic data supplemented by anatomical evidence, is often somewhat empirical in character, and is largely applied for technical purposes. Among the grades chiefly so applied, the "species" is a matter of convenience, variously limited in response to special requirements, while the "family" is a matter of judgment, crystallising slowly into definite form as evidence accumulates. But the "genus" is relatively stable, and, in consequence of its stability, has long been "a thing of dignity." The distinctive air thus imparted to botany is best appreciated when a zoological index is examined.

The use of scientific names, more precise than popular terms and more convenient than descriptive phrases, facilitates the work of reference in applied study. These names are accidents which do not affect the taxonomic status of the units to which they are applied, but do, however, reflect the want of uniformity in the limitation of these units. The non-systematist who has to apply systematic results appreciates that, as knowledge now stands, this is unavoidable, and makes allowance for the state of affairs. But applied workers complain that, in addition to this, descriptive writers show a tendency to care more for names than for the forms they connote, and wantonly alter the designations of familiar forms. The complaint is just, yet the action is not wanton. The tendency in its present form is of recent origin, and, paradoxical as the statement may seem, is the outcome of a wish for uniformity and stability in nomenclature. Of these two qualities the latter is of more importance in applied work, and therefore the more essential. Unfortunately the systematist has given a preponderating attention to the former, and, in his effort to attain a somewhat purposeless consistency, has allowed his science to wait upon the arts of bibliography. He has placed his neck under a galling and fantastic yoke, for nomenclature, though a good and faithful servant, is an exacting and singularly inept master.

To err is human, and the standard of diagnostic work, high as it is, falls short of the standard which the systematic worker desires to attain. It is this fact that explains the remarkable openness of mind, and the great readiness to accept correction, to which systematic study conduces. To this also is attributable the singular freedom of systematic research from the practice of making capital of the fancied shortcomings of fellow-workers. Exhibitions of this commercial spirit are not altogether unknown, and in one narrow field, where systematic results are practically applied, they are sufficiently common to appear characteristic. But they are contrary to the traditional spirit of systematic study, which is uncongenial to the arts of *réclame*.

The subject is by no means exhausted. Time, however, forbids more; but the purpose of this sketch will have been fulfilled if it has helped those whose work lies elsewhere to appreciate more clearly what systematic study tries to accomplish, and to realise the place it fills in the household of our common mistress, the *Scientia amabilis*.

SUB-SECTION OF K.

AGRICULTURE.

OPENING ADDRESS BY MAJOR P. G. CRAIGIE, C.B., F.S.S., CHAIRMAN OF THE SUB-SECTION.

THE occupant of this chair, in the great annual convention of the promoters and appliers of science, cannot fail at the outset of a new session to put on record his emphatic endorsement of the claim, so strongly and so reasonably pressed by his distinguished predecessor at Dublin, that distinctively agricultural problems, instead of being regarded as a subsidiary sub-section of any single division of the Association, should be accorded the full dignity and convenience of a "Section." Specialised research is today one of the governing features of scientific inquiry. It is but fitting, therefore, that those who are trying to equip the agriculturist with all the knowledge which recent speculation and experiment have to offer for the fuller and more economic development of the soil should at least be allotted equal space and sectional rank with the engineer, whose problems are discussed in Section G, or with the schoolmaster, whose educational methods are debated in Section L.

If there were any country in the world where an apology could legitimately be offered for relegating agricultural science to a secondary position, it is certainly not that in which we meet to-day. In this wide Dominion of Canada, in this progressive province of Manitoba, in this great city of Winnipeg, where the agricultural industry must dominate the interests of the people, hardly any subject in the whole range of study can claim a more paramount degree of attention than the utilisation of the land for the use of man.

This is by no means a matter which can be disposed of as an occasional side-issue in the deliberations of any single Section. If we agriculturists have been tardy in coming to be taught by the men of science, we are in earnest now in the application for instruction that we make. Neither is it to any one science we appeal. Even the stern mathematician or physicist of Section A can teach us something, arithmetical and meteorological, for the right conduct of our business and the wiser forecasting of our plans. The chemists of Section B have, in an infinite variety of tasks, to come to the aid of the farmer, and they have doubtless much to tell of the magic they can promise in the direction of fertilising methods. Section C must be raided for the experts who know the contents of the soil itself and its capacities. Section D may have much to pass on to us concerning the live stock and the insect enemies of our farms. Section E may enlighten us on the world-wide distribution of crops and the new regions awaiting the skill of the husbandman. To Section F we look for warnings as to the economic conditions and barriers which—as we are apt to forget—hedge round our industry, and for the statistics which must govern the varying direction which we give to our enterprise from time to time. The mechanical operations of our calling suggest to us the practical assistance which Section G can surely offer. Nor does even Section H lie wholly remote from the inquiries we may need to make as to the resources of the globe and the wants of diverse communities. The physiology of Section I opens regions of research quite germane to many of our daily studies. Under Section K, as an overlord, we rest to-day assured that if every botanist is not a farmer, every farmer must in a sense be a practical botanist, for ever face to face with the plant and its environment. Perhaps also, in common with all the rest of the world, we may have something to our advantage to hear from the pedagogues of Section L, who may advise our scientific counsellors as to the best form in which even the practical farmer may be taught.

Addressing ourselves, however, to the immediate task in the sub-section allotted to us, I suggest to you to-day that, having regard to the place where we meet, I may, as a proper prelude to your debates, invite you to consider, even if only in the broadest way, what are the leading factors that govern the fluctuations of this our industry of agriculture all the world over, and in new countries in particular. The first factor of all is undoubtedly population—its growth, its rapidly varying local distribution, and its changing and diversified needs. It is for man that crops are raised, whether these crops are to furnish food for direct consumption or for the sustenance of live stock, or whether they furnish us with our clothing, like the wool and the cotton of other lands, or with the materials for shelter, as the great timber crops which your vast forests here may bear. When we know what is the demand at any given place and time, we shall be prepared to give a more exact examination to the means of turning out the effective supply at the right moment and in the right place, be it of wheat, of meat, of fruit, of wool, of flax, of cotton, or of timber.

Sir Horace Plunkett told us last summer that he hoped to find in an Agricultural Section "some humanised supplement to the separated milk of statistics." Perhaps he unconsciously reflected in that remark the suspicion that in earlier days the agricultural debates, which, for want of a better place, took place in the Economics and Statistics Section, unduly paraded the bare figures of the position. But I myself confess that, however mortals may shrink from the rigid arbitrament of arithmetic, neither the teaching of the man of science nor the rhetorical advice of the philosopher will lead the agricultural student of the future, even if he have the luxury of a complete Section of his own, to any fertile result, unless he begins by a clear diagnosis of the facts as they stand, on the one hand as regards population, on the other as regards production. We shall by no means waste time if we try to investigate, with some approach to exactness, what are the areas still available for extended cultivation, and who and where are the consumers of our products, and what are their present and future demands.

Obviously, however, in the limits of an Address like this it is impracticable to make, in any detail, a world survey such as this implies, and it is only the most patent of the changes in the world's populations and their agricultural demands which I can put before you. There was a time when the human family lived in self-contained groups, extracting their requirements from the soil which lay around them. So lately as one hundred years ago there was very little of the international trade in food or other agricultural products such as is familiar to our practice to-day. The nations largely lived on their own territories, and the world has wide sections still where production is limited by local needs. But even a hundred years ago or more perpetual questions were emerging as to the time when men should have multiplied more rapidly than food. The transportation revolutions of the nineteenth century may be almost said to have laid that scare by their aid to the mobility alike of the world's populations and of the world's produce. For the migration of men from dense settlements to open lands on the one hand, and the transport of their produce to the cities of the old world on the other, have simplified, and may simplify still further, the solution. It is all a question of distribution.

If the world holds to-day just twice as many souls (as the best demographic authorities seem to assume) as it did only some two generations back, this growth has been by no means uniform, and the development is governed and provoked by the pressure of population on sustenance. Sometimes, I think, we are apt to forget what Prof. Marshall, of Cambridge, has so well laid down, that "man is the centre of the problem of production as well as that of consumption, and also of that further problem of the relation between the two which goes by the name of distribution and exchange." Vastly has the latter problem been simplified by the giant strides the second half of last century has seen in annulling distance and in facilitating transport, until all the world bids fair to become a single community. Whether the present distinguished British Ambassador to the United States was right in looking forward to the gradual unification of the type of the world's inhabitants by the diverse processes of ultimate extinction and absorption of inferior races, I think we will agree with him that the spread into new regions of conquering or colonising races has provoked desires for, and made practicable the supply of, far more varied wants than once were even contemplated, or could indeed have been made available, while the producing areas were sundered widely from the consuming centres.

The sixteen hundred million souls this earth of ours now carries are at present by no means evenly spread over its surface, and a population chart reveals the most extraordinary diversity in the density of the people on the soil. More than one-half are on the continent of Asia, and of these a large section are densely clustered in India, China, and Japan. In Europe, where the average density is double that of Asia, and approximately one-fourth of the world's inhabitants are gathered, many portions are nevertheless still far less thickly peopled than the Eastern States just named. Populations, over any considerable areas, exceeding 500 to the square mile, may be found on the world's map not only in parts of the United Kingdom, in Belgium, or in Saxony, but yet again on the Lower Ganges, on the Chinese coast, and even in portions of the narrow valley of the Nile. But the Indian or the Chinaman are not, broadly speaking, to be ranked among the communities of which we are thinking when we concentrate our attention on the increasing transport of breadstuffs or of meat from the New World to the Old, which has become the prominent feature of the agriculture of our own day, whatever attention may have to be given to the conditions of the Far East at some distant date.

The great movements of agricultural products which have signalised the last half-century are not for the most currents of food supply into Asia, or into Africa, or North America, despite certain limited exceptions which are just beginning to attract attention, as possibly hereafter significant in the case of imports of wheat into Japan or China, of Australian meat into Eastern Asia and South Africa. The Asiatic or the African agriculturist is for the most part content to find the primary necessities of life close at hand. It is mainly Europe, and indeed Western Europe, that calls to-day for the import of breadstuffs or meat or dairy produce. There the growing volume of sea-borne imports has not only materially influenced the agriculture of old settled countries, but at the same time has signalled to the European toiler that space and plenty awaits him oversea, and has stimulated the development of new spheres of cultivation at a rate which the relatively sparse population of the New World, unless largely recruited by immigration, could never accomplish.

I ventured some years ago, from the chair of the Royal Statistical Society, to review the recent changes we have seen in the structure of the world's populations, and urged the greater wisdom of bringing the men to the food rather than the food to the men. The centripetal force which was, in all parts of the earth and not in the oldest countries only, packing more and more together the human family in vast industrial centres, which drew the materials of their handicraft and the food for their maintenance from far distant lands, seemed to my judgment a much less healthy form of development than the older centrifugal impulse which led man to move himself to the newer regions, where the produce was nearer to the mouth of the consumer, and where he could fulfil the oldest obligation of the race to go forth and replenish the earth and subdue it. The vision that meets us here of ample land awaiting man, of possibilities of agricultural production which can only be realised by well-considered and augmented immigration, impresses the visitor from an old and overcrowded country. Before and above all speculations of what transport has done, and may yet do, to carry masses of agricultural produce across the ocean, I must claim, as the better prospect, a steady settlement of these wide acres by a population resting on the soil which this great Dominion offers, and drawing from it, by a more diversified and more general and more wholesome type of farming, a far better, and in the long run a more economic, return than the mere extraction of grain for export can ever promise.

Taking the thirteen States of Western and Central Europe as an example of what I mean, there were added there, in the last seventy years of the nineteenth century, on a comparatively limited surface, something like 100,000,000 new consumers to the 167,000,000 persons previously resident on the 1,700,000 square miles of territory occupied by this group of nations. These numbers, too, take no count of the emigration which has lightened the pressure on the soils of the home lands of Europe. Clearly the maintenance of nearly 70 per cent. more consumers must have meant either a vast development of local agricultural production or a vast demand upon the acreage of the new land of the West, or both. The defective nature of the early statistics obstructs the search one naturally makes into the extent on which these new populations on the old lands have been fed on larger local areas, or from larger yields on non-expansive areas. Adopting, therefore, a much shorter range of view, the lifetime of a single generation has given us 30 per cent. more consumers in Western and Central Europe than were there in 1870, the German element rising apparently by 50 per cent., the Scandinavian, Belgian, and Dutch group of small nationalities by 44 per cent., and the United Kingdom by 40 per cent. in this interval, while these developments were of course reduced in their effect on the total by the slower growth of the South-Western nations and the nearly stationary condition of France.

No larger areas, but rather smaller ones, of the chief food grains are apparent in Great Britain or Scandinavia or North-Western Europe. The German areas of wheat and rye show practically little change, and although, if the Hungarian areas are larger in the centre of Europe, the general movement is not upward in respect of food-producing area. Even in live stock the numbers scarcely keep pace with population, for although the herds and the swine of Western and Central Europe have risen by nearly a fourth in the one case and three-fifths in the other, the sheep, except in Great Britain, are much fewer now.

On the average of the first quinquennium of the present century the home production of wheat represented only about 20 per cent. of the consumption in the United Kingdom or in Holland, 23 per cent. (apparently) in Belgium, 64 per cent. in Germany, and perhaps 80 per cent. in Italy; and the imported grain to fill the deficits was considerably more than 400,000,000 bushels. Nearly half this came, of course, from Eastern Europe, and particularly Russia. Such a mass of produce would require 20,000,000 acres elsewhere, even if the exporters could raise it, as most have certainly *not* done, at twenty bushels per acre, and nearly double that area if the yield was only that of some of our largest exporters to-day.

The actual reductions of area in Western Europe are not in the aggregate extensive, although Belgium has seen her grain area shrink from 30 to 25 per cent. of her total surface, France from 28 to 25·5 per cent., and the United Kingdom from 12 to 10 per cent. The grain-growing capacity of European States varies greatly, and it would be interesting, were the data everywhere available, to see how far we have distinct evidence of an appreciable if not any great advance in the yields extracted from the non-expanding areas under the more recent conditions of scientific knowledge. Nowhere is so large a share of the total surface under grain as in Roumania, an Eastern European State and not inconsiderable wheat exporter, and there, at all events, the total grain acreage developed between 1886 and 1906 by nearly 25 per cent., and the surface under wheat by 72 per cent. The yield there, according to some official reports, was something over fifteen bushels per acre in the five years before 1890, and in those ending 1906 it was more than nineteen bushels—the latest year nearly touching twenty-three bushels; the barley yields of the same State rising from an average in the former quinquennium of thirteen bushels to more than nineteen bushels in the latter.

In Hungary, another European grain exporter, the wheat acreage has been materially developed, rising from more than 7,000,000 acres to 9,500,000 in twenty years to 1906, and but slightly receding since, while the yields are also materially greater.

France, with a drop in wheat acreage of 1,000,000 out of 17,000,000 acres, has between 1884 and 1908 raised the average of her production on a five years' mean from 17·8 bushels to 20·2 bushels, and thus turned out somewhat more produce from a lessened surface.

Germany, on a constant but much smaller wheat area of 4,700,000 acres, with a quinquennial average yield of 20·3 bushels, would seem to have raised this to 27·9 in 1899–1903, touching a still higher level in more recent seasons, when 30 bushels were apparently approached, although some changes in her statistical methods of inquiry may slightly reduce this comparison.

Some effort to feed new mouths from old acres has thus indeed been made. Nevertheless, without disregarding altogether the qualifications which a careful statistician would deem it his duty to admit, one may broadly say Western Europe looks mainly for the growing needs of her consumers to the still exporting States of Eastern Europe, to the New World regions of North and South America, and in a minor degree to Australasia.

Before we quit our session here in Winnipeg we may expect to learn something of scientific interest and of economic guidance respecting the response of Canada to the Old World's call. But it is not for grain alone that densely peopled countries turn to the new fields of the West. Probably the geographical conditions of our place of assembly this year will not lead us at all closely into discussion on the variations in the sources and fluctuations in the volume of the wool supply, or that of cotton, but the possible development of live stock on the territories of newly settled countries may be expected to come well within our purview, and afford us lessons in the development of the export trade in meat and dairy products, and the relation of the Canadian to the surplus of other States. The Royal Statistical Society of London had a paper this summer by an old colleague of mine, Mr. R. H. Hooker, which, although primarily devoted to the supply of Great Britain herself, and the price of meat in her markets, has a world-wide view of what is going on all around us in the conditions of production and of transport in a commodity as important to human life as wheat itself.

Fully a quarter of a century has gone by since, on a former visit to Canadian soil at Montreal in 1884, I raised a debate on this subject of the production and consumption of meat, and the various conditions of its transport. The twenty-five years that have passed since then have not rendered that particular topic a less important one for the consumers of old countries or the farmers of new, but ever-varying factors are presented by the opening of new territories to exploitation and the denser massing of accumulated populations with growing needs, and increasing preference for the most concentrated form of aliment. Among the most recent factors to be remembered as influencing one side of the meat-trade future are the admissions of qualified experts in the United States as to the degree in which the growth of population there was beginning to trench upon the meat surplus of that Republic. On the other hand, the producer will not fail to bear in mind the rapidly advancing importance of partially developed areas and the great advantage of the more economic forms of dead-meat transport now adopted in South America, and will weigh against these the degree in which the herds of the vast prairies of North-Western Canada may be further utilised when questions of handling economically the resultant meat supply may be effectively elaborated.

To-day, however, and here especially, one cannot but be reminded that in whatever direction we look for the aid of science to stimulate the development of Canadian resources, or to help the producers now in these provinces in measuring the probabilities that lie before them, or to summon eager emigrants to the land you have to offer them, there is an intense and ever-engrossing interest in the present and the future of wheat. Alike, therefore, to the statistician and economist on the one hand, and to the experimentalist and investigator on the other, we turn to ask what advice they can give to the farmer of a new country with an area so vast as the North-West of Canada presents, whether and how far and at what rate, with profit to himself and with benefit to the bread consumer across the ocean, he can push the extension of the well-nigh eight million acres of wheat land which the Dominion claims to show her visitors in 1909.

The problem, important as it is to this particular region where we are met, cannot, however, rightly be treated as a purely Canadian question. It is a problem of world-wide interest and of great magnitude and more complexity than has been sometimes recognised, for it is none other than the issue of the race between population and production so far as at least one primary essential of human diet—bread—is concerned.

Within a year of the last visit to this Dominion of the British Association the question was raised by no less an authority than the then President of that body at the Bristol meeting of 1898, whether the possible wheatfields of the globe possessed a potential capacity of expansion sufficient to meet the hypothetical needs of the bread-eaters of even one generation ahead; whether, in fact, a dearth of wheat supply was not already within sight, and by 1931 would be upon us. The suggestion that the wheat-producing soil of the world was already becoming unequal to the strain put upon it by the multiplication of men was not unnaturally met by a vigorous criticism. The mere suspicion that some day, however, there would not be land enough to go round, that famine could be averted only by the beneficial magic of the chemist, is too vital a possibility—even if some of us do not place the date so near or rely so fully on some of the computations made—not to command a very careful examination of the remedy propounded, the promise of the artificial production of nitrate in such a volume and at such a price as would raise the average of the world's production from 12·7 to 20, if not even to 30 bushels of wheat per acre.

The fixation of nitrogen, not as a dream but as a certainty, was, it will be remembered, claimed by Sir William Crookes as the condition on which the great Caucasian race was to retain its prominence in the world, and avoid being squeezed out of existence by races to whom wheaten bread is not the "staff of life."

Personally, I confess I am not so pessimistic as to the surface still available for wheat-growing even without this aid. If we grant that the so-called contributory areas, at a date two or three years before the close of last century, were just what was then stated, that the bread-eating population of that date was rightly guessed at 516,500,000—a much more difficult certainty to reach in the manner adopted by the American statistician whose figures were adopted—and that both the growth of population and of "unit consumption" would proceed exactly in the ratio suggested, it may legitimately be asked, does it nevertheless follow that no such increment of area can be looked for as would satisfy the larger mass of consumers calculated for as likely to be dependent upon wheat in 1911 or 1931 on the scale here laid down?

I should not, in any statistical investigation into these questions, be contented to assume the probability of the exact continuance of previous ratios in the rate of production, or that of individual consumption over such periods, and my experience of very big averages makes me shy of adopting a simple mean of such wide diversities as correctly representing the head-rate consumption of wheat. These are points which might be more fittingly debated elsewhere. I want to narrow the issue now to the actual and more recent course of the wheat-growing surface; for it seems to me that the lesson of such figures as we have in the past, and as those of Mr. Wood Davis's tables, is rather one of irregular than of arrested extension. The periodical opening up of new areas, very often in advance of consumptive requirements of the time, would seem almost invariably to be followed by a pause while prices recover from the over-supply, and that again by new developments and exploitation in new directions, or by better methods on the areas made tributary to the wants of the ever-increasing men.

We may admit that the course of the wheat acreage from 1870 to 1884 and thence onward to 1898 showed—first, a material advance outstripping that of population, then an admitted and serious check, with a subsequent advance, although one below that of the bread consumers of the world.

Let me ask, however, if a later view of the wheat area at the disposal of the world's consumers is not well qualified materially to diminish, if not to dissipate, the "cosmic scare" which, no doubt contrary to the real design of the distinguished chemist who followed Mr. Davis's estimates, was induced by the figures of 1898? My own comparisons of the later growth of acreage covers only the decade from 1897 to 1907, or as nearly to these years as figures permit, and in the form I originally designed it might bring into view something less than 230,000,000 acres as the world's present extent of wheat-field. But, to place matters on a more comparative level, I am willing to omit the large Indian totals and some few of the distant regions which, partly on account of the somewhat uncertain identity of the areas they include at different dates, and partly on account of their relatively small contribution to the bread of the Western world, do not find a place in the estimates with which I am now making a comparison. For the leading groups of other areas the figures stand in millions of acres to a single decimal:—

Groups	1897	1907	Increase in 10 years
Russian Empire	46·6	59·5	12·9
United States	39·5	45·2	5·7
Three chief European Wheat States	37·6	39·8	2·2
The Rest of Europe	20·8	21·4	0·6
Argentina and Uruguay	6·7	15·0	8·3
Canada	3·0	6·6	3·6
Australasia	5·0	6·0	1·0
Total	159·2	193·5	34·3

Now, whatever be the estimated increase in wheat-eating population between these two dates, it cannot in the aggregate be 21½ per cent., as is the growth of the wheat surface in these States. Nor would the result be materially affected if allowance were to be made for the three or four million acres represented by the exports of unnamed States in this table, or even by the inclusion of any minor units of wheat-growing, such as Portugal, or Greece, or Switzerland, for which Mr. Wood Davis estimated from sources not recognised in our official statistics, their totals being well under a single million acres, and the variation, if any, probably insignificant.

If, therefore, the growth of men outstripped the growth of wheat, as we have been warned was the case between 1884 and 1897, the growth of wheatfields has been well over the rate of population increase since that exceptional period, just as it was in the still earlier period between 1871 and 1884. Nor is the check to the rye acreage and its decline by 4 per cent., which seemed to have happened concurrently with the wheat check between 1884–97, continuing; for that, in the aggregate, seems to have returned to, though it has not perhaps much exceeded, the older level.

Comparisons at single terminal points have always a danger which may be avoided by examining more carefully the leading facts year by year. On the diagram which I introduce here I have tried, therefore, roughly to sketch the curves which indicate the growth of wheat acreage, both before and since 1898, in Russia, the United States, Argentina, Australia, and Canada, as typical of the exporting centres, while the acreage in France and Hungary has been added for comparison. The effect is, I think, to bring out the very much greater extension which has been going on during the last decade than could well have been looked for on the basis of the 1884–97 figures.

For the Russian Empire as a whole data are available only since 1895, but I have shown by a separate and steadily mounting line the wheat area of the fifty governments of European Russia, which are comparative for the entire period, and the latter are quite sufficient to establish my conclusion. There is, too, a suggestiveness about the course of prices (in shillings per quarter) in England, the chief recipient of wheat exports, which I have traced by a separate curve across this diagram. This may perhaps aid those who are disposed to make a closer study of the figures. That study may not improbably suggest that in the very latest year—for I have carried the diagram to 1908 where I can—we may be once again nearing another check, or temporary halt, in the course of wheat extension, such as that which puzzled inquirers more than ten years ago, but which proved only a pause in the task of finding all the bread the consumers wanted under the stimulus of better prices. The further leap of prices in 1909 to beyond the 40*s*. limit in England may effectively encourage extension.

Acreage of Wheat in Million Acres.

Year	Russian Empire	Of which in European Russia	United States	France	Hungary	Argentina	Australasia	Canada	Of which in N.-W.
1884	—	28·9	39·5	17·4	6·8	0·6	3·8	2·4	—
1885	—	—	34·2	17·2	6·8	—	—	—	—
1886	—	—	36·8	17·2	6·8	—	—	—	—
1887	—	—	37·6	17·2	7·3	—	—	—	—
1888	—	30·6	37·3	17·2	—	—	—	—	—
1889	—	—	38·1	17·4	—	—	3·8	—	—
1890	—	—	36·1	17·4	—	—	3·7	—	—
1891	—	—	39·9	14·2	7·9	—	3·4	2·7	—
1892	—	32·6	38·6	17·3	8·1	3·3	3·7	—	—
1893	—	32·4	34·4	17·5	8·6	—	4·0	—	—
1894	41·6	32·9	34·9	17·3	8·5	—	4·0	—	—
1895	42·2	31·9	34·0	17·3	8·3	5·1	3·6	—	—
1896	45·9	34·8	34·6	17·0	8·3	—	4·0	—	—
1897	46·7	35·6	38·5	16·3	7·4	—	4·5	—	—
1898	47·0	36·0	44·1	17·2	8·2	—	5·0	—	—
1899	49·7	38·0	44·6	17·1	8·4	—	5·9	—	—
1900	52·3	40·0	42·5	17·0	8·8	—	6·0	—	2·5
1901	54·3	41·9	49·9	16·8	8·9	8·3	5·6	4·2	—
1902	55·1	42·6	46·2	16·2	8·9	8·1	5·2	—	—
1903	57·2	43·8	49·5	16·0	9·2	9·1	5·5	—	—
1904	59·2	45·6	44·1	16·1	9·1	10·7	5·8	—	—
1905	62·2	48·1	47·9	16·1	9·2	12·1	6·5	—	3·9
1906	63·6	49·0	47·3	16·1	9·5	14·0	6·3	—	5·1
1907	60·0	45·5	45·2	16·3	8·6	14·1	6·1	6·1	—
1908	—	—	47·6	16·1	8·5	14·2	5·6	6·6	5·6

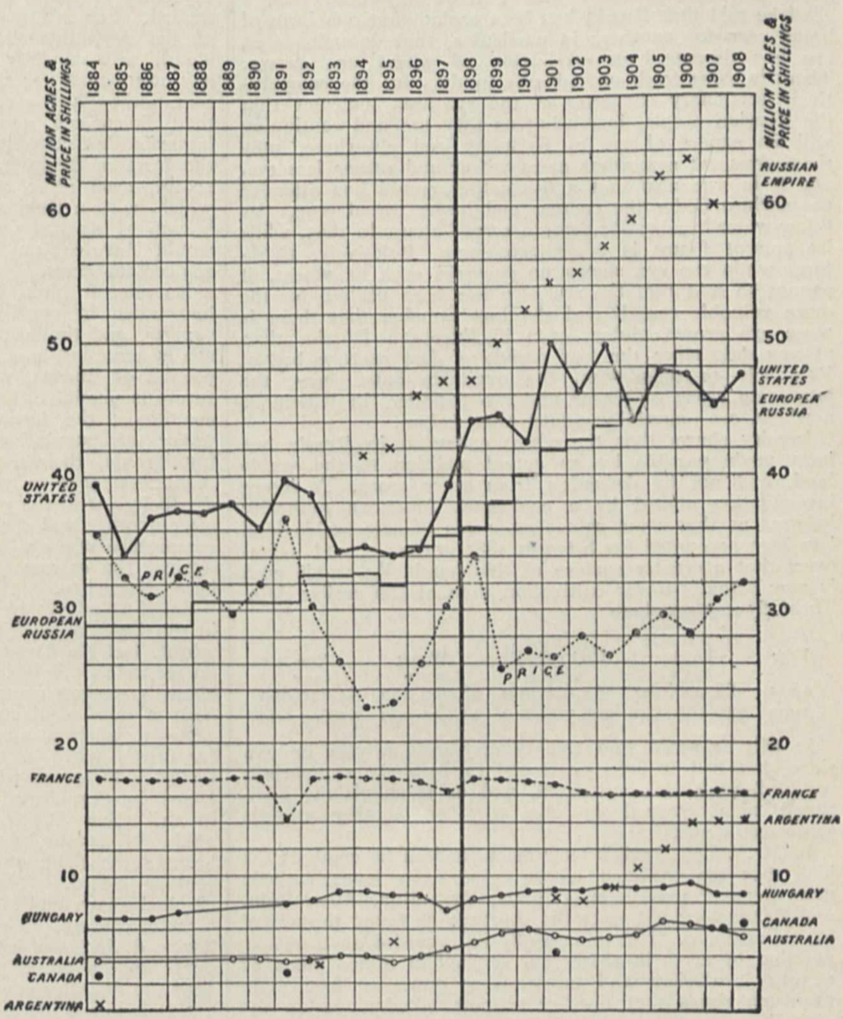
The exceptional arrest of wheat-growing in the United States between the years 1880–96, when—if we may accept the official statistics as actually representing fact—the rapid rise, which actually doubled the wheat acreage between 1870 to 1880, stopped altogether, was, I believe, the preponderating factor which suggested a general halt in wheat-growing. It should therefore be looked at more closely, and to get rid of the danger of attaching too much importance to the data of single years, the quinquennial average movement in the States over the whole of the last forty years may be summarised as under :—

Five-year Periods	Acreage in U.S.A.	Distinctive Wheat Acreage Levels
1868–72 ...	19,500,000	Extending rapidly up to 1880
1873–77 ...	25,500,000	
1878–82 ...	35,500,000	Nearly stationary from 1880 to 1896
1883–87 ...	37,000,000	
1888–92 ...	38,000,000	
1893–97 ...	35,500,000	Again extending to maxima reached in 1901 and 1903, with a later slight decline in the latest years
1898–1902 ...	45,500,000	
1903–1907 ...	46,800,000	

Population in the States has, of course, augmented steadily all over the forty years, from 37,000,000 to 86,000,000, yet all through the stationary years, as well as those of advancing acreage, exports of wheat and flour continued—as much as a third of the crop being shipped abroad in some years—and the transfer of the wheat lands north-westward in the States was doubtless the striking feature of the recovery. Rightly to understand the revolution in the wheat-growing of certain States of the Union would require a treatise for which time could not be given here.

Let me, however, recur again to the general position. In the table already given for the past decade the latest increase to be accounted for is 34,000,000 acres. I ask you to note that the Russian quota forms more than a third of the whole. Now it was Russia that was in a very special degree the subject of unfavourable remark in the wheat problem controversy of ten years ago. She was spoken of, I remember, as having reduced her consumption of bread by 14 per cent., and only by this means continuing her exports in defiance of her true needs, and contributing to the rest of the world therefore a merely provisional and precarious excess. I am not aware how the calculation here alluded to had been arrived at, nor have statisticians perhaps a very robust faith in the estimated numbers of the Russian population before the great census of 1897, but the subsequent history of her apparent wheat surplus is interesting.

The exports of wheat from Russia, which we were warned could not continue, and which had doubtless been unusually large between 1893 and 1898, shrank for three years after that date as if they would realise the prophecy which would relegate Russia from the ranks of exporters to the task of feeding her own population. But that mysterious empire has since then resumed her large supplies, and from 1902 to 1906 the exports ranged higher than before. Although forming only 24 per cent. of her estimated wheat crop, Russia's exports averaged 141,000,000 bushels over the first five years of this century, against 104,000,000 bushels over the whole preceding fifteen years. Quite lately we seem to see some restriction, but the history of the trade forbids a confident opinion that she has reached the end of her contributions to other lands.



So far as the areas under wheat are recorded, the Russian agriculturist keeps on extending his industry, and, low as the yields may frequently be, they are tending upward under, it may be presumed, some reform of the very primitive conditions of production. Within the fifty governments of European Russia alone, and omitting the Polish or Caucasian figures, which do not go so far back, the average area of 29,000,000 acres only in the 'eighties became 40,000,000 at the close of the century, rising to a maximum of 49,000,000 acres in 1906, a point from which a decline was shown in 1907 to 45,600,000 acres. This, however, even taking the latest and lower figure, is an advance of 10,000,000 acres in the last decade, or nearly 30 per cent.—surely considerably in advance of even the Russian growth of population, great as that is.

It has, I think, not been sufficiently realised that in the two decades stretching from 1887 to 1906, European Russia has added 1,000,000 acres of wheat per annum. This is not only a 70 per cent. advance in twenty years, but it is double the absolute area of 10,000,000 acres which the United States added in this interval. From such official estimates as are furnished, the total produce of these fifty governments, where alone the figures are continuous, increased in a still higher ratio. The average production, which did not exceed 180,000,000 bushels in the five years before 1879, or 226,000,000 bushels in the quinquennium ending 1889, reached what appears to have been a maximum in 1904, and was averaged at 415,000,000 bushels for the whole five years' period then ending. If the later years are again at a lower level, they represent very nearly double the produce before 1879. The yield per acre, which stood below eight bushels to the acre between 1883 and 1892, averaged nine bushels over the next ten years, and has been 10·9, 10·4, and 11·4 bushels respectively in the three seasons ending 1904. In the south-western region, where the yield was just over eleven bushels in the decade ending 1892, it seems to have averaged fifteen in the ten years ending 1902, while more than eighteen and nineteen bushels were reported in 1903–4.

These figures omit the Polish, Caucasian, and Asiatic districts, for which a much smaller retrospect is possible. The acreage in Poland is small—little more than a million—and nearly constant in extent. But the wheat of Northern Caucasia, first accounted for in 1894, has risen from 5,600,000 acres to 8,300,000 in 1906, and the Siberian totals, after increasing, apparently but slightly, from 3,400,000 acres in 1895 to 4,800,000 acres at the close of the century, do not seem much to exceed 5,000,000 acres now. Russian wheat production does not therefore seem a wholly arrested process.

I own I was hardly prepared for this old nation's progress in wheat-growing, and I have no doubt that I shall be told that Russia has been exchanging one form of bread corn for another; in particular, that dependence on rye has decreased as production of wheat has grown. There is some truth undoubtedly in this, for the comparatively stationary character of the rye area indicates that the Russian people, increasing as they are and continuing still an export of rye to Germany and elsewhere, may themselves eat somewhat more wheat and rather less rye, and it is true also that a fluctuating record has attended the surface under the coarser and larger cereal crop. Its "low-water" point—61,900,000 acres—occurs in 1893, while its present figure is 66,000,000 acres. Relatively, therefore, while the rye shows no progress such as wheat, it cannot be said that the rye area has been utilised for the more valuable cereal, and the fact remains that there is more rye grown to-day, even in European Russia, than at any date since the last decade of last century began. Relatively to population, the available data show, the aggregate crops of wheat and rye together, in Russia as a whole, are materially greater than before.

Inquiry shows that the wheat extension in Russia has been made possible by an actual addition to the arable land, and not by deduction from other crops. A recent investigation quoted by a competent American authority informs us that some 23,000,000 acres of new arable land has been accounted for between 1881 and 1904, and, moreover, that a greater surface of this nominally arable area is now actually under cultivation than at the earlier date. These figures stand:—

Year	Total Arable Land acres	Under Crop acres	Wheat acres	Rye acres
1881	288,000,000	174,600,000	28,900,000	64,600,000
1904	310,700,000	205,900,000	45,600,000	65,600,000

It will be noted that this inquiry ends a year or two since, but had it been continued to 1906 the comparison would have been accentuated, and as it stands the additional area cropped in one way or another exceeds 31,000,000 acres.

In Mr. Wood Davis's later memorandum he combats the idea that the expected wheat crops from four relatively new areas of production—Siberia, Argentina, Australasia, and Canada—would meet the shortage he found threatened by his estimate. Not unnaturally he regarded an 8,100,000 addition of acres in these four regions in fifteen years as a very insufficient and unpromising quota to feed more than ten times that number of new bread-eaters on the globe between 1883–4 and 1898–9.

Assuming he rightly gave the increment of wheat between these dates as under, if I add to his table the latest data that I have, these new and gradually opening areas will show a rate of progress much greater in the nine succeeding years than before, even if there was no further increase in Siberia; for as to the areas to be included there I am certain. The figures I give in millions of acres:—

	1883–4	1898–9	Fifteen years increase	1907–8	Nine years increase
Siberia ...	2·0	3·3	1·3	3·3	—
Argentina	1·4	6·1	4·7	14·2	8·1
Australasia	3·2	4·5	1·3	5·6	1·1
Canada ...	2·4	3·2	0·8	6·6	3·4
Total ...	9·0	17·1	8·1	29·7	12·6

In the forecasts offered ten years ago Argentina as a wheat-grower was given a dozen years from 1898 to reach a possible acreage of 12,000,000 acres. She has reached that figure and passed it in less than a decade, and later current official estimates seem to concede to that region a close approximation to 15,000,000 acres to-day. As the actual pace here has bettered so considerably that prophesied, one may legitimately question the further limitations which allowed to Argentina no prospect of ever reaching a wheat area of 30,000,000 acres at any time. That these prophecies by no means coincide with later and probably quite similarly vague forecasts in the other direction goes without saying. In a recent official publication by the U.S.A. Government containing the report of an expert on the resources of Argentina and her farming methods, the competitive prospects of the great grain-exporting Republic of the South were scarcely so lightly treated. For my own part I rather agree with an officer of the Argentine Government there quoted (Señor Tidblom), who candidly admits that it was impossible with any accuracy to forecast the ultimate wheat area of Argentina, although I observe he adds that there were "more than 80,000,000 acres in the Republic that could be *immediately* devoted to successful wheat-farming if we had the farmers to do it." I have seen, though I could not accept, even more sanguine estimates in other quarters, which, with a yield of only ten bushels per acre, promised a crop of 1,238,000,000 bushels at some future date, and would involve an area of wheat land approaching 124,000,000 acres.

No one, I think, can note the strides which Argentina has taken in rapidly augmenting her wheat areas and exports, and that concurrently with the commanding place she is assuming as a meat rearer and exporter to the older peoples of Europe, without some recognition that a great future is possible. On the other hand, apart from climatic conditions, the future must be largely governed by the factor of population; and the nature of the Italian immigrants, their mode of culture, their non-intention in many instances to remain and own the land or identify themselves with the country—preferring to exploit one farm after another and reside on them until they make a small competence wherewith to return to Europe—are all reasons against the extremely favourable prospects which I have here adverted to.

Small relatively to the great extent of surface included in the Commonwealth of Australia is the proportion under wheat, but the Commonwealth is none the less as a rule an exporter. A little more than thirty years ago only about 1,400,000 acres were grown. This seems to have been a good deal more than doubled in the five years 1876–81, when a much smaller rate of increase followed for fifteen years—a check apparently reflecting the same tendency to arrest which we have seen so typically illustrated in the United States. Again, after 1896, just as in the great Western Republic, wheat-growing became again in favour, and the rapid spurt which followed brought the Commonwealth total to 5,700,000 acres as the century closed. Thereafter the rate of growth seemed checked anew, and after passing a maximum of just under 6,300,000 acres, it stands to-day under 6,000,000 acres. Twice during the last twenty years has Australia shown on balance a net importation of wheat, but from 1903 to 1907 the quantity exported has averaged 36,000,000 bushels, and it is not without interest to observe that the Australian exports of the present century have not all been consumed in Britain—South Africa, the western coasts of South America, and even some parts of India sharing in the surplus product of the Antipodean Continent.

The conditions and the future of Australian wheat have been quite recently dealt with in an interesting paper by Mr. A. E. Humphreys, read before the Society of Arts in London. It is here pointed out that the soils on which it is grown are rich in assimilable nitrogen, requiring little manurial expenditure in that direction, but poor in their percentage of phosphoric acid, while the climatic conditions as regards moisture have proved remarkably difficult. Efforts have been made, and apparently, if recent experiences be confirmed, with success, to breed new varieties of the wheat plant adapted to the peculiar climatic conditions of Australia and likely to increase the low average yields hitherto obtained. It is obvious that under Australian conditions the breeding of varieties of the wheat plant which will thrive on a low rainfall would make all the difference to Australia as a source of wheat exports. From 1902–7 the Australian average yield was only half that of Manitoba, or nine bushels per acre; but this included one year of disastrous drought (1902–3), wherein the Commonwealth average fell below 2½ bushels to the acre. In New South Wales and Victoria, wherein more than half the acreage lay, it was even below this according to the official figures. Such instances offer the strongest evidence that could be offered of the extreme variability of Australian conditions, and make one almost hesitate to quote Mr. Humphreys' own cheerful estimate that in the State of New South Wales alone, wherein nearly a third of the Australian acreage is found to-day, or 1,886,000 acres, there was a possible area of good wheat land of nearly ten times this, or 18,000,000 acres.

To the last I have left another sphere of wheat extension, and one that will be most of all familiar to my audience. Yet here again the forecast of the Canadian future made in 1898 was surely unduly pessimistic. The opinion then quoted by Sir William Crookes as that of trustworthy authorities assigned to the Dominion a bare total of 6,000,000 acres under wheat as all that could be expected to be reached within a dozen years. That period has not yet fully come, but I observe that by December 31, 1908, the official figures show an acreage as reached within the decade which exceeds by 10 per cent. the maximum allotted to 1910. If I were to add the figure now ascertained for the 1909 crop, a total of 7,750,000 acres is now reckoned upon, so that here again the forecast has been outstripped. The further proposal to estimate the maximum of the Canadian potential capacity for wheat production by 1923 at no more than 12,000,000 acres will therefore, I imagine, meet severe critics in Winnipeg to-day.

I greatly wish that our contribution to the knowledge of the economic future of Canadian development may be, as the result of discussions here, some approach to an agreement to avoid all exaggeration on the one hand or on the other in these forecasts of future wheat-growing in the North-West; but I am very conscious of the risk of all far-reaching prophecy in a problem where the more or less uncertain growth of the immigrant population plays as great a part as the soil or the climate.

Sir William Crookes, in endorsing the most modest estimates of the capacity of this region, mentions that he had before him calculations which, I think most of us will agree, were, to say the least, exaggerated in an opposite direction, attributing to Canada 500,000,000 acres of profitably utilisable wheat land. Against such inflated prophecies he argued that the whole area employed in both temperate zones of the world for growing all the staple food-crops was not more than 580,000,000 acres, and that in no country had more than 9 per cent. of the area been devoted to wheat culture. But error of estimate in one direction or another is quite inevitable when the available data on which to form a conclusion are so scanty. Replying later to journalistic criticism, Sir William, it must be remembered, acknowledged the undoubted fertility of portions of the North-West provinces; but, basing the conclusion on official meteorological statistics and on supplementary data supplied by Mr. Wood Davis as to the July and August temperatures of these regions, he suggested that "from one-half to one-third only" of Manitoba—the south-west portion already fully occupied—was adapted to wheat. It was doubtless in the light of these climatic records that he inclined to regard 200,000 square miles of the whole 300,000 square miles comprising Assiniboia, Alberta, and Saskatchewan, as these regions were then defined, as lying "outside the districts of profitable wheat-growing," while even of the remainder it was apparently suggested that it would take thirty years from 1898 to place as much as 18,000,000 acres *under all grain crops*. Can we here to-day, with another ten years' experience, reach a somewhat greater accuracy in this search into the possibilities before us?

As illustrating the remarkable discordance of view hitherto existing, it is well to have before us, as a starting point for debate, some specimens of later but still most widely varying estimates of the capabilities of this country. These I quote from the cautious report rendered by Prof. Mavor to the British Board of Trade in 1904, midway through the decade now closing. More or less speculative as it is fully acknowledged all estimates must be which purport to define the area "physically or economically susceptible of wheat production," that painstaking investigator set aside, as of little value, hypothetical curves setting forth the "northern limit of cereal production," trustworthy data for which "were not forthcoming, and if they were they would be constantly changing." After enumerating under fourteen different heads and sub-heads a formidable list of distinct but materially qualifying "conditions" or factors covering questions of soil, of temperature, and meteorology, of moisture, sunshine, and acclimatisation of the plant, Prof. Mavor suggests that, broadly speaking, the cleavage of the areas of different fertility runs obliquely from south-east to north-west through the great quadrilateral of the Canadian North-West. Alike in the north-eastern and in the south-western angle the conditions seemed to him more or less unfavourable. The south-eastern and north-western corners and the belt connecting them, however, presented relatively favourable conditions; an exception qualifying this subdivision was, however, suggested in the extreme north-west.

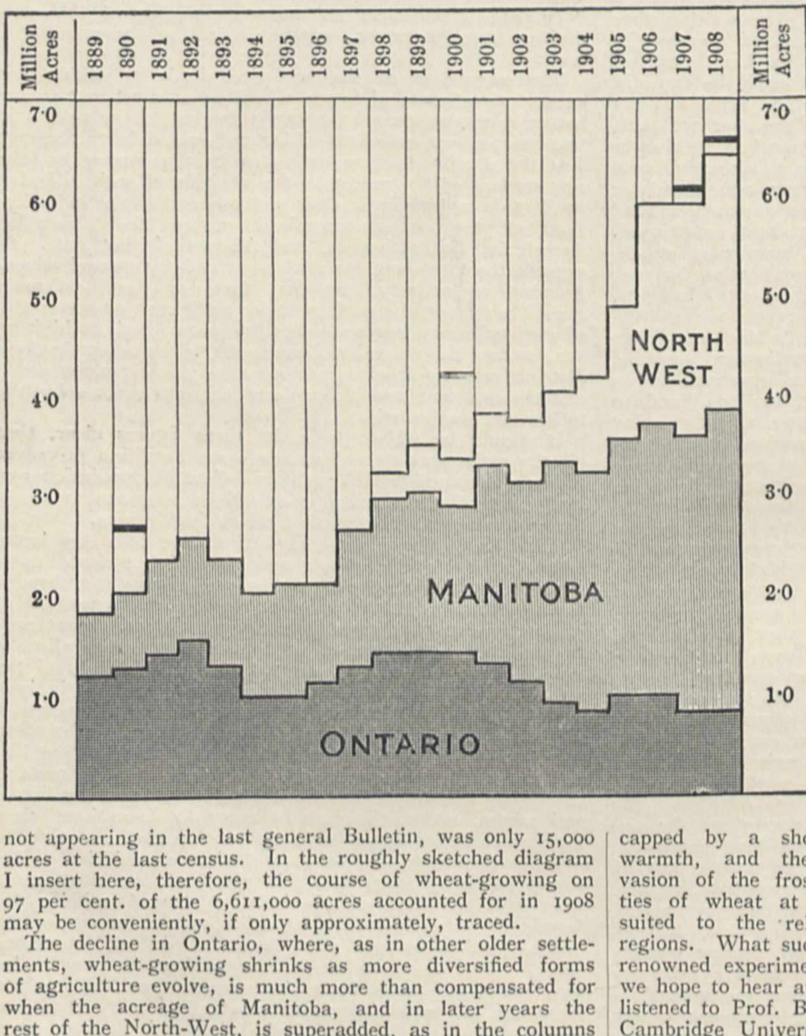
The vagueness of the statistical basis on which any numerical estimate of future wheat areas must rest cannot better be shown than by briefly referring to the results of five independent estimates which are quoted in this report. For the details of these estimates it is necessary to refer any student of the report to the analysis of each, differing as they do materially in their methods and in the classification of the areas comprised within the Manitoba, Assiniboia, Saskatchewan, and Alberta of that date. As regards the total area for settlement and for annual wheat-growing respectively, the first three of these estimates varied in placing the surface fit for settlement or susceptible of cultivation as low as 92,000,000 acres, and as high as 171,000,000, the annual surface available for wheat in these districts ranging from 13,750,000 acres to 42,750,000 acres, and the resultant possible produce from 254,000,000 bushels to 812,000,000 bushels.

It should be added, to make these figures clear, that all the estimators quoted assume as a condition precedent to their accomplishment such an influx of population and settlement of the country as would be adequate to secure the cultivation of the hypothetical cultivable area.

With Prof. Mavor, we may think that both the lower estimates are over-cautious and the third perhaps over-sanguine, while most properly he reminds us that beyond the physical capacity of any region, the question of economic advantage remains to be solved, under what may be conditions prevalent at a distant time, what effect a rise of price might have, and whether the farmers of the future would devote so much of their land as is here suggested, and so much of their working capital, to wheat alone. I ought to add that a fourth estimate referred to in the report takes the graphic form of a map, distinguishing the suggested area where the wheat crop is certain, where less certainty exists from the effect of summer frosts, and where, again, the crop is uncertain from insufficient moisture. Yet another estimate was quoted as made in 1892, but endorsed as not over-stating possibilities of the future in July, 1904, and this classified somewhat more than half the land of Manitoba as "land suitable for farming," or 23,000,000 acres, allotting to the rest of the North-West 52,000,000 acres more, or in all 75,000,000 acres. The same estimator, forecasting the results for 1912 (or three years from the present time), allotted to Manitoba a probable wheat production of 168,340,000 bushels, and to Alberta, Assiniboia, and Saskatchewan 181,600,000 bushels. This crop of 350,000,000 bushels of wheat was in addition to an estimate of a further 200,000,000 bushels of oats and 50,000,000 bushels of barley. I have little hesitation in concluding, with Prof. Mavor, that such widely divergent results, arrived at, as we are told, by competent estimators, illustrated the impossibility at the time of that report of setting out precise limits of cultivation in a region in which so much has yet to be done. To-day I would ask, Has the lapse of another quinquennium, full of interesting movements in both the population and the crops of the North-West, enabled us to reach any greater certainty? If so, the opportunity of this meeting affords an occasion to submit the conclusions, optimistic or pessimistic, practical or theoretical, economic or scientific, to the test of friendly and thorough discussion.

It is a relief to turn from the perplexing variety of these speculations as to the future to the relatively more solid ground afforded by the actual records of wheat extension here. If the progress of the past, and here once again more especially of the very latest decade, is to govern the prospect of the years to come, the wheat area of Canada must still possess a great expansive power.

There are defects of continuous statistics showing from year to year the total acreage of the Dominion, although the recent good work of the Census and Statistics Office promises that this will henceforth be remedied. But outside of the three great wheat-growing sections—Ontario, Manitoba, and the North-West—the surface under this cereal is not material. By the latest figures available the four Eastern Provinces do not now grow 170,000 acres collectively, while the small surface in British Columbia,



not appearing in the last general Bulletin, was only 15,000 acres at the last census. In the roughly sketched diagram I insert here, therefore, the course of wheat-growing on 97 per cent. of the 6,611,000 acres accounted for in 1908 may be conveniently, if only approximately, traced.

The decline in Ontario, where, as in other older settlements, wheat-growing shrinks as more diversified forms of agriculture evolve, is much more than compensated for when the acreage of Manitoba, and in later years the rest of the North-West, is superadded, as in the columns of this diagram, and the rapidity of the recent extension, which—had the 1909 figures reached my hands sooner would have carried the total area far beyond the seven million limit—testifies to the energy in the task of bread-raising which this hopeful section of the British Empire displays.[1]

[1] Were the preliminary estimates for 1909 taken into account, the total acreage would have been given as 7,750,000 acres—a rise of 1,139,000 acres in the latest twelve months. This is indeed the net result, for the West has added 1,402,000 acres—of which 1,289,000 were in Saskatchewan and 113,000 in Alberta—while there are declines in the East and in Ontario of an almost exact equivalent of the last-quoted figure, or 114,000 acres, and likewise a reduction of as much as 149,000 acres in Manitoba since 1908.

But whatever determinations we can reach on the hypothetical questions here propounded, whether we may regard the greater rate of wheat-field extension in the world at large, which has marked the last decade, as disposing of immediate alarm for the bread supply of the next generation, or whether we find in the recent whisper of augmenting prices corroboration of the gain of population on subsistence, it is clear that our statistical records require a further development and a much improved continuity, especially in the new regions of the wheat supply of the future. Nor yet, again, can we dispense with the urgent lesson that science has much to teach us in making more use than we do of the areas acknowledged to be under more or less rudimentary cultivation. If Sir William Crookes was right in adopting the American statistician's average of 12·7 bushels per acre as the mean of the recognisable wheat-fields of the world, the prospect of the extra seven bushels he sought as immediately desirable will make us eager to learn the very latest triumphs of the laboratory in winning for the soil a freer measure of the nitrogen of the air. Even here in Manitoba, where a much higher yield seems on the average to be maintained under existing conditions, and where the cultivators with their 18 bushels average start from a vastly higher level, the promise of such a scientific ally should gladden the heart of the hard-working pioneer.

One caution, however, I feel it my duty to give, as a practical rather than a scientific agriculturist. Whatever wonders are offered in the way of manurial adjuncts or mechanical contrivances, do not let our advisers overlook the paramount consideration of the cost which the newer systems may involve. For the extensive farming of a young country it is above all requisite to remember that expensive methods of cultivation are not as feasible as in the intensive husbandry of old settled regions. Hopefully as we may wait on the chemist's help, I confess that, for my own part, I incline still more confidently to the botanist, under whose ægis of protection agriculture has this year been placed by the decision of the authorities. The producer of new and prolific and yet disease-resisting and frost-defying breeds of wheat plants is to-day more than ever encouraged by what has been done in many lands of late in this direction, to suit the crop to its environment. Nothing could be a greater boon to the wheat farmers, handicapped by a short and irregular supply of summer warmth, and the occasional but often untimely invasion of the frost fiend, than the production of varieties of wheat at once prolific and early ripening, and suited to the relatively scanty moisture of semi-arid regions. What success Canadian investigators, with their renowned experimental system, have had in this direction we hope to hear at Winnipeg, while some of us who have listened to Prof. Biffen, of the Agricultural Department of Cambridge University, look for hopeful results from the application of Mendelian laws to the breeding of wheat.

In closing, let me add that though it is a quarter of a century since I last was here, the message I gave local agriculturists then is one I am tempted to repeat now. It is no use to treat the vast territories you have at your disposal as if they were a mere wheat mine to be exploited in all haste and without regard to its permanence and its future profitable development. It is unwise to proceed as if bread were the only item of food requiring attention at your hands, and to regard a spasmodic rush of grain for a limited number of years from a poorly tilled surface as the only way to profitable returns. The stale maxim of not carrying all your eggs in one basket has a very profound truth to rest upon. The farming of the future must ultimately be one of more careful tillage, more scientific rotations, and of consideration for the changes in the grouping of population and in the world-wide conditions of man and his varying wants. What is going on all over the world has to be learned and studied well, and wheat pioneers of the North-West must not forget the possibility of yet new competitors arising in the single task of wheat-growing, whether they are to be looked for in the still developing sections of the Russian Empire and the still open levels of Argentina, the little-known regions of Manchuria, the basin of the Tigris and Euphrates, the more completely irrigated plains of India, the tablelands of Central Africa, or perhaps under new conditions and a more developed control of the reserves of water supply on the southern shores of the Mediterranean or even in the long tilled valley of the Nile.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—According to the *British Medical Journal*, a movement is on foot for the establishment of university chairs at the Royal Infirmary for the teaching of (1) medicine and clinical medicine; (2) surgery and clinical surgery; (3) midwifery; and (4) pathology. It is proposed that these four professors should form the teaching staff so far as the Royal Infirmary is concerned. Under this arrangement, in place of a complete, there would be a partial medical school at the Royal Infirmary, so that university students, if they preferred, might take their final year at that institution instead of at the Western Infirmary and Gilmorehill. Towards the accomplishment of this object it is understood that the Muirhead trustees are willing to give two sums of 400*l.* a year each to found two of the chairs, that the funds of St. Mungo's College are to be concentrated on one chair, and that the Carnegie trustees are to supply the funds for the fourth chair. The scheme will require to be sanctioned by Parliament, and draft provisional orders for that purpose are being prepared. These will be submitted to the members of the University Court for their approval, probably at a meeting in October.

Dr. G. A. Gibson, professor of mathematics in the Glasgow and West of Scotland Technical College, has been appointed professor of mathematics in the University of Glasgow in succession to Prof. Jack. Prof. Gibson has published a number of original contributions of importance to mathematical science, and is the author of works on the calculus which are acknowledged to be among the best in the English language. His wide knowledge of the history and present state of mathematical science, unusual powers of logical and lucid exposition, and ability as a creative scholar, ensure enthusiasm for mathematical studies at the University and increased activity in scientific investigation.

LONDON.—University College:—The following public introductory lectures will be given as under:—Sir William Ramsay, K.C.B., F.R.S., on "Radium Emanation: one of the Argon Lines of Gases," on Monday (October 4); Prof. H. R. Kenwood, on "What Hygiene demands of School Teachers," on Wednesday (October 6); Prof. J. A. Fleming, F.R.S., on "Electrical Inventions and the Training of Electrical Engineers," on Wednesday (October 6); Prof. Garwood, "The Origin of Scenery" (October 7); Prof. Carveth Read, "The Psychology of Character" (October 7).

MANCHESTER.—The new chemical laboratories of the University will be opened on October 4, when it is expected that the Chancellor, Viscount Morley of Blackburn, will be present and confer honorary degrees on the American Ambassador; Sir Robert Stout, Chancellor of the University of New Zealand; Sir Alfred C. Lyall; and Prof. Otto Wallach, of the University of Göttingen.

MR. JOHN FISHER has been appointed lecturer in biology at the Agricultural College at Cedara, near Maritzburg.

THE prizes and diplomas awarded at the South-eastern Agricultural College will be distributed on October 9 by Principal H. A. Miers, F.R.S.

PROF. W. OSLER, F.R.S., will take as the subject of his address before the London School of Tropical Medicine on October 26 "The Nation and the Tropics."

DR. WALTER MURRAY, of the University of Dalhousie, Halifax, according to *Science*, has been elected president of the new University of Saskatchewan, situated at Saskatoon.

SIR T. CLIFFORD ALLBUTT, K.C.B., F.R.S., will distribute the prizes and deliver an address at the opening of the winter session of Charing Cross Hospital Medical College, instead of Lord Ridley, as was announced.

ACCORDING to a Reuter message, the Czech University of Prague has conferred the honorary degree of Doctor of Philosophy upon the following men of science:—Sir Archibald Geikie, K.C.B., P.R.S., Dr. J. E. Marr, F.R.S., Dr. Francis Darwin, F.R.S., and Prof. T. W. Richards, of Harvard University

MR. WILLIAM BROWN, lecturer in electrotechnology at the Royal College of Science, Dublin, has been appointed to the professorship of physics in the college in succession to Prof. W. F. Barrett, F.R.S., who is to retire on October 1 under the Treasury regulations as to age. Mr. Brown's successor is to be Mr. Felixe Whackett, one of the junior fellows of the Royal University of Ireland.

THE following courses of free Gresham lectures are announced for delivery at the City of London School:—geometry, by Mr. W. H. Wagstaff (beginning on October 5); physic, by Dr. Sandwith (beginning on October 26); astronomy, by Mr. S. A. Saunder (beginning on November 2). This is the first term these lectures will have been delivered other than at Gresham College.

IN connection with the Child Study Society there will be a reception by the president at 90 Buckingham Palace Road on October 7, when short addresses will be delivered by Miss A. Ravenhill, Dr. C. W. Kimmins, and Dr. G. E. Shuttleworth. Succeeding lectures will be by the Right Hon. Sir John Gorst, Dr. W. C. Sullivan, and Dr. A. R. Abelson on, respectively, "The Care of Children under the Poor Law," "The Child Criminal," and "Mental Fatigue."

TWO more calendars of London colleges have reached us, those of the East London College and Birkbeck College. The East London College is a school of the University of London in the faculties of arts, science, and engineering, and a rapid development in its work took place during last session. To the equipment of the school of engineering—civil, mechanical, and electrical—valuable additions have been made, while the botanical department has been reorganised. A considerable sum of money was placed at the disposal of the college committee for these purposes by the Drapers' Company, who specially ear-marked a portion of their benefaction for the improvement of the college library, which is now well housed and possesses a good collection of works dealing with the subjects in the college curriculum. We learn from its calendar that the pressing need of Birkbeck College is for increased space; the usefulness of the college is curtailed by its limited accommodation. New and more spacious college buildings, with more class-rooms and larger laboratories better adapted to modern requirements, would give a great impetus to the work of the college, and it may be hoped, in view of the marked success of the work accomplished in the past, that it will prove possible to secure the money necessary for reorganisation.

AT the meeting of the Chicago section of the American Mathematical Society on January 2 of this year, a committee was appointed for the purpose of investigating the possibility of improving the character of mathematical appointments in colleges and universities. In the July Bulletin Prof. E. J. Wilczynski publishes the proposals submitted by him to the committee. He suggested (1) that vacancies should be announced in the Bulletin in a special column devoted to the purpose; (2) that in the case of major positions, *i.e.* posts of 400*l.* a year upwards, if a university should desire expert assistance in filling a post, the council should elect a nominating committee for the purpose, the names of the members being published in the Bulletin; (3) in the case of minor positions, Prof. Wilczynski does not consider that much could be done owing to the frequency of vacancies, but, at the same time, an annual standing committee might be appointed. While these suggestions only apply to America, and the report of the committee, which is on somewhat different lines, is to be published elsewhere, the idea suggests itself that reform is none the less needed in Great Britain, and that not for mathematical appointments alone. The present system of sending in printed testimonials is not only a heavy expense to the younger candidates, who can ill afford the money, but in the case of older candidates it involves a serious loss of time that would otherwise be available for research, and debars many from offering themselves for appointments.

MUCH interesting information as to the provision made for instruction in science and technology in the great provincial centres of population can be gleaned from the calendars and prospectuses issued at this time of the year by the colleges and institutes which have grown up since the Technical Instruction Acts came into force. Among such year-books received we notice those of Armstrong College, Newcastle-upon-Tyne, the Belfast Municipal Technical Institute, and the Bradford Technical College. While at each of these well-equipped institutions the claims of pure science as the foundation of all successful industrial practice are duly recognised, each rightly makes a special effort to suit its classes in technology to the particular manufacturing needs of the area in which it is situated. It is possible only to give a few instances. At Armstrong College there are special courses for miners, and prominence is given to naval architecture. In connection with the latter work it is noteworthy that the B.Sc. degree of the University of Durham, of which this is a constituent college, is awarded in naval architecture. In the Belfast institute day courses have been established to provide a sound training in mechanical and electrical engineering, in the science and technology of the textile industries, and in applied chemistry. Similarly in Bradford, the department of textile industries deals with every aspect of the industry, and diplomas, we observe, are awarded in preparing, combing, and spinning, in weaving and designing, and in chemistry and dyeing.

SOME months ago a committee was formed, with Dr. E. Berl, of Zürich, as secretary, which decided to present to Prof. Georg Lunge, in celebration of his seventieth birthday and the jubilee of his doctorate, a gold medal bearing his portrait, and to collect and hand over to him a sum of money—40,000 francs have already been collected—to be disposed of at his discretion. The formal presentation was made by Prof. Bosshard in the chief chemical lecture theatre of the Zürich Polytechnic on Sunday, September 19, the theatre being crowded with chemists from almost every European country. Following this ceremony congratulatory letters and addresses were delivered by the delegates, Dr. Landolt, speaking for the Swiss Society of Chemical Industry, leading the way. He was followed by Dr. R. Schmidt, director of the famous Elberfeld works, who represented the Verein deutscher Chemiker, and by Geheimrat Bunte, who brought an address from the Karlsruhe Technical College. Dr. Lepetit brought an address from the Società chimica Italiana, and Dr. F. C. Garrett spoke for the Newcastle section of the Society of Chemical Industry, the present-day representative of the Newcastle Chemical Society, of which Dr. Lunge was one of the founders. Chemists who have studied at Zürich are naturally among Prof. Lunge's most devoted admirers, and on behalf of those resident in Great Britain Dr. Richard Seligman presented an address signed by many of Lunge's old students and English friends. Dr. R. Nötzli brought congratulations from Austria, and Herr Bell spoke on behalf of those who still have the good fortune to be working at Zürich. In addition, there were numerous presentations from the various learned societies of Switzerland and Germany, whilst several hundred congratulatory telegrams, including one from the Society of Chemical Industry, were received. In an admirable speech Prof. Lunge thanked the many speakers and the societies they represented, and announced his intention of handing over the money which had been collected to the polytechnic, the interest to be used at the discretion of the professors of chemistry for the assistance of young chemists who would otherwise have difficulty in continuing their studies or investigations for a sufficiently long period.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 20.—M. Bouchard in the chair.—Multiple monochromatic images of the sun given by the large lines of the spectrum: H. **Deslandres** and L. **d'Azambuja.** A historical account of the study of the different layers of the solar atmosphere by means of monochromatic images of the dark lines. In the present paper an account is given of new work, in which the successive layers of iron, calcium, and hydrogen have been distinguished. The upper layers, the most interesting but the most difficult to isolate, have been specially studied, the large spectroheliograph with three slits, built in 1907, having been of great service in this connection.—The earthquake of June 11, 1909: Alfred **Angot.** A map is given of the district affected, showing the zones of equal disturbance.—The action of mineral waters on the striation and form of the valves of diatoms: A. **Lauby.**—The washing of cider apples with an oxidising calcium salt, leading to a pure fermentation: Henri **Alliot** and Gilbert **Gimel.** It has been shown that washing the apples with a weak solution of calcium hypochlorite is very advantageous.—The preventive action of normal serum from the sheep on *Trypanosoma duttoni*: A. **Thiroux.** —Calculation of the depth of seismic hypocentres: Comas **Solá.**

CONTENTS.