THURSDAY, SEPTEMBER 15, 1904.

NEW AND OLD VIEWS ON GLACIATION.

Die Gletscher. By Dr. Hans Hess, königl. gymnasial-Professor in Ansbach. Pp. xii+426. (Brunswick: F. Vieweg und Sohn, 1904.) Price 15 marks.

THE author of this closely written treatise reminds us that it is nineteen years since Heim issued his classical "Handbuch der Gletscherkunde," and that the numerous additions to our knowledge since 1885 may well be brought together in a convenient form. Dr. Hess has an intimate personal knowledge of European glaciers, on which he has made patient and numerical observations; and in the difficult matter of the theory of glacier-motion he has had the cooperation of Prof. Finsterwalder, of Munich. The work of Finsterwalder, indeed, is in many ways an inspiration throughout the book, but the references to Chamberlin, Brückner, Drygalski, Penck, Reid, and many others show what an immense amount of material has been added to our knowledge in very recent years.

In summarising the conclusions of these authors, the work of Dr. Hess becomes somewhat encyclopædic, and it will be felt, according to the idiosyncrasies of the reader, that certain subjects are unduly dwelt on, while others are summarily compressed. Those who live in countries that were at one time buried under confluent sheets of ice will wish to see an extended history of Polar and Alaskan glaciers, and a further discussion of the widely spread moraine-material which appeared on their melting and retreat. The mention (p. 388) of Kames and Eskers as "durch die Schmelzwasser geformte Hügel in den Schotterbänken" will hardly satisfy dwellers in Britain or Scandinavia, not to say the Prussian plain; nor does it represent the views recently accepted by Prof. Jas. Geikie, from whose work it is professedly a translation. We ought, however, to be willing to refer to memoirs on special districts when pursuing inquiries such as these, and we may well be grateful to Dr. Hess for the new details brought to our notice from the regions in which he himself has studied.

The book opens with a review of previous observation, in which priority is accorded to John Playfair for realising the meaning of erratic blocks so far back as 1802. The physical characters of ice are then discussed, and full stress is laid on the recognition of ice as a viscous body, yielding to pressures and adapting itself to its surroundings. Glacier-ice (p. 20) suffers some reduction in plasticity owing to the admixture of sand and dust. The discovery by McConnel and Kidd, and by Emden, of the plasticity of the individual ice-crystal led Emden (p. 316) to remark that a glacier consisting of a single crystal at the temperature of its melting point would move precisely as a granular glacier. Regelation, as an explanation of glacier-motion, though still holding its own in physical text-books, has been set by geologists in the second place in recent years. In the regeneration of fractured glaciers, however, as Hess points out, this phenomenon plays a most important part.

We could wish that the tenth section, on the theory of glacier-movement, had followed closely on the first, and had thus offered an explanation of much that is obscure in the earlier chapters of the book. The development of Finsterwalder's "Strömlinien" is greatly needed during the discussion of moraines, and readers of so special a treatise are naturally familiar enough with general physical geography and the form of glaciers to understand the exposition of Finsterwalder's views at an early stage. This exposition, from p. 325 onward, shows how every point in the surface of the firn-basin is connected by a "Strömlinie" with a corresponding point on the surface of the glacier lower down. The ice-particle enters the firn at one end of the line, by deposition from the atmosphere, and disappears from the glacier, by melting or evaporation, at the other end of the line. In between, it has had a course within the ice-mass, longer or shorter, according to the form of the rock-floor and of the bounding walls. The lower boundary of the firn marks the line of division between the area where the flow-lines enter the glacier and that in which they emerge upon its surface. While a "Strömlinie" never lies entirely on the glacier-surface, a "Bewegungslinie" is (pp. 138 and 327) the course of a stone dropped upon and remaining on the surface. Shortly, "Strömlinien" emerge at all points along "Bewegungslinien," but do not coincide with them.

Dr. Hess regards the stratified structure of glacier-ice as essentially arising, by natural conditions and irregularities of deposition, in the area of the firn; the appearance becomes intensified by streaming out and extension lower down (p. 173), but has nothing to do with internal pressures. Experimental evidence of this conclusion is provided. An interesting case of unconformity in the bedding of ice-layers is quoted and illustrated from Finsterwalder on p. 177.

The title of the seventh section, "Eis und Fels," reminds us that massive ice is as much one of the rocks of the earth's crust as desert-sand or a reef of coral. Marine limestones are, for instance, formed of material withdrawn from invisible solution in the sea; on one side they may receive almost molecular additions, on the other side they may disappear again by solution. An ice-mass is similarly added to or removed at different points, but it is none the less a rock. Its plastic behaviour, however, among other rocks has led us to think of it as a thing apart, just as we sometimes forget that mercury has a crystallographic form. The chapter in question will attract attention on account of its treatment of moraines, and the belief of the author in the rapidity of the erosion that takes place upon the glacier-floor. From personal observations, which are now being carried further, he estimates this erosion, in specially active cases, as indicating a reduction of the floor-level by 3 cm. per annum. Allowing for the additional influence of water-erosion, which he considers to be far less than that of the moraine-laden ice, he uses the figure of 3 cm., somewhat adventurously, in calculating (p. 376) the age of some of the larger valleys of the Alps.

A fine picture (p. 35) is given to show how the fissile structure of rocks affects their mode of weathering by the ice. The author holds that large blocks are re-

moved from the walls and floor of glaciers wherever the planes of division lie at favourable angles. In this way, medial moraines have a very real existence below the surface of the glacier as well as upon it, since a rocky island yields ice-scratched material over its surfaces of contact with the ice that sweeps round it on either side. "Such medial moraines (p. 194) possess only ground-moraine material"; the word "only," however, seems negatived by the following sentence:—"their constituent débris is not limited to the surface, but reaches right down to the base. In consequence, the débris seen at the surface is not constant in quantity as in the pure medial moraines, but increases in proportion as the end of the glacier is neared, in accordance with the progress of ablation."

Internal moraines may similarly arise from projections in the firn-area; the fragments are carried forward as a wall within the ice. A little diagram on p. 203 makes Finsterwalder's scheme of moraine-structure clear, though it perhaps exaggerates the filmy character of the ordinary ground-moraine.

It has seemed to many geologists that the increasing stress laid on the plasticity of ice, and the ease with which it adapts itself to obstacles, make it all the more necessary to look to frost and storm, and to the erosive action of sub-glacial streams, as the agents by which glaciated hollows are cut out. The passages (p. 361 *et seq.*) on cirques—no such Gallic word is really admitted to this treatise—and the forms of Alpine valleys will show how much room there is for differences of opinion on this point. We fancy that the views put forward by Dr. Hess as to the simple "peneplain" character of the pre-Glacial Alpine slopes will receive considerable criticism from those who have described the successive movements along the mountain-axis in Miocene and Pliocene times. The grouping of the pre-Glacial river deposits of France and Switzerland, as they are traced back into the hills, should give us some idea of the depth of the valleys before the ice spread down into them. The work of rivers at the present day in rapidly destroying the Glacial troughs, and in carving out ravines on ice-worn walls, leads many of us to regard glaciers mainly as moulders and preservers of the basins which they temporarily fill. Dr. Hess, however, extends his support of the excavation-theory to the Scandinavian fjords (p. 388), and it is well to realise that these views, once widely prevalent, have not lost their hold upon men who can measure and observe.

Modern English writers may find their contentions somewhat slightly dealt with, and their names occasionally mis-spelt. Through a certain Teutonicism, moreover, the glacial terms familiar to three-quarters of the globe are omitted from the text and from the index. Scarcely any German work mentions *roches moutonnées*, made classical by De Saussure; but it is hard to see *nieves penitentes* admitted as a newcomer.

In conclusion, Dr. Hess has produced a book that must find a place in every scientific library, both as the work of an original observer and as a record of the active progress of geological research.

GRENVILLE A. J. COLE.

MATHEMATICS FOR SCHOOLS.

Practical Geometry for Beginners. By V. Le Neve Foster and F. W. Dobbs. Pp. ix+96. (London: Macmillan and Co., Ltd., 1904.) Price 2*s.* 6*d.*

Elementary Algebra. Part i. By W. M. Baker, M.A., and A. A. Bourne, M.A. Pp. viii+275+lii. (London: George Bell and Sons, 1904.) Price 3*s.*

A New Trigonometry for Schools. Part i. By W. G. Borchardt, M.A., B.Sc., and the Rev. A. D. Perrott, M.A. Pp. vii+237+xxxv. (London: George Bell and Sons, 1904.) Price 2*s.* 6*d.*

The Elements of Plane Trigonometry. By R. Lachlan, Sc.D., and W. C. Fletcher, M.A. Pp. v+164. (London: Edward Arnold.) Price 2*s.*

Preliminary Practical Mathematics. By S. G. Starling, B.Sc., A.R.C.Sc., and F. C. Clarke, B.Sc., A.R.C.Sc. Pp. viii+168. (London: Edward Arnold.) Price 1*s.* 6*d.*

Constructive Geometry. By John G. Kerr, LL.D. Pp. 122. (London: Blackie and Son, Ltd., 1904.) Price 1*s.* 6*d.*

New School Arithmetic. Part i. By Charles Pendlebury, M.A., F.R.A.S., assisted by F. E. Robinson, M.A. Pp. xv+206+xxi. (London: George Bell and Sons, 1904.) Price 2*s.* 6*d.*

THE Practical Geometry by Messrs. Le Neve Foster and Dobbs consists of a collection of more than seven hundred examples, grouped in sets, each set illustrating some fundamental geometrical principle, the whole covering the subject-matter of Euclid, Book i. There is little or no descriptive matter, but the examples themselves are carefully selected and arranged, so as to lead the pupil by easy steps from experimental quantitative work, in which geometrical truths are discovered, to generalisations based on the knowledge thus obtained. In part i. the examples are entirely practical. In part ii. the work is partly deductive, and this section is intended to supplement the study of pure geometry, and especially to be used in conjunction with Mr. Allcock's "Theoretical Geometry for Beginners." These two parts are followed by a large number of miscellaneous examples and by twenty-six illustrations of geometrical patterns, in which the student finds scope for the application of the knowledge he has obtained. The book will be found very useful in supplementing any elementary text-book which is confined to the abstract reasoning of pure geometry.

A feature of the Algebra by Messrs. Baker and Bourne is the profuse supply of easy and well graduated examples provided at short intervals, enabling even the very backward student who works through them to acquire by almost insensible stages facility in the manipulation of algebraical symbols, and a sound knowledge of algebraical processes. Revision papers are given from time to time, by which he can test his progress. Considerable use is made of squared paper in the graphing of algebraical functions, the solution of equations, and in other ways, thus greatly adding to the interest of the work, and giving a better insight into the nature of the subject. This book is the first instalment of a larger work, to be completed in a second volume. It carries the subject up to the

solution and theory of quadratic equations. The style is attractive, and well suited to beginners. The answers themselves occupy more than fifty pages, and the volume can, if desired, be obtained without these at a reduction in cost.

The movement of reform in the teaching of elementary mathematics has affected trigonometry, and an outcome is seen in the new text-book by Messrs. Borchardt and Perrott, in which the authors have aimed at presenting the subject in a manner suited to the new conditions. Four-figure mathematical tables are provided for general use. Graphs are introduced from time to time. The first endeavour of the authors is to give the student a good working knowledge of the elements of trigonometry, with facility in practical computation. The opening chapters are thus confined to acute angles. Easy problems are solved on heights and distances, but more attention might well have been given to the solution of right-angled triangles under all sorts of conditions, as this is fundamental. In establishing the general formula for angles of any magnitude, the authors have not perceived that a satisfactory account can only be given by introducing the conception of a vector, with the projections of rotation vectors and vector polygons. Consequently, the heart of the matter is missed, and the foundation for future development is not completely laid. The usual formulæ for triangles, and for compound, multiple, and sub-multiple angles are established, the work consisting largely of a mass of trigonometrical transformations. It is not evident why practical applications should be confined to problems in surveying. There are other rich sources to draw from. Thus, an investigation of simple harmonic motion could be made to throw a flood of light on the significance of trigonometrical formulæ, awakening a living interest in dead symbols. This is the first half of the complete text-book. The part which is to follow will contain chapters on De Moivre's theorem, the exponential theorem, trigonometrical series, &c. The book is a fair attempt to teach elementary trigonometry in a more rational manner, but falls far short of the ideal text-book on the subject.

The remarks just made apply generally to the volume by Messrs. Lachlan and Fletcher, except that the whole of the subject-matter, including De Moivre's theorem, &c., is compressed into one small volume, and in order to be suitable for beginners would require considerably to be amplified and supplemented by the teacher.

The "Preliminary Practical Mathematics" by Messrs. Starling and Clarke is the result of experience gained with technical students, who find, when entering the laboratory or workshop, that their mathematical knowledge is not suited to the requirements, and who have not time to enter on an extended mathematical course to supply the deficiency. If the subject were properly taught to boys at school, a book like the present would not be required.

The ground covered in Mr. Kerr's "Constructive Geometry" is substantially that of the first three books of Euclid's Elements, but the treatment of the subject is in accordance with modern ideas, and is very suitable indeed for beginners. Starting with a few concrete objects and using simple drawing appliances for quantitative experimental work, the pupil "is helped to build up ideas about lines, points, triangles, circles, &c., in precisely the same way as that followed in dealing with the elements of physics and chemistry." Deductive reasoning is increasingly employed as the pupil advances, and we think the author is justified in hoping that "there will be as net result an extensive fund of available knowledge on which more advanced work can rest securely, and also such habits of inquiry and thought as will give a stimulus to further study."

The "New School Arithmetic" by Messrs. Pendlebury and Robinson is based on the sixteenth edition of the Arithmetic by the former, the first edition of which was published eighteen years ago. During this time commercial conditions have changed, scientific requirements have advanced, and a reform in the teaching of elementary mathematics has been inaugurated. The authors have aimed at producing a text-book which shall be fully abreast of the times. Thus metric weights and measures are given and used along with British, and these, being introduced at an early stage, afford excellent concrete examples in illustration of vulgar and decimal fractions. The new style of multiplication is used exclusively, and thus at the proper time approximate methods become natural and easy. Squared paper and other graphical illustrations are used with good effect, and algebraical symbols are introduced on appropriate occasions. The present volume deals with money, weights and measures, and examples thereon, with vulgar and decimal fractions, and with the decimalisation of money. The examples are very numerous and well graduated. The style is simple and clear, and altogether this excellent text-book deserves a wide circulation.

OUR BOOKSHELF.

Die Vorgeschichte des Menschen. By G. Schwalbe. Pp. 52+1 plate. (Brunswick: Vieweg und Sohn, 1904.)

THE author of this work is already well known by his writings on *Pithecanthropus erectus*, the Neanderthal skull, and that of Egisheim. The basis of the pamphlet now before us is a lecture delivered by the author at the meeting of the Society of German Naturalists and Physicians, held at Cassel in 1903, but two valuable appendices have been added to the original lecture. The line of argument runs in the main on palæontological and anatomical evidence, though the existence of man in pre-Glacial times is regarded as an established fact. The writer claims for the Neanderthal man a specific distinction from the "homo sapiens" of Linnæus, and would term him "homo primigenius." He traces the relations of this early representative of the human race not only with the *Pithecanthropus erectus*, but with the Dryopithecus and some of the more anthropoid forms of living apes, and in the illustrative plate gives diagrams of the forms of the different skulls. The agreement of the human remains from Spy, in Belgium, with those from the Neanderthal is accepted, and those from the Krapina cave, in Croatia, though varying in the brachycephalic direction, are regarded as belonging to the "homo primigenius." Mr. Schwalbe seems even inclined to accept evidence of the existence of man in Tertiary times. Whether his conclusions can in all cases be adopted without hesitation or not, his arguments are worthy of careful consideration, and the

appendices, which include an extensive catalogue of the literature on the subject of primæval man, will be found to contain a large amount of useful information.

J. E.

Metallurgia dell' Oro. By Ing. Emilio Cortese. Pp. xv+262; 35 incisioni. (Milano: Ulrico Hoepli, 1904.) Price 3 lire.

Metalli Preziosi. By Ing. A. Zinone. Pp. xi+315. (Milano: Ulrico Hoepli, 1904.) Price 3 lire.

NOTHING exactly resembling the Hoepli manuals is published in the English language, though in French the "Encyclopédie scientifique des Aide-Memoire" constitutes a close parallel. The Hoepli series now amounts to 800 little volumes dealing with science, literature, and the fine arts. The method of publishing is useful, and contrasts favourably with the inconvenient system adopted in the old-fashioned encyclopædias with large volumes containing heterogeneous congeries of subjects. The latest additions to the series are neatly bound, well printed with good sized type, and can be carried in the pocket. The book on the metallurgy of gold contains brief accounts of the washing and sluicing of auriferous gravels, and of the crushing and amalgamation of gold ores. There are also chapters on the Plattner and Mears processes of chlorination, on cyaniding, and on the refining and parting of gold bullion. The descriptions are fairly clear and accurate, but some of them deal with antiquated processes. The Newbery-Vautin process, the Crauford mill, and Greenwood's electrolytic process are all described, but on the other hand no mention is made of the use of the lead-zinc couple in the precipitation of gold from cyanide solutions, or of Taverner's lead-smelting process. In the other book, the metals dealt with are silver, gold, and platinum. The properties of these metals and their alloys, and the methods of assaying and treating their ores are briefly described, and the remaining eighty-five pages of the book are devoted to the uses of gold and silver in the arts. Both volumes are supplied with a complete table of contents, but suffer from the absence of indexes.

The Telephone Service: its Past, its Present, and its Future. By H. L. Webb. Pp. 118. (London: Whittaker and Co., 1904.) Price 1s. net.

AN interesting description of the general working of the modern city telephone system is given in the pages of this book. No attempt is made to describe the power plant of the modern telephone exchange, or the details of other parts of the machinery by which an efficient telephone service is maintained, but the general principles of this means of communication are clearly explained, and suggested developments of telephone policy in Great Britain are discussed. Every subscriber who reads the book will be given an intelligent and tolerant view of the telephone service.

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.*]

Magnetic Disturbances and Navigation.

CAN the compasses of modern ships be influenced by magnetic disturbances to such a degree as to imperil navigation? The disaster which on the morning of June 28 befell the Danish s.s. *Norge*, and by which about 600 lives were lost, ought, in the opinion of the present writer, to bring this question to the front. The course of the ship should take her about 25 miles south of Rockall. The last observations, by which position, deviation, and the absence of current were ascertained, were made only twelve hours before the ship struck, and showed nothing extraordinary. It seems impossible to explain the discrepancy between the real position and that of the reckoning on the morning of June 28 without assuming a sudden and considerable alteration of the deviation on the compass.

This view is supported by communications, called forth by the disaster, from two captains, who have, or at any rate think they have, directly observed such alterations. The communications run as follows:—

(1) "A few years ago I (Captain Hveysel, s.s. *L. H. Carl*) was on a voyage from the United States of America to Denmark, following the great circle from Newfoundland to Pentland Firth. About 200 miles west of Rockall I had the position at noon accurately determined by observations of the sun, but as the sky was clear in the dusk, I determined anew the latitude, as well as the longitude, by stellar observations, and found to my astonishment that the ship had gone forward in a direction about 1 point more southerly than calculated according to the reckoning. By observation of the pole star it was in fact ascertained that both the compasses of the ship had acquired a hitherto unknown easterly deviation of 10° to 11°. The weather was fine, but a faint northern light was observed, which I supposed to be the cause of the magnetic disturbance. The course was shaped in accordance with the new deviation, but I continued to take the bearings of the pole star, and towards midnight the compasses were observed to return to their normal deviation, while the aurora disappeared."

(2) "I, Captain F. W. Horner, master of the s.s. *Elixir* of West Hartlepool, while on a voyage from Port Inglis, Florida, to Linhamn, Sweden, between noon June 24 and noon June 25, in the vicinity of the Island of Rockall, found by observation of the sun that the deviation on the compasses had changed 9°, whereby my ship had gone 25 miles out of her course to the north. I was steering to pass 20 miles north of Rockall, and found by observation at noon June 25 that I had passed 45 miles north of it. After passing through the Pentland Firth the compasses again returned to normal."

This last observation has a special interest as relating to the immediate vicinity of Rockall, and to about the same time as the shipwreck of the s.s. *Norge*. Can any of your readers furnish facts of a similar nature?

So far as I have been able to ascertain, disturbances of the declination needle of like duration and intensity are completely unknown, but, to my mind at least, compasses, mounted in steel ships and compensated by powerful magnets, cannot be directly comparable to the needles of a magnetic observatory. Is it possible to explain such temporary deviations of ships' compasses, as appear to have been observed in the cases related above, from the known variations of the earth's magnetism?

AUGUST KROGH.

The Physiological Laboratory, Copenhagen University.

The Great Red Spot on Jupiter.

OWING to very ill-health, I have not been able to make observations of Jupiter during the last few weeks, but have been interested in receiving the results of some other observers. It appears that the great red spot is rapidly accelerating its motion, so that its longitude is decreasing, and with a continuation of this behaviour the spot will ultimately correspond with the position of the zero meridian of system ii. of Crommelin's ephemerides. The present longitude of the marking is about 25°, which is the same as it was in the summer of 1898, so that the mean period of rotation during the last six years has been identical with the rate of system ii., viz. 9h. 55m. 40·63s.

The variations in the velocity of the spot during the past few years have exhibited a curious oscillation, and it will be important to watch the future developments of the object. It would be interesting to see in NATURE during ensuing months some reports from observers as to whether this singularly durable marking maintains its present rapid westerly drift.

W. F. DENNING.

Bristol, September 12.

THE OLDER CIVILISATION OF GREECE: A PREHISTORIC SEA-POWER.[1]

READERS of the articles on the "Older Civilisation of Greece" which have from time to time appeared in the columns of NATURE will remember that the archæological labours of Mr. Arthur J. Evans, F.R.S., Prof. Ludovico Halbherr, Mr. D. G. Hogarth, and Mr. R. C. Bosanquet (not to mention their assistants, of whom Dr. Duncan Mackenzie and Prof. Luigi Pernier are the most distinguished) in the island of Crete have succeeded in disinterring for modern science the remains of an ancient civilisation as highly developed as the contemporary cultures of Egypt and Babylonia, and possibly as old; in any case a thousand years older than the civilisation of Greece which we have learnt to know at our schools and academies—the Greek civilisation of the schoolmasters and the sculptors. Of this prehistoric civilisation (for prehistoric it still remains, since we cannot yet read its written records) the first remains were found by the famous Schliemann at Mycenæ and Tiryns, hence the use of the term "Mycenæan" to describe it. The excavations in Crete have of late years very considerably modified our conceptions of its character; we see now that the chief seat of its development was not the continent of Greece, but the great island of Crete, and that the two most important remains of its Cretan phase were the great stone palaces of Knossos and Phaistos, which have been excavated by Dr. Evans and Prof. Halbherr respectively.

Now it is evident that the whole Mycenæan civilisation did not pass away without leaving some trace of its greatness and power upon the minds of the semi-barbarous tribes from the north who overthrew it, and afterwards built up the renascent "classical" culture of Greece upon its ruins, just as the English built up the modern renascent Roman civilisation of England on the ruins of the Romano-British culture which they destroyed. Just as traditions of the greatness of the Romans remained in the minds of the English, so, but to a much greater extent, traditions of their "Pelasgian" forerunners remained in the minds of the later Greeks and combined with their own "Aryan" tales to form the legendary history of early Greece. A considerable proportion of the Greek legends—the Wars of Troy and of the Seven against Thebes, the stories of the Atridæ and of the Minyæ, &c.—are undoubtedly altered reminiscences of the prehistoric period of high civilisation to which the remains discovered at Mycenæ, at Orchomenos, at Knossos, and at Phaistos belong. Among these legends, which certainly contain a substratum of historical truth, those of the Thalassocracy of the Cretans under the sway of the great and wise Minos are the most important. It is certain that the palace discovered by Mr. Evans at Knossos is the veritable Labyrinth of the Minotaur; one may believe in the Labyrinth without being accused of also believing in the Minotaur, and if one believes in the Labyrinth one also believes in the magnificence and power of its builders, whether their names be Minos and Dædalus or not. Probably their names were not really in the least like Minos or Dædalus, but it is evident that these appellations signify, the one the powerful prehistoric dynasty of Knossos, the other the skilled craftsmen who made for them the beautiful works of art which we can admire in the Museum of Candia, and which are photographically reproduced in the pages of the "Annual of the British School at Athens."

The most characteristic feature of the Knossian or "Minoan" power in legend is the fact that it was a sea-power. This is always insisted upon. Cretans raid the Attic coast, found colonies in Sicily and at Miletus, and so on. A power of the calibre of that which is revealed to us by the Cretan excavations can never have confined its operations to the isle of Crete alone. And the evidence of over-sea connections, with Egypt and with the continent of Greece, is so strong that there can be little doubt that the legends are right, and that Minoan Crete held a thalassocracy, was a great sea-power. Sea-power means the foundation of colonies, and apparently Minoan Crete was no exception to this rule. It may be that the coast settlement of Paláikastro, beyond Sitía at the extreme eastern end of the island, was a Minoan colony established on the non-Minoan, possibly hostile, shore of the Eteokretans, though it is only fair to say that Mr. Bosanquet is not in favour of the theory of the predominantly non-Minoan character of the Sitía country in Minoan days. At Phylakopi, in the island of Melos, the nearest of the Cyclades to Crete, has been

FIG. 1.—Shrine of snake-goddess with marble cross as central cult object. Conjectural arrangement. (From "The Annual of the British School at Athens.")

1 "The Annual of the British School at Athens," No. ix., 1903-4. Pp. x+422, and Plates. (London: Macmillan and Co., Ltd.) Price 17s. net. "Excavations at Phylakopi in Melos." Hellenic Society Supplementary Paper, No. 4. Pp. xv+280, and Plates. (London: Macmillan and Co., Ltd.) Price 30s. net.

discovered a strongly walled settlement of indubitably "Minoan" character, superimposed upon the ruins of earlier, no doubt native, towns; that this was a Cretan over-sea colony there can be little doubt.

The excavations which have revealed to us these striking confirmations of the Greek legend of the

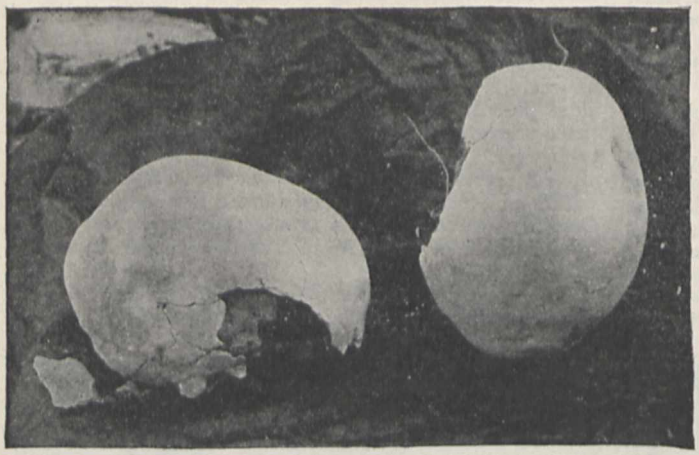

FIG. 2.—Two of the ancient crania exhumed at Hagios Nikolaos. (From "The Annual of the British School at Athens.")

Minoan thalassocracy have been carried out by the British School at Athens during the last eight years under the control of its successive directors, Mr. Cecil Smith, the present keeper of Greek and Roman antiquities in the British Museum, Mr. D. G. Hogarth, and Mr. R. C. Bosanquet. The energy of the British School at Phylakopi and Paláikastro, combined with the remarkable results achieved by Dr. Arthur Evans at Knossos, has largely helped to win for England that foremost position in practical Greek archæology which she holds at present. For not even our friendly rivals in Germany can for a moment dispute the fact that England and Italy are *facile principes* in Greek archæology at the present day. Germany is only tardily following in our footsteps with the excavations at Orchomenos, and has not even yet secured for herself a site for exploration in Crete, while France seems hopelessly wedded to classical traditions, and has no thought for the extraordinary prehistoric civilisation, twin-sister it would almost seem to that of Egypt, which is revealing itself in Crete.

The chief publication of the year dealing with these English discoveries is, as usual, the "Annual of the British School at Athens." The volume for 1904 contains Dr. A. J. Evans's annual report on Knossos, and Mr. Bosanquet's report on Paláikastro. Dr. Evans tells us how his work in the Labyrinth still goes on, and seems to be no nearer completion. Discoveries of the highest historical importance still continue to be made. An extraordinary light has been thrown upon the religion of Pelasgian Greece by the discovery of the images of a snake-goddess by Miss Boyd (American excavations) at Gournià, half-way between Knossos and Paláikastro, and by Dr. Evans at Knossos, in the latter case in conjunction with a *cross* as central cult-object. What is to be made of this? Any day's work, any turn of the spade, may turn up something extraordinary. And these same snake-goddesses of Knossos are made of a fine varicoloured glazed faïence, like that of Egypt. That the Minoans derived this idea from Egypt is certain. Other objects of the same glaze were found, shells especially; the colour of the glaze of many of these shells is that of the rare Egyptian glazed faïence of the dynasties of the Old Empire, between B.C. 4000 and B.C. 2000. This typical colour is a light blue, radically different from the shining dark blue of the twelfth dynasty or the beautiful colours of the blue glazed pottery of the eighteenth. It is not, however, very different from the light blue of the twenty-sixth dynasty. The reason is not far to seek; the twenty-sixth dynasty artists archaïsed here as in greater matters; they imitated the colour of the earliest faïence. The date of the Minoan palace of Knossos is between the epoch of the twelfth dynasty and that of the eighteenth; the date of the old light blue faïence is earlier, between B.C. 4000 and the twelfth dynasty. It was this faïence that the Minoan potters imitated. The conclusion as to the date at which Greek civilisation first began to borrow ideas from that of Egypt may seem extraordinary; but Mr. Evans's diggings at Knossos have already produced so many extraordinary things that we are prepared for more.

We do not expect the same remarkable discoveries from Mr. Bosanquet's diggings at Paláikastro. It is a poorer site, and it is not the Labyrinth of Minos. Enough has, however, been found more than to maintain the interest of former years of excavation, and there is little doubt that here was a Minoan settlement like that of Phylakopi. Two new features at Paláikastro are the remains of primitive burials from the cave of Hagios Nikólaos and the remarkable ossuaries at the sites of Roussolakkos and Patema, and the great hoard of votive terracottas found by Messrs. Myres and Currelly on the hill of

FIG. 3.—External face of great wall, showing revetment on the right and bastion in the distance. (From "Excavations at Phylakopi in Melos.")

Petsofà or Tsofàs, south of Paláikastro. The skeletons are usually in the contracted position characteristic of the Neolithic race of the Mediterranean; they show small stature (average 1.625 m.) and dolichocephalic head-form. Mr. Duckworth, who describes them, says "it seems that the early Cretans anticipated in head-

form and stature the proportions assigned to the 'Mediterranean race' [of Sergi], and thus can be described as the earliest known representatives of that race" (p. 354). It is, however, confusing to speak of the Paláikastro people as "anticipating" the Mediterraneans in any way; the Paláikastro skulls, though no doubt a few hundred years older than "those discovered at Zakro [on the coast south of Paláikastro] and described by Boyd Dawkins, and those from Erganos [a Mycenæan site in a valley running up from the Pediada plain into the Lasíthí mountain-system near the Aphendis Sarakinos] described by Sergi" (p. 353), are of Bronze age date, while the Neolithic Mediterraneans belong to Sergi's race as much as the Mycenæans; the Paláikastro people *were* "Mediterraneans" (as Mr. Duckworth says on p. 349)—they did not anticipate them.

The Petsofà find of votive terracottas is paralleled by the very similar pocket of votive female figures and models of female breasts, &c., phalli, and figures of cows, of red pottery and blue glazed faïence, found by Prof. Naville and myself during the past season in the eighteenth dynasty dust-heap of Queen Hatshepsu's temple at Deir-el-Bahari, in Egypt; a number of these votive figures were exhibited at the annual show of the Egypt Exploration Fund at University College, Gower Street, in July.

The pottery from Paláikastro is discussed by Mr. R. M. Dawkins, who publishes a very fine "filler-vase" (p. 311) of the well known Mycenæan type. For a parallel Mr. Dawkins refers to a representation of a vase in the tomb of Rekhmara, at Thebes in Egypt, published by Mr. W. M. Müller in his "Asien und Europa," p. 340, and by me in "The Oldest Civilization of Greece," frontispiece. This representation of the vase in question, for which not Mr. Müller, but the great Champollion is responsible, is, however, inaccurate. Mr. Dawkins would have found a better parallel from the tomb of Rekhmara in last year's "Annual of the British School," p. 171. Mr. Dawkins also contributes a most interesting account of a visit to the rather remote island of Karpathos, between Crete and Rhodes, which should be of interest to geographers and anthropologists. To anybody who has seen them from the Eteokretan heights above Sitía, or from the shores of Grandes Bay by which Paláikastro lies, the islands of Kasos and Karpathos offer a most alluring invitation; but it is not everybody who can spare the time to accept it. Mr. Dawkins has been able to do so, and is lucky.

The excavations at Phylakopi, in Melos, were conducted by the School before those at Paláikastro, in Crete, were begun. They are not yet completed, the work at Paláikastro having been taken up with the idea of returning to Phylakopi at some future date. It is to be hoped that this aspiration will be fulfilled, for Phylakopi is among the most interesting of "Mycenæan" sites. The excavations were carried out from 1896 to 1899, Mr. Cecil Smith being in command during the first two years, Mr. Hogarth in the third, and Mr. Mackenzie, now Mr. Evans's assistant at Knossos, in the fourth. Mr. Mackenzie was present during the whole four seasons, thus supplying the "element of continuity" in the excavations. Each of these gentlemen has contributed his quotum to the combined work which has been issued for the school by the Society for the Promotion of Hellenic Studies under the direction of an editorial committee, composed of Mr. Bosanquet, Mr. E. A. Gardner, and Mr. G. F. Hill, of the British Museum. Messrs. Arthur Evans, Bosanquet, G. C. Edgar, F. D. Atkinson, and F. B. Welch have also contributed to the volume.

The result is a remarkably valuable and well got-up book, with an extremely good series of illustrations. Among articles which are all of equal value and interest it is invidious to direct special attention to any in particular, but while Mr. Bosanquet's on the wall-paintings and Mr. Edgar's on the pottery are of special interest to "Mycenæologists," those of Mr. Bosanquet on the early Ægean trade in obsidian, which seems to have radiated from Melos, and of Mr. Mackenzie on the general historical relations of the successive settlements, especially in connection with the Minoan culture, which Mr. Mackenzie has had such unequalled opportunities of observing in the course of his work with Mr. Evans at Knossos, will be of more general interest, and should be carefully noted by all students of early culture-development. The famous fresco of the flying-fish, the most remarkable example of Mycenæan art found at Phylakopi, is published in colour on Plate iii.; as a delineation of the animal it is remarkably accurate, and as a design most admirable.

FIG. 4.—The site from north-east. Beach of boulders in the foreground. (From "Excavations at Phylakopi in Melos.")

Enough has been said to show that this year's record of the annual progress of the discovery of the older civilisation of Greece has in no way fallen behind its predecessors in interest. H. R. HALL.

NOTES.

ON Saturday last, September 10, the *Discovery* arrived at Portsmouth with the members of the British Antarctic Expedition. On Sunday Captain Scott received a telegram from the King offering His Majesty's congratulations on the success and safe return of the explorers. The King has directed that a new medal for service in the Polar regions shall be struck and granted to the officers and crew of the *Discovery* in recognition of the successful accomplishment of their enterprise. Commander Scott has been promoted to the rank of captain in the Royal Navy; and the nation's thanks are due to him, the officers, scientific staff, and crew of the *Discovery* for the successful way in which they have maintained the credit of our country in the records of geographical discovery. The first news of the expedition after the departure of the *Discovery* from New Zealand in

December, 1901, was brought by the relief ship *Morning*, which arrived at Lyttelton in March, 1903. From the information then received, described in NATURE of April 2, 1903 (vol. lxvii. p. 516), it was evident that the expedition had already achieved great success, both in the way of exploration and of scientific observation. Further details of the first year's work of the expedition, especially with regard to the great southern ice barrier and the nature of the lands discovered, are contained in Captain Scott's official report communicated to the presidents of the Royal and the Royal Geographical Societies, summarised in these columns on July 30, 1903 (vol. lxviii. p. 307). Upon the return of the *Discovery* to Lyttelton at the beginning of last April, accompanied by the relief ships *Morning* and *Terra Nova*, it became known that many specimens of great scientific interest had been collected, including fossil remains of dicotyledonous plants from an altitude of 8000 feet. The material thus accumulated, as well as the continuous magnetic records and other observations in terrestrial physics, will be of the greatest value to science, and the study of it will engage the attention of naturalists and physicists for some time to come. The specimens brought home include the emperor penguin and other rare Arctic birds and their eggs, geological and other specimens, a large number of photographs of Antarctic scenes, some of which were taken by moonlight; and a set of coloured drawings of parhelions observed when the sun rose.

THE report of the council of the Society of Chemical Industry was presented to the annual general meeting opened in New York on Thursday, September 8. From this report we learn that the number of members on the register on July 31 was 4134, as compared with 3050 at the previous annual meeting. The council urges that Government, through a department, should be in closer touch with commerce and industries. In Germany the functions of the Ministry of Commerce comprise the control of "all matters affecting handicrafts," and to it, as a consultative body, is attached the technical committee for industry, which studies the scientific progress of industries, and keeps the minister in touch with them. America has recently established a department of commerce and labour, and France has had a Minister of Commerce for some years. The council two years ago appointed a committee to cooperate with members of Parliament and others who are in favour of this reform. The council has given its support to a petition asking the Treasury that the National Physical Laboratory may be placed in a position to do its important international work by means of a grant for capital expenditure and an increased annual subvention. Among the more important researches carried out by the laboratory during the past year may be mentioned those on pure iron-carbon alloys, certain nickel-steel alloys, mercury standards of resistance, a comparison of thermometers up to 1100° C., and measurements of the specific heat of superheated steam up to a pressure of 200 lb. to the square inch. The society's medal, founded in 1896, and awarded by the council once in every two years for conspicuous service rendered to applied chemistry by research, discovery, invention, or improvements in processes, has this year been awarded to Prof. Ira Remsen, president of the Johns Hopkins University of Baltimore.

A LARGE party of members of the Liége Association of Engineers, the leading technical society in Belgium, visited London on September 12 and 13. On September 12 they proceeded to Teddington and visited the National Physical Laboratory, where they were received by Sir Edward Carbutt on behalf of the executive committee. On September 13 they were entertained at dinner at the Hotel Cecil by the Iron and Steel Institute. Mr. E. Windsor Richards, who was president when the institute visited Liége in 1894, occupied the chair, and an eloquent speech of welcome was delivered by Sir James Kitson, past-president of the Iron and Steel Institute, and ably responded to by Mr. Jules Magery, the president of the Belgian society.

THE second International Philosophical Congress was held at the University of Geneva under the presidency of M. Ernest Naville on September 4–8, and was attended by 500 members, representative of every school of philosophic thought in Europe. We learn from the *Times* that the following papers were read:—Prof. Boutroux, of l'Institut Paris, on the *rôle* of the history of philosophy in the study of philosophy; Profs. Stein (of the University of Bern) and Gourd (of the University of Geneva), the definition of philosophy; Prof. Windelband (of Heidelberg), the present task of logic and philosophical inquiry in relation to natural science and culture; Profs. Vifredo Pareto (of Lausanne) and De Greef (of Brussels), the individual and society; and Profs. Reinke (of Kiel) and Giard (of Paris), neovitalism and finality in biology. At the sectional meetings the subjects under discussion were the history of philosophy, general philosophy and psychology, applied philosophy, logic and philosophy of the sciences, and history of the sciences.

IN connection with the reception given by the United States Naval Observatory to the eighth International Geographic Congress at Washington on Thursday, September 8, a special set of time signals was sent over the Western Union Telegraph Company's system from Washington to England for transmission over the lines of the Government, the Eastern Telegraph Company, and the Great Northern and Western Telegraph Companies to observatories in various parts of the world. The object of the signals was to mark the actual passing of midnight at Washington, and accompanying the signals was the following message:—"The eighth International Geographic Congress now in session in Washington sends with this midnight signal its greeting to the nations of the world through the courtesy of the various telegraph and cable companies." The *Times* states that the observatories at the following places sent complimentary responses in most cases immediately on receipt of the foregoing messages and signals:—Greenwich, Pulkowa (Russia), Helsingfors, Madrid, Lisbon, Rome, Madras, Mauritius, Cape Town, Melbourne, Adelaide, Sydney, Wellington, N.Z., Rio de Janeiro, and Cocos. It was hoped that the signals would have a favourable influence on the movement to secure the universal adoption of standard time, based on the meridian of Greenwich.

Science announces that the Department of Agriculture at Washington is making definite arrangements concerning the work which will be carried on with the Guatemalan ants found by Mr. O. F. Cook in Guatemala to kill the cotton boll weevil. Mr. Cook has authority under the chief of the Bureau of Entomology to carry to completion the study of the life-history of the Guatemalan ant, and of such other species of ants as may be involved, in order properly to understand the life-history of this species. He will also direct and superintend the further introduction of the *kelep* ant from Guatemala if the same is deemed necessary, and will supervise and carry out the work connected with the colonisation of the ant in the southern United States.

AN exceptional rainfall in Cuba is reported in the *Times* of September 10 as having occurred on June 13. Mr. W. A. Wilson, of the Public Works Office at Santiago,

writes that the storm lasted for three hours, and was accompanied with almost continuous thunder and lightning, and he estimates that at least 12 inches of rain fell during that time. Bridges and houses were washed away, and about a hundred lives were lost in that locality. The storm extended over a considerable area, probably 200 to 300 square miles, and the Guaninicum and Platanillo Rivers each rose 33 feet. Mr. Wilson gauged the fall for an hour and a half, during which time nearly 7 inches were measured. Santiago is a station of the U.S. Weather Bureau; we shall therefore hope to receive a fuller account of the storm. In looking through their last published report (1902–3), we do not find any figures equalling the above, but in Symons's "British Rainfall for 1902" 3·50 inches are recorded in one hour. The most noteworthy facts appear to be the duration of the great intensity of the fall and the large area over which the storm occurred.

THE Meteorological Council has recently issued part I. of "Climatological Observations at Colonial and Foreign Stations." In the preface Dr. W. N. Shaw states that the council has contemplated for some time the issue of summaries of the observations which they receive from the Foreign Office, the Colonial Office, or directly from the observers in various British colonies and dependencies, but that it has been unable hitherto to carry out the preparation of the observations for the press. Mr. E. G. Ravenstein, who was chairman of a committee appointed by the British Association at the Cardiff meeting in 1891 for the collection and discussion of observations from tropical Africa, has, however, been good enough to put together the observations for a large number of stations, and to superintend the preparation of the summaries. These have now been issued by the Meteorological Council for the years 1900–2, with summaries for previous years, and form a very valuable contribution to the meteorology of that part of the world. The observations refer chiefly to stations in the Egyptian Sudan, British East and Central Africa, and Rhodesia. The volume is accompanied by useful sketch maps showing the positions of the various stations.

DR. F. M. EXNER contributed a useful paper to the Vienna Academy of Sciences (*Sitzb.*, Heft x., 1903) on a relation between the distribution of air pressure and amount of cloud, based on an examination of the mean values of twenty years' observations. The question to be solved was with what distribution of pressure, with a west wind of given strength, has Vienna a certain amount of cloud or rainfall. The result of the investigation showed that when the air flowed from an area of steep barometric gradients to one of slight gradients, it was accompanied by bad weather, and *vice versâ*. The reason is that in the first case more air flows towards the locality than flows away from it horizontally, so that a portion of it finds its way to the upper strata, while in the second case the opposite occurs. The same rule would apply not only to a west wind, but would hold good for wind from any quarter. The paper is illustrated by a series of charts.

MESSRS. S. HIRZEL, of Leipzig, announce a new publication bearing the title *Jahrbuch der Radioaktivität und Elektronik*, to be edited by Dr. J. Stark, of Göttingen. Each volume will be issued in four quarterly parts.

THE mathematical and scientific section of the Imperial Academy of Sciences, Vienna, announces a prize of 2000 krone to be awarded for the best thesis embodying "an improvement in our knowledge of the hysteresis of dielectrics." The competition will close on December 31, 1906.

No. 16 of the *Physikalische Zeitschrift* contains several papers dealing with radio-activity. F. Paschen shows that when the kathode rays produced by radium are caused to impinge from above upon a photographic plate placed film downwards on a small sheet of platinum, an intense blackening is produced in the negative which corresponds in outline with the metal. That this effect is due to a secondary radiation, and is not caused merely by reflection of the kathode rays from the platinum, appears to be proved by the fact that when these rays are directly transmitted through a sufficiently thin plate of the metal, the darkening beneath the metallic film is much more intense than elsewhere. It is the γ rays which seem to be mainly responsible for the secondary radiation. Mr. H. A. Bumstead has carefully investigated the nature of the radio-activity induced in a negatively charged wire by exposure to the atmosphere. He concludes that the atmosphere contains principally the emanation of radium, but that the thorium emanation is also present to an extent varying largely with conditions such as the temperature and stillness of the air. On the other hand, Dr. E. F. Burton considers that the radio-active emanation which is evolved on heating raw petroleum is due solely to radium, and that a small quantity of radium itself is present in the oil. Miss C. Böhm-Wendt describes measurements which show that the amount of ionisation produced by polonium in different gases is independent of the nature of the gas. In this respect, therefore, polonium resembles radium.

IT has long been a controversial question whether by the action of heat alone the line spectrum of gases can be produced. In the July number of the *Atti dei Lincei* R. Nasini and F. Anderlini endeavour to give a definite answer to the problem. On subjecting the vapour of iodine to a high temperature in a carbon tube heated in an electric furnace, they found that at slightly above 1000° an emission spectrum is produced which is the inverse of the usual absorption spectrum of iodine vapour. Similarly nitrogen at temperatures above 3000° gives an emission spectrum in which the principal lines characteristic of the element are visible. Under the conditions used it is probable that electrical influences were excluded, and that the spectra obtained were due solely to the high temperature employed. In the same number of the *Atti* L. Vanzetti has studied the electrolysis of glutaric acid in order to decide whether the dibasic aliphatic acids are capable of being converted in this way into polymethylene hydrocarbons, and whether the synthesis of a closed ring can thus be effected. The acid gave, however, only ordinary propylene, not a trace of trimethylene being formed.

WE have received copies of two interim reports issued by the Engineering Standards Committee. One of the publications contains British standard tables of copper conductors and thicknesses of dielectric; the other includes the British standard specification for tubular tramway poles. The tables and specification are to be regarded as final, and they will be embodied in the final report of the Engineering Standards Committee, which will combine all specifications. The tables dealing with copper conductors give the British standard sizes of stranded conductors for electric supply, and separate tables are concerned respectively with large, intermediate, and small sizes. Other tables provide British standard radial thicknesses for jute or paper dielectric, lead and armour, for underground cables, and British standard radial thicknesses for rubber dielectric, for lead sheathing and armouring. The specification for tramway poles gives full particulars as to construction, length, length of section, outside diameters, minimum thickness, &c., and also as to

what tests should be applied to the poles. As the preface to the specification says, a standard specification having now been arrived at as the result of the joint labours of the committee and the makers, it is hoped that, in future, the standards recommended by the committee will be universally adopted by all engineers engaged in designing and installing electrical tramways throughout the British Empire.

THE contents of the June number of the *American Naturalist* are chiefly biographical and botanical, Dr. R. T. Jackson contributing an account (with a portrait) of the life and work of the late C. E. Beecher, while Dr. B. M. Davis continues his studies on the plant-cell, and Mr. F. C. Lucas illustrates diagrammatically the range of variation displayed by the blossoms of the common cone-flower (*Rudbeckia hirta*).

THE entomological division of the Biological Laboratory of Manila has issued an illustrated *Bulletin* of fifty-eight pages, by Mr. C. S. Banks, the Government entomologist, on insects affecting the cacao, intended specially for the benefit of cultivators of that valuable crop in the Philippines. Every part of the cacao plant, from the root to the fruit, has its particular enemies, black ants and cicadas attacking the roots, while beetle-grubs bore into the trunk, and various Coccidæ and aphides damage the fruit. Fortunately the ravages of certain of these scourges are somewhat checked by other insects which prey upon the species damaging the cacao. Much further work is required before the whole history of cacao-hunting insects can be known, and the best means of checking their ravages devised.

WE have received from the publishers, Messrs. Asher and Co., Bedford Street, W.C., a specimen of a series of fifty coloured biological diagrams, reproduced from the German issue of Messrs. Schröder and Kulls, but with the explanatory legends in English. The plates are 34 by 42 inches in size, are printed in from six to eight colours, and are sold at 3*s*. each. The one with which we have been favoured illustrates the structure and life-history of the cockchafer, with comparative studies of other beetles. It is admirably adapted for school purposes. Judging from reduced photographic reproductions of other diagrams, we think those devoted to invertebrates are superior to those illustrative of mammals, so far as drawing is concerned; but this is a common feature in German zoological art.

IN the September issue of the *Quarterly Journal of Microscopical Science* Prof. E. R. Lankester re-publishes his valuable and profusely illustrated article on the structure and classification of the Arachnida from the tenth edition of the "Encyclopædia Britannica." One of the points emphasised in this communication is the affinity of the king-crab (Limulus) and the trilobites to the Arachnida rather than to the Crustacea; and in summarising the evidence for the arachnid nature of the former, the author alludes to the interesting discovery by Mr. Pocock of a rudiment of the seventh segment of the scorpion-limb in Limulus, thus bringing the two genera very closely into line. Another interesting feature to which special attention is directed is the mode of evolution of the "lung-book" of the scorpion from the "gill-book" of the king-crab, which appears to be a unique phenomenon. Among the other contents of the number in question may be mentioned two papers by Prof. W. B. Benham on new worms from New Zealand, and one by Dr. H. J. Hansen on new parasitic copepod crustaceans.

PARTS iii. and iv. of vol. xlv. of *Smithsonian Miscellaneous Contributions* contain an important paper by Mr. M. W. Lyon on the hares, rabbits, and picas, illustrated by a number of figures of their comparative osteology and dentition. Needless to say, the old Linnean genus Lepus is much subdivided, and, unfortunately, the generic and subgeneric divisions adopted by the author by no means coincide with those proposed a few years ago by Dr. Forsyth Major in the *Transactions* of the Linnean Society—a notable divergence being the generic separation of the South African thick-tailed hare from the rabbit. Owing to the complexity of the classification adopted, some of the species of Leporidæ cannot at present be definitely placed, and are therefore, strictly speaking, without subgeneric names. This will, however, be remedied in the course of time, and there is no doubt whatever that the present memoir—whether or no its proposed scheme of classification be adopted in its entirety—is an important contribution towards the right understanding of an exceedingly difficult group of mammals.

A SERIES of Jurassic ammonites from Echizen and Nagato in Japan has been described and figured by Prof. Matajiro Yokoyama (*Journ. Coll. Sci. Tokyo*, vol. xix., art. 20). The strata in the province of Echizen comprise a series of shales and sandstones, mostly of fresh-water origin, but divisible into a Lower or Ammonite bed, a Middle or Plant bed, and an Upper or Cyrena bed. The Ammonites include several new species of Perisphinctes, all more or less allied to foreign Lower Oxfordian forms, and one species of Oppelia, which exhibits a distant relationship to *Oppelia nobilis* of the Tithonian. The strata which have yielded Ammonites in Nagato consist of clay-slates, so that the fossils are much compressed. Species of Hildoceras, one of which is near to *Am. Levisoni* (of Wright); of Harpoceras, near to *A. lythensis* and *A. exaratus*; of Cœloceras, near to *A. fibulatus*; and of Dactylioceras, near to *A. annulatus*, indicate that the Nagato slates belong to the Lias, and probably to the upper part of it.

SOME useful hints on the practical development of a farm wood-lot are given in a *Bulletin* of the Hatch Experiment Station of the Massachusetts Agricultural College, issued last May. The products required in this particular case were fire-wood, fencing posts, and lumber for making fruit boxes, besides which some poles and more valuable timber were obtained. The writer, Mr. F. A. Waugh, recommends larch for posts and chestnut and hickory for lumber. The illustrations added are numerous and well chosen.

THE formation of root-hairs in the vascular cryptogams and flowering plants has been studied by Mr. R. G. Leavitt, and his account, which is published in the *Proceedings* of the Boston Society of Naturalists (April), contains several points of interest. In the case of lycopods, horsetails, and a few ferns, the trichoblasts are determinate, but in all dicotyledons, except the Nymphæaceæ and most of the true ferns, root-hairs may arise from any external cell. Of monocotyledons, the Liliifloræ and Spadicifloræ generally conform to the latter type, but in the Helobieæ, Glumifloræ, and Enantioblastæ the root-hairs develop from definite cells.

THE annual report of the Botanical Department of Trinidad for the year ending March 31 has been received. The superintendent, Mr. J. H. Hart, states that he has succeeded in raising seedling sugar canes in Trinidad which compare with the best varieties obtained in Barbados, Antigua, and elsewhere. It appears that owing to the practice of cutting the plants annually in May, the seed production and the sucrose content are reduced, so that the experiment will be tried of allowing plants for seed to remain over for a longer period. The plantations of

Balata, *Mimusops globosa*, and of the imported timber trees, Honduras mahogany and African mahogany, *Kasya senegalensis*, are growing freely

FOR the forthcoming new edition of the "Imperial Gazetteer of India," Sir J. D. Hooker has written a chapter on the flora of India, which is prefaced by an introductory summary. With the authority of the Secretary of State for India, this chapter has been issued in an advanced form, and the summary is reprinted in the *Journal of Botany* (August). In the same number an account will be found of certain changes which will be proposed at the forthcoming congress of botanists to be held at Vienna in June, 1905, in connection with the rules which govern botanical nomenclature. The three lists of suggestions here given take the form of alterations in, or additions to, the Paris code, and have been drafted respectively by British botanists of the British Museum, American botanists of the Gray Herbarium, and a group of Italian botanists.

THE latest addition to the Manueli Hoepli is a handbook dealing with artisan dwellings, by the engineer Effren Magrini, of Turin. In the same series Dr. Guido Sandrinelli has issued a new and completely revised edition of the manual of the late Pietro Gallizia on strength of materials and applied elasticity. It deals with calculations of strains and stresses in beams and other structures, and allied problems of use to the practical engineer.

No. 5 of the *Bulletin* of the Belgium Academy of Sciences contains an account by A. de Hemptinne of a remarkable electrolytic synthesis of stearic acid from oleic acid. This acid, when subjected in an atmosphere of hydrogen to the discharge of a Tesla transformer, combines with the gas to form principally stearic acid. In No. 6 of the *Bulletin* is a description of the preparation and properties of a number of fluorine-substituted amines. These substances are remarkable because of their extraordinary stability as compared with the corresponding chloro- and bromo-derivatives, which, as a rule, decompose rapidly at the ordinary temperature.

To the *Smithsonian Miscellaneous Collections* (vol. xlv., parts iii. and iv.) Prof. F. A. Lucas contributes an account of a nearly perfect skeleton of a pavement-toothed iguanodon (Trachodon or Claosaurus). The edentulous predentary and premandibular bones of the iguanodont dinosaurs are considered by the author to have been sheathed in horn, and thus to have formed a beak adapted for nipping off the branches or herbage on which these reptiles fed. Among other contributors to the same part are also Messrs. Jordan and Snyder, who describe several new deep-water fishes from Japan. These include a shark of the genus Pristiurus, as well as one of Pseudotriacis, and likewise a new genus, Trismegistus, allied to Liparis. *Trismegistus owstoni*, as the third of these new species is called, is certainly a very remarkable fish, somewhat like a sole in shape, although, of course, bilaterally symmetrical, with the skin dotted with prickles supported on broad bases, so as to recall inverted drawing-pins.

IN the August number of the *American Journal of Science* Mr. Bertram B. Boltwood records observations which indicate that the quantities of radium present in several uranium minerals, which have been examined, are directly proportional to the quantities of uranium contained in the minerals. This is perhaps to be regarded as experimental evidence in favour of the suggestion that radium is formed by the breaking down of the uranium atom.

IN the August issue of the *Annales de Chimie et de Physique* is a contribution by Messrs. Moissan and Rigaut on the use of metallic calcium in the preparation of argon. It is shown that the last traces of nitrogen, which are not so easily removed by a heated mixture of lime and metallic magnesium, are readily absorbed by passage of the gas over a small quantity of metallic calcium. An apparatus is described in which argon can be continuously produced at the rate of a litre every twelve hours.

SOME interesting experiments relating to the electrolytic reduction of carbonic acid are described by Messrs. Coehn and Jahn in the *Berichte der deutschen chemischen Gesellschaft* (vol. xxxvii. p. 2836). The reduction cannot be effected in acid solutions or in solutions containing the normal carbonates, but takes place readily in bicarbonate solutions. From this the authors conclude that the reducing action is limited to the bicarbonate ion, and that the carbonate ion and the undissociated carbonic acid molecule are not reducible. The reduction only takes place at those electrodes at which hydrogen is discharged at a considerable over-voltage, and the product of reduction is formic acid.

WE have received a copy of the report and recommendations presented to the Pharmacopœia Committee of the General Medical Council by Prof. Wyndham R. Dunstan and Mr. H. H. Robinson with reference to the tests for the detection of arsenic in the drugs of the British Pharmacopœia. It is found that the test proposed by Mayençon and Bergeret in 1874, if performed under certain conditions, is best adapted to the purpose. This test depends on the production by arseniuretted hydrogen of a stain on paper soaked in mercuric chloride. The method possesses the advantage of requiring only such a degree of purity in the acid and zinc as is to be found in purchaseable materials, and thus avoids the special purifications involved in the Marsh-Berzelius test. The stain decided on as the standard of comparison is that given by 0·012 milligram of arsenic.

OUR ASTRONOMICAL COLUMN.

RE-DISCOVERY OF ENCKE'S COMET.—A telegram from the Kiel Centralstelle announces the re-discovery of Encke's comet at the Koenigstuhl on September 11. The position of the comet at 13h. 16·9m. (local M.T.) was

R.A. = 1h. 46m. 16s., dec. = +25° 24′.

These positions seem to be very slightly lower than the apparent positions given in the ephemeris reproduced in these columns on September 8. As this is the second comet of this year, it will be designated 1904 *b*.

DR. COMMON'S 60-INCH REFLECTOR.—In *Circular* No. 83 of the Harvard College Observatory, Prof. E. C. Pickering announces that, thanks to the generosity of an anonymous donor, who, unconditionally, gave twenty thousand dollars to the observatory, and to the intermediary services of Prof. Turner, the observatory has been able to purchase the well known 60-inch mirror which was made by the late Dr. Common.

Arrangements are being made to transport the mirror to Cambridge (Mass.) as soon as possible, and, when mounted, it will be used to complete the photometric survey of the heavens which has been so thoroughly—so far as means would permit—prosecuted at Harvard. With an instrument of this aperture it will be possible to measure the light of the very faintest stars known.

Prof. Pickering states that Mr. T. A. Common, from whom the mirror was purchased, let them have it on such favourable terms that he may fairly be regarded as having contributed a large portion of the cost.

VARIABLE STARS IN THE LARGE MAGELLANIC CLOUD.—Although the Magellanic clouds have been looked upon as centres of extraordinary physical conditions, the congregation of variable stars within their limits has hitherto remained unnoticed.

In *Circular* No. 79 of the Harvard College Observatory, however, it was announced that an examination of the Harvard photographs showed that the small cloud contained numerous variables. Consequently, an examination of the photographs of the large cloud was made, and resulted in the discovery of 152 new variable stars within its boundaries. A catalogue of these, giving their positions (for 1900·0), their magnitudes, and the magnitude-range of their light-variations, is published in No. 82 of the Harvard College Observatory *Circulars*.

All these variables have short periods, and seem to be arranged in definite groups, the most remarkable of which begins near N.G.C. 1850, and extends towards a point about one degree south of N.G.C. 2070. This group contains more than half the stars observed, and the included stars are remarkable for their faintness and for the small range of their variations.

THE SUN'S ANTI-APEX.—Mr. J. E. Gore sends the following remarks upon Prof. Kobold's study of the sun's proper motion, mentioned in last week's NATURE (p. 459):—"Prof. Kobold gives the position $A=159°{\cdot}6$, $D=-54°{\cdot}7$, or R.A. 10h. 38·4m., $\delta=-54°{\cdot}7$, and says the point is near α Argus. (His words are, 'Der berechnete Punkt liegt am Himmel ganz in der Nähe von α Argus, der gegenüberliegende Punkt in der Nähe von δ Cephei,' *Astronomische Nachrichten*, 3961.)

"This is, however, not correct, for the position of α Argus (Canopus) is R.A. 6h. 21·8m., $\delta=-52°\ 39'$ (1900). His statement that the 'opposite point' (the apex) lies near δ Cephei is, however, correct. The point found by Prof. Kobold for the anti-apex lies a little north of the famous variable star η Argus. This point lies in the Milky Way, as stated by Prof. Kobold. The fact that most of the determinations of the position of the solar apex lie in or near the Milky Way seems to suggest that the sun may be moving in an orbit 'nearly coinciding with the plane of the Milky Way.' This was pointed out by Mr. G. C. Bompas in the *Observatory*, January, 1896."

OBSERVATIONS OF THE SOLAR SURFACE, JANUARY–MARCH.—M. Guillaume, director of the Lyons Observatory, communicated a *résumé* of his observations of the solar surface during the first three months of the present year to the Paris Academy of Sciences on August 1.

The total spotted area was less than half the amount for the previous trimestre, the observed values being 2572 and 5220 millionths respectively. This was not due, however, to the absence of spots, for the phenomena have decidedly entered upon a period of increasing activity; the solar disc has not been free of spots since September 21.

In the preceding cycle the present condition of activity obtained 1·6 years after the minimum of 1889; in the present cycle 2·0 years have elapsed since that of 1901.

During the period under discussion 77 groups of faculæ with a total area of 86·0 thousandths were recorded, instead of 64 groups and 66·0 thousandths as recorded in the previous trimestre. The faculæ were also less symmetrically arranged in regard to latitude, there being 35 groups in the southern hemisphere and 42 in the northern in place of 33 and 31 respectively (*Comptes rendus*, No. 5).

INSTRUCTIONS TO VARIABLE STAR OBSERVERS.—At a meeting of the Société astronomique de France held in 1900 it was decided to form a section for the observation of visual variable stars, and for the organisation of the section a committee was formed.

This committee now publishes, in the September *Bulletin* of the society, the first chapter of a set of very detailed instructions to variable star observers.

This first instalment contains a list of stars which are especially suitable for observations of the nature proposed, minute instructions as to the methods of observing and of recording and reducing the results, and many other hints which will be found extremely useful by anyone engaged in making visual observations of variable stars.

OBSERVATIONS OF FUNDAMENTAL STARS.—In the catalogue of 2798 zodiacal stars published by Sir David Gill in 1899, 210 of the objects named were designated "fundamental stars," but the places of only about two-thirds of these were given in Newcomb's fundamental star catalogue for 1900.

To facilitate the work of other observers, Mr. R. H. Tucker, of Lick Observatory, has just published the observed places of the remaining third in No. 3965 of the *Astronomische Nachrichten*. He gives the designation, the magnitude, the observed positions (reduced to 1900), the precessional values, and, in some cases, the proper motion in each coordinate of all the stars which are given in the zodiacal catalogue but are not mentioned in Newcomb's catalogue.

THE BRITISH ASSOCIATION.

SECTION K.

SUBSECTION, AGRICULTURE.

OPENING ADDRESS BY WILLIAM SOMERVILLE, M.A., D.Sc., D.Œc., CHAIRMAN OF THE SUBSECTION.

THE audience that I have to-day the honour of addressing may be assumed to consist of a considerable proportion of the members of the British Association, and some others, who are primarily interested in, and have themselves made appreciable contributions to, the progress of Agricultural Science. I may, therefore, take the opportunity of congratulating you on this fresh evidence of progress in the subject that you have at heart, and of offering to the British Association our thanks for the encouragement and stimulus which are associated with the formation of an agricultural subsection. Perhaps I rightly interpret your feelings when I say that for the present we are satisfied with the position attained by our subject, but that we trust to see this and other meetings demonstrating that Agricultural Science is not unworthy of further advancement.

In view of the large amount of work that lies before us during the next few days, I do not propose to intervene for long between you and the contributions to original research which we have been promised. The scope of my remarks will be limited no less by time than by the fact that it would be presumptuous in me to attempt to traverse the whole field of Agricultural Science, including, as it may be held to do, the no small compartments of Horticulture and Forestry. What I propose to do, therefore, is to confine myself to touching upon a few of the subjects that have recently been receiving attention at the hands of scientific investigators, especially abroad. I have purposely avoided discussing English work, partly because it may be assumed that we are all familiar with it, and partly because, where friends are concerned, selection is difficult.

Although Agriculture has only now been elevated to a position of semi-independence in the programme of this Association, it has, in the aggregate, received much attention at the meetings inaugurated with that at York in 1831. It is interesting to turn up the early volumes of the Reports, and to ascertain what was running in the minds of our predecessors, and what the problems that they thought it vital to solve. In the account of the first meeting in this town in 1833 we find a Report by Lindley on the Philosophy of Botany, two of the items in which are of interest to students of Rural Economy. Apparently at that time much attention was being given to the mode of the formation of wood. Two theories appear to have divided botanists—the one that wood was organised in the leaves, and sent down the stem in the form of embryonic but organised fibres, to be deposited on the surface of wood already formed. The other theory was that wood was secreted *in situ* by the bark and older wood. It is to the former of these theories that Lindley gives his adherence. Although this problem has ceased to interest, the same cannot be said of another subject discussed in the same Report, namely, the so-called "fæcal excretions" of plants. In the words of Lindley, "A new apple orchard cannot be made to succeed on the site of an old apple orchard unless some years intervene between the destruction of the one and the planting of the other; in

gardens no amount of manure will enable one kind of fruit-tree to flourish on a spot from which another tree of the same species has been recently removed, and all farmers practically evince, by the rotation of their crops, their experience of the existence of the law." He attributes to Macaire the demonstration of the fact that all plants part with a fæcal matter by their roots. These excretions he held to be poisonous, maintaining that, although plants generate poisonous secretions, they cannot absorb them by their roots without death, concluding that "the necessity of the rotation of crops is more dependent upon the soil being poisoned than upon its being exhausted." He indicated the lines along which investigation might with advantage proceed, one of the questions put forward being "the degree in which such excretions are poisonous to the plants that yield them, or to others."

In 1833 botanists and agriculturists had not the advantage of the knowledge that is at our disposal through the continuous growth for a long series of years of certain crops at Rothamsted, but consideration of the fact that some crops (as, for example, pure forests of beech, silver fir, Scots pine and other trees, as also permanent pasture) may be grown for hundreds of years on the same ground without any evidence of poisoning might have led to the conclusion that the law, as it was called, was not of general application. It is, of course, true that rotations are an advantage, and it is a matter of experience that certain crops—*e.g.* clover and turnips—cannot be grown continuously on the same land, but the cause is not now associated with excretions. The reason for the failure of clover, or the cause of land becoming "clover-sick," as it is called, is still a debated point; but I may hazard the conjecture that it is due to the fact that organisms or enzymes inimical to the vital activity of the minute living bodies, that exist in symbiotic relationship with the clover plants, increase with great rapidity when the living bodies that they affect are present in abundance. Red clover is the species that is usually associated with the term clover-sickness, but it would appear that a precisely similar phenomenon is exhibited in the growth even of wild white clover. It is a matter of common observation that on certain classes of land white clover is stimulated to such vigorous growth by the use of phosphatic manures that for one year at least it monopolises the area to the almost total exclusion of other plants. But such rank luxuriance is not of long duration. In a year or two the clover disappears to a very large extent, and cannot at once be restored by any process with which we are acquainted. The land has, in fact, become sick to white clover. But given a period of rest, during which the inimical agents will disappear, and it again becomes possible to stimulate white clover to vigorous growth. We have, it seems to me, an analogous state of things in the case of certain insects. On the Continent the caterpillar of the Nun Moth (*Liparis monacha*, L.) periodically proves extremely destructive to certain conifers, and it is found that in the first year the insects are moderately abundant, in the second they are excessively abundant, while in the third the visitation begins to decline, and usually terminates quite suddenly. The causes of this cessation have been thoroughly worked out, and are found in the great increase of parasitic insects, and insecticidal fungi, including bacteria. I believe it will be found that the almost sudden cessation of our periodic visitations of the diamond-back moth is due to a similar cause.

The failure of turnips is apparently largely, if not entirely, due to the increase of insects and parasitic fungi.

The subject of harmful excretions has recently obtained renewed attention through the work being done at the Woburn Fruit Station. No point has received more striking demonstration there than the harmful influence that growing grass exerts on fruit-trees. It has been shown that this prejudicial influence is not due to the withdrawal of moisture, to the curtailment of supplies of plant food, to interference with aëration, or to modifications of temperature. In Mr. Pickering's opinion,[1] "the exclusion of all these possible explanations drives us to believe that the cause of the action of grass is due to some directly poisonous action which it exerts on the trees, possibly through the intervention of bacteria, or possibly taking place more directly." It is satisfactory to know that the subject, which is of considerable scientific and practical importance, is likely to be vigorously followed up.

In the early 'forties attention was being directed to a subject that even now has a great attraction for agriculturists, namely, the stimulating and exhausting effect of artificial manures, especially nitrate of soda. The principle that "stimuli lose their full effect upon living matter when frequently repeated" was generally held to account for the want of response that crops exhibited to repeated dressings of nitrate of soda; but Prof. Daubeny in 1841[1] pointed out what is now generally accepted as the true cause, namely, the exhaustion of the soil of other substances. This, he said, can be counteracted by giving other manures, of which he instanced bone meal. His suggestions for future investigations have been largely followed, though, as we now know, they are of theoretical rather than practical importance. He proposed the alternatives:

(1) Analysis of the soil, discovery of the amount of available plant food, and the application of the substances found to be deficient up to the probable measure of the crop's requirements.

(2) Discovery, by analysis of the yield, or estimation by calculation, of the amount of plant food removed in the produce, and the application to the soil in the form of manure of what was withdrawn by the crop.

Daubeny suggested that manuring should be undertaken on a system of book-keeping—on the one side being entered all the items of plant food taken out by crops, and on the other all that is applied in the form of manures, the two sides of the account being made to balance. This theory of manuring is distinctly suggestive, and often fits in rather remarkably with actual practice, though the comparative agreement between theory and practice is due to causes that the author of the theory probably hardly contemplated. Take, for instance, the case of wheat. An average crop removes from an acre about 50 lbs. nitrogen, 30 lbs. potash, and 20 lbs. phosphoric acid. This loss would be restored by the use of some 3 cwt. nitrate of soda, 2 cwt. kainit, and 1½ cwt. superphosphate; and on many soils wheat could, no doubt, be grown continuously for many years on such a mixture, aided by good tillage, without the yield suffering materially. But we now know that much of the plant food offered in manure never enters the crop at all, so that the balancing of the account is due almost as much to chance as to calculation. This becomes more apparent when we regard such a crop as meadow hay, which in actual practice is often grown for a long series of years on the same land. To balance the withdrawal of phosphoric acid by an average yield of this crop only about ¾ cwt. of superphosphate per acre is theoretically necessary, but on most soils an average yield would not be maintained by the use of so small a quantity.

During the 'fifties the volumes of the Association contain several important contributions from the two distinguished Englishmen to whom the world's agriculture owes so much, Lawes and Gilbert. Their first contribution was made in 1851, and dealt with Liebig's mineral theory, a subject with which their names will always be associated. They drew upon their rich store of experimental data to prove that the yield of wheat is much more influenced by ammonia than by minerals, and they gave it as their deliberate opinion that the analysis of the crop is no direct guide whatever as to the nature of the manure required to be provided in the ordinary course of agriculture. With the reservation "in the ordinary course of agriculture," the dictum cannot be questioned, though in the circumstances of the continuous growth of wheat, as has been pointed out, conclusions indicated by the analysis of a crop happen to accord, at least approximately, with manurial practice.

Field experiments or demonstrations, which have been such a prominent feature of the educational work of the past decade, appear to have been first introduced at the meeting of the Association in 1861 by Dr. Voelcker.

While agricultural subjects have claimed a considerable share of the time of the Association, forestry has not been altogether overlooked. As early as 1838 we find attention being directed to what has of recent years come to be a burning question—namely, the maintenance of our timber supplies. At that early date, when the industrial develop-

[1] "The Effects of Grass on Apple Trees." *Journal R.A.S.E.* Vol. lxiv. p. 365.

[1] "On Manures considered as Stimuli to Vegetation."

ment of the country was, comparatively speaking, in its infancy, the estimate of our timber requirements was, in the light of present experience, amusing in its modesty. Captain Cook estimated that "100,000 acres of waste taken from the Grampian Hills for the growth of larch would in two generations not only supply the ordinary wants of the country, but enable us to export timber."[1] Assuming a rotation of eighty years, this estimate postulates that the produce of some 1200 acres, of a value of about 120,000*l.*, was sufficient to make us independent of foreign supplies. Such is the estimate of 1838; now let us turn to the estimate of 1904. Dr. Schlich, in his volume on "Forestry in the United Kingdom,"[2] passes in review Britain's timber requirements, and, after making allowance for woods like mahogany, teak, &c., which cannot be grown here, he comes to the conclusion that "if all these items are added up we find that we now pay for imports in timber . . . the sum of 27,000,000*l.*, all of which could be produced in this country." Assuming as before that the value of an acre of mature forest is 100*l.*, it means that our imports are drawn from 270,000 acres, and to maintain our supplies merely at their present level a forest area of more than 20,000,000 acres, worked on an eighty years' rotation, is necessary.

Although it has been reserved for the Cambridge Meeting of 1904 to witness the delivery of an Address from the Chair of an Agricultural Subsection, this is by no means the first occasion on which an agricultural subject has furnished the theme for a Presidential Address. In 1880 the then Dr. Gilbert presided over Section B, and chose for his subject Agricultural Chemistry; in 1894 Prof. Bayley Balfour inaugurated the work of the Biological Section with an Address on Forestry; while in 1898 the President of the Association focussed the vision of all thinking men on the greatest agricultural problem of all—the World's Supply of Wheat.

German Investigations on the Action of Conservation Agents on Farmyard Manure.

Those who have followed the progress of Agricultural Science in Germany must have noticed how much attention has been given during the past ten years to investigating the changes that take place in farmyard manure during storage under varying conditions. The stimulus and funds for this work have for the most part been supplied by the German Agricultural Society, which in 1892 resolved to carry through an exhaustive inquiry. For this purpose it enlisted the cooperation of several of the most fully equipped stations in the Empire, and the reports that have appeared bear testimony to the industry and analytical ingenuity that have been brought to bear on this important subject.

The experiments were originally designed to extend over four years, the first, 1892–3, being devoted to preliminary, chiefly laboratory, experiments; the others, to work on a scale more in accordance with farm practice. But although the period originally contemplated is now long past, the problem is by no means solved, and the Society has recently been making a fresh grant for additional experiments of a similar character. In point of fact, the subject has been found to bristle with difficulties, and the results obtained with small quantities of manure, or in summer, have not always been confirmed with large quantities of manure, or in winter.

In 1897 I published an account[3] of the more important results obtained up to that time, confining myself chiefly to questions of temperature and the loss of organic matter, and the conclusion arrived at was that "none of the conservation agents usually employed appears to have any very important influence on the decomposition of farmyard manure."

Since then several important reports[4] have appeared, and I propose shortly to refer to their contents.

1 Cook, "On the Genera Pinus and Abies."
2 Bradbury, Agnew and Co., 1904.
3 *Journal Board of Agriculture*, September, 1897.
4 Hansen and Günther, "Versuche über Stallmist-Behandlung," *Arbeiten der Deut. Land. Gesell.* Heft 30, 1898. Pfeiffer, "Stallmist-Konservirung," *Ibid.* Heft 73, 1902. Immendorff, "Ueber Stallmist-Bewahrung," *Mitt. der Deut. Land. Gesell.* Heft 21, 1903. Schneidewind, "Fünfter Bericht über die Versuchswirtschaft," *Lauchstädt, Land. Jahrb.* xxxiii. p. 190.

While the experiments have in almost all cases dealt with the fate of nitrogen, phosphoric acid, and potash, the chief interest centres round the nitrogen, for, given reasonably satisfactory conditions of storage, it is only this constituent of farmyard manure that is likely to suffer loss. But much importance, from the experimental point of view, attaches to the analytical results obtained with the other two substances, for the reason that the quantities of these found are the surest test of the accuracy of the work. The general method of procedure has been to employ a fairly simple but sufficiently nutritious food-mixture, and to allow a definite quantity of this and of litter for a certain number of selected cows. The weight of nitrogen, phosphoric acid, and potash in the food is accurately determined, all of which ultimately reaches the manure, less what goes into the milk, and into the live-weight increase, if any. If the account of what the animals receive as food and litter, and what they furnish as liquid and solid fæces, milk, and animal increase, approximately balances as regards mineral matter, it may be assumed that the sampling and analysis have been sufficiently accurate to justify definite conclusions being based on any deficiency in nitrogen that may be found.

The work of Hansen and Günther, Pfeiffer, and Immendorff was carried out at consecutive periods from 1893 to 1902, at the experimental station of Zwätzen, near Jena, where stalls and dung-pits had been constructed for the purposes of this research. Schneidewind's experiments were conducted at the station of Lauchstädt, near Halle.

Effects of Kainit.—This was used by Hansen and Günther at the rate of 0·75 kg. per 1000 kg. live weight of stock per day, while Pfeiffer and Immendorff used twice as much. The kainit was in no case spread on the litter in the stall, as this would have caused inflammation of the skin of the udder, legs, and abdomen of the cows, but was sprinkled on the manure as spread and pressed into the pits. In certain series of the experiments the manure was removed from the stalls daily, in others it was only removed once a week. Two weeks was the usual time necessary to collect a sufficient quantity of manure, which, with the liquids, usually amounted to about 8000 kg. at Zwätzen, and about one-fifth of this weight at Lauchstädt. The period of storage was generally about four months.

Hansen and Günther found that in pits the untreated manure lost 11·5 per cent. of nitrogen; while the manure treated with kainit lost 14·4 per cent.

Pfeiffer found that the loss of nitrogen in untreated manure was 17·2 per cent., which compares with a loss of 19·5 per cent. in the presence of kainit. The loss of nitrogen when kainit was used by Immendorff was 21·3 per cent., the loss in the untreated manure not being given in his tentative report so far available. Schneidewind did not experiment with kainit. The results of these experiments are in complete relative agreement, and show that the loss of nitrogen is greater when kainit is used than when it is withheld.

Effects of Superphosphate.—This substance was spread twice daily over the litter in the stall at the rate of 0·75 kg. per 1000 kg. live weight. The results obtained were as follows:—

—	% Loss of Total Nitrogen	
	In untreated dung	When super. used
Hansen and Günther ...	10·25	16·25
Pfeiffer	17·20	20·80
Immendorff	—	19·80

With superphosphate, as with kainit, the loss of nitrogen during the storage of dung has been increased. It may, however, be mentioned that Hansen and Günther and Immendorff found that superphosphate conserved nitrogen to an appreciable extent so long as the dung lay in the stall, but that its effects disappeared whenever its acid phosphate and free sulphuric acid had been neutralised by ammonia, and this rapidly occurred in the pit.

Effects of Precipitated Phosphatic Gypsum.—This at the

rate of 1 kg. per 1000 kg. live weight was tried by Hansen and Günther and Immendorff, the substance employed containing fully 8 per cent. P_2O_5. It was spread twice daily on the litter in the stall. The result obtained by Hansen and Günther was that after lying for seventeen weeks in the pits the manure that had been untreated had lost 10·35 per cent. of nitrogen, whereas that treated with the phosphatic gypsum showed a loss of 14·47 per cent. The loss of nitrogen found by Immendorff when this substance was used amounted to 19·8 per cent. This substance, like the others, would therefore appear to be valueless as a fixer of nitrogen.

Effects of Gypsum.—This substance has long been recommended as an agent for conserving nitrogen in the dung-heap. The results of its use, spread twice daily on the litter in the stall at the rate of 1 kg. per 1000 kg., live weight, in the experiments conducted by Hansen and Günther, were that in the presence of gypsum the loss of nitrogen amounted to 11·89 per cent., which compares with a loss of 8·56 per cent. when nothing was mixed with the dung.

Schneidewind, using a much larger quantity of gypsum, namely, 5 lbs. per 100 lbs. of dung, found that the loss of nitrogen was reduced from 35·69 per cent. to 15·22 per cent. In this connection he says: "The use of gypsum has markedly reduced the loss of nitrogen. Assuming the conserved nitrogen to have a good action on the crop, this agent may be said to have paid. But as the bulk of the nitrogen so conserved was found to consist of slow-acting albuminoid compounds, and seeing that the sulphate of lime was largely reduced to sulphides, which are directly injurious to plants, we cannot conclude that the use of gypsum has been profitable. Investigations with this substance will, however, be continued."

Hansen and Günther carried their experiments the length of using the various lots of manure on crops, but this part of their researches was hardly more favourable to the use of conservation agents than the other. They thus express themselves: "When the various manures were used on crops, five times in six the treated manure acted no better than the untreated. Only on one occasion was an improvement observable. Field and pit experiments alike have proved that the conservation agents employed are of no value." Schneidewind expresses himself equally forcibly when he says: "As the result of many experiments conducted by ourselves and others, we have arrived at the conclusion that chemical substances are valueless as conserving agents."

Pfeiffer also tried sulphuric acid sprinkled over the manure as it was placed daily in the pit, when it was found that the loss of nitrogen was reduced from 27·8 per cent. to 7·1 per cent. In this connection Pfeiffer says: "The cost, however, was nearly a mark for each kilo. of nitrogen conserved, and the use of sulphuric acid is associated with so many drawbacks that its employment cannot be recommended."

Schneidewind came to a similar conclusion, and thus expresses himself: "As a result of numerous conservation experiments carried out with various quantities of sulphuric acid, and with various acid sulphates, we cannot advise the use of these substances."

But although no benefits have been obtained from the use of the substances indicated, some useful information is available as to the advantages of giving attention in other directions to the management of farmyard manure. Hansen and Günther took four lots of manure of similar character, storing two of the lots in pits and placing the other two in heaps in the open field. From the end of September until the middle of December the pitted material had on the average parted with 13·25 per cent. of total nitrogen, whereas the loss in the manure in heaps averaged 25·3 per cent. When the behaviour of the ammoniacal nitrogen was investigated it was found that the loss was 35·73 per cent. in the pits and 82·5 per cent. in the heaps. The loss, therefore, is greatest in that part of the nitrogen which is the most active and the most valuable.

In another series of experiments by the same investigators the manure was all placed in pits, but in one case it was spread equally and trodden down, while the escape of liquids was prevented. In the other case the manure was simply thrown loosely and irregularly into the pit without spreading or treading, the surface being left uneven and therefore much exposed to the air, while the liquids were allowed to drain away. After lying for twenty-two weeks the loss of nitrogen was 15·76 per cent. in the pit containing the carefully treated manure, whereas in the other pit the loss amounted to 34·58 per cent.

Pfeiffer in a series of experiments proved that much of the nitrogen that disappears from manure is lost before the manure is transferred from the stall to the dungstead. He is strongly of opinion that stalls, boxes, and the like, should either be cleaned out twice daily, or, if the construction admits, the manure should be left to accumulate until it is some feet in depth, as in the system of management that prevails in cattle-courts and yards in this country.

The general conclusion arrived at, and clearly expressed by Pfeiffer, is that excessive loss in manure can be best avoided by storing it in a deep mass in a water-tight dungstead placed in a well-shaded situation, in which the material is firmly compressed. The necessary compression can be secured in various ways, perhaps most conveniently and effectively by means of the treading of cattle. The use of a considerable proportion of moss-litter is strongly recommended. This substance not only absorbs and retains the liquids, but, being acid, it fixes ammonia. In the absence of moss-litter, loamy soil rich in humus will prove a useful substitute.

The Chemical Fixation of Atmospheric Nitrogen.

It has for long been the dream of chemists to discover, or welcome the discovery of, a chemical process, capable of industrial application, by which the nitrogen of the air could be made available to replace or to supplement our rather limited supplies of nitrogenous manures. In his Presidential Address, Sir William Crookes had something to say on this fascinating subject, and looked hopefully to electricity to solve the problem. He pointed out that with current costing one-third of a penny per Board of Trade unit a ton of nitrate of soda could be produced for 26*l.*; while at a cost of one-seventeenth of a penny per unit—a rate possible when large natural sources of power, like Niagara, are available—the cost of such artificial nitrate of soda need not be more than 5*l.* per ton.[1]

Dr. von Lepel, in giving an account of recent work on this subject to the winter meeting of the German Agricultural Society in February of this year,[2] puts the cost of electric nitrate, as compared with Chili nitrate, in the proportion of 24 to 39, which is in close agreement with Sir William Crookes's estimate. Lepel points out that the material obtained, neutralised by some alkali, consists of a mixture of nitrate and nitrite. When used in pot-culture experiments it has given results closely agreeing with those furnished by Chili nitrate.

Good progress would also appear to have been made in another direction in the commercial fixation of atmospheric nitrogen, and a short account of the results was communicated by Prof. Gerlach, of Posen, to the meeting of the German Agricultural Society already referred to, and is published in the same issue of the *Mittheilungen*.

When air which has been freed of oxygen is conducted through finely disintegrated calcium carbide at a high temperature, one atom of carbon is displaced by two atoms of nitrogen, and calcium cyanamide ($CaCN_2$) is formed. This substance is also produced when a mixture of lime or chalk and charcoal is heated to a temperature of 2000° C. in a current of air.[3] When pure, this substance holds 35 per cent. of nitrogen, but in its crude commercial form it contains only about 20 per cent. Treated with acids, calcium cyanamide is changed into dicyandiamide, a substance holding nearly 67 per cent. of nitrogen, but directly poisonous to plants. Or, if heated in superheated steam, calcium cyanamide parts with all its nitrogen as ammonia, which, of course, is easily brought into a portable form.

But experiments conducted at Posen and Darmstadt during the past three years, both in pots and in the open field, have shown that calcium cyanamide itself is a useful nitrogenous manure, field experiments giving results about 20 per cent. below those obtained by the use of an equal amount of nitrogen in the form of sulphate of ammonia.

1 Crookes, "The Wheat Problem," p. 47.

2 Dr. von Lepel, "Neuere Versuche zur Nutzbarmachung des atmosphärischen Stickstoffs durch Elektrische Flammenbogen," *Mitteil. d. Deut. Land. Gesell.*, 1904, Stuck 8.

3 Bull, *Imp. Inst.* June 30, 1904.

In prepared soil in pots the results fully surpassed those obtained both with nitrate of soda and sulphate of ammonia, the less satisfactory yields obtained in the field being perhaps due to the organic acids inducing the formation of a certain amount of the poisonous dicyandiamide.

So far as one may judge from the information available, it would appear that agriculture will not have long to wait until it is placed in the possession of new supplies of that most powerful agent of production, nitrogen, and Sir William Crookes will see the fulfilment of his prediction that "the future can take care of itself."

Nitragin.

A few years ago much interest was excited in this and other countries by the announcement that the scientific discoveries of Hellriegel and Wilfarth had received commercial application, and that the organisms of the nodules of the roots of Leguminosæ could be purchased in a form convenient for artificial inoculation. The specific cultures placed upon the market were largely tested practically and experimentally, but the results were such as to convince even the patentees, Nobbe and Hiltner, that the problem which promised so much for agriculture had not been satisfactorily solved. Since that time, however, investigators have not been idle, and the present position of the subject is to be found in a recent Report by Hiltner and Störmer.[1]

It was early recognised that the organisms (bacteria) which inhabited the root-nodules of the various species of Leguminosæ were not all alike, and that, in fact, they showed marked physiological if not morphological distinctions. Any particular species of leguminous plant is found to resist more or less successfully the attempt of these various organisms to effect an entrance into its root-hairs, and according to the power of the organism to gain access, and to establish colonies, so is the particular plant benefited and the stock of fixed nitrogen increased. This power of adaptability of the organism is designated its "virulence," a term, however, which is perhaps hardly suited to our English mode of expression, though it may for the present be retained. It has been found that organisms of what is called "high virulence" are capable of entering with ease the root-hairs of vigorous plants at an early stage of their growth, and of inducing the formation of nodules that are large, numerous, and placed high up on the roots. Organisms of low virulence, on the other hand, can only enter plants of feebler growth, or plants that have passed the most vigorous stage of youth, so that the nodules, in this case, are small and scarce, and distributed, for the most part, near the ends of the roots. The practical object, therefore, would appear to be the breeding of strains or varieties of organisms of high virulence, adapted to the symbiotic requirements of the various important species of farm and garden leguminous crops.

The nitragin put on the market a few years ago was used in two ways, being either applied directly to the fields, or mixed with water and brought into contact with the seed before sowing. Under the former method of procedure an increase of crop was obtained only when the nitragin was used on land containing much humus. The explanation given for failure under other conditions was that the bacteria artificially introduced perished for want of food before the leguminous seed germinated and produced plants.

Failure of the nitragin to effect an improvement in the crop when it was sprinkled on the seed is now believed to be due to the action of secretions produced by the seed in the early stages of germination. These secretions are found to be rich in salts of potash, and when brought into contact with the bacteria in question they induce changes allied to plasmolysis, and these changes are subsequently followed by death. This difficulty was found to be got over by moistening the seed and allowing it to sprout before the nitragin was applied; but manifestly such a procedure would always be difficult, and often impossible, to carry out in practice. The object, however, would appear to have been gained in another way, namely, by cultivating the bacteria in a medium that imparts to them the necessary power of resistance. Such nourishment may take various forms, but that which gave the best results consisted of a mixture of skim milk, grape sugar and pepton, and it is in this medium that the organisms of the nitragin now distributed are cultivated.

Early in the present year the new nitragin was being offered free of cost to all members of the German Agricultural Society on the condition that it was used in accordance with the directions that accompany it. In consequence of the large demand the free offer was in April withdrawn, but the substance may be purchased from Prof. Hiltner, of Munich, in quantities sufficient to treat the seed of a half to one acre at the price of one shilling. The United States Department of Agriculture are so convinced of the practical utility of the improved nitragin that they are distributing large quantities to American farmers. In this way the material will be thoroughly tried in two hemispheres under practical conditions, and abundant evidence should soon be forthcoming as regards its effects. It is to be hoped that British investigators will not be deterred by past disappointments from putting the new form of nitragin to the test.

Improvement of Varieties of Crops.

Speaking generally, the attention of agricultural investigators during the past fifty years has been directed more to manurial and similar problems than to the improvement of the yield of crops through the agency of superior varieties. This, it seems to me, is the outcome of the tradition that agricultural science is based upon chemistry, using the term in its old-fashioned and restricted sense, and as a consequence farmers have looked principally to the chemical laboratory for light and leading. It is true that much excellent work has been accomplished from the botanical side, but this has been performed rather by farmers, seedsmen, or amateurs, than by trained botanists. But fortunately the botanist is now getting his opportunity, and the possibilities before him are sufficiently attractive.

Judging by the results that have been obtained, it would appear that wide divergences as regards yield, nutritive qualities, resistance to disease, and other important properties exist between varieties of the same plant-species; so much so, in fact, is this the case that attention to the relationship between variety and locality would appear to be one of the most important matters to which a farmer can give consideration. But it has been found that new varieties are frequently unstable, reverting rather rapidly to an unsatisfactory form, or displaying a lack of power of resistance to disease. It therefore becomes necessary constantly to be producing new varieties to take the place of those that are worn out, and it seems reasonable to anticipate that the professional botanist will take a much larger part in this work than has been the case in the past.

Not only is the yield of a crop greatly influenced as regards quantity and quality by the variety of seed employed, but, as is well known to practical farmers, the local origin of the same variety of seed has a marked influence on many properties of plants (vigour, resistance to disease, and resistance to frost, and to weather generally), and these properties quickly react on the yield. In this country we have a prejudice in favour of the seed of English-grown red clover, Provence Lucerne, Scotch potatoes, Belgian flax, Ayrshire ryegrass, pine and larch from Scotland, Norfolk and Cambridge barley, Warp-land wheat, &c., and there seems no reason to doubt that such preferences are based upon sound experience. This subject would appear to be one that is still full of interesting and important possibilities, and last year I had the opportunity of seeing some striking results in a new and unexpected direction. During the past few years the Austrian Experimental Forestry Station of Mariabrunn has given much attention to the influence of the local origin of the seed on the resulting trees, especially the common spruce, and, although it is too early to pronounce a final judgment on the results, these are already so conspicuous as to warrant my placing some figures before you.[1]

In the autumn of 1896 a supply of seed was obtained from certain definite localities, the trees that yielded it being of varying dimensions and situated at various altitudes. The seed was sown in the spring of 1897 in the nursery attached to the station, and, having been transplanted into lines, a portion of the young trees are growing there now. Others

1 "Bericht über neue Untersuchungen über die Wurzelknöllchen der Leguminosen und deren Erreger," *Arbeiten aus der Biol. Abteil. für Land- und Forstwirtschaft am K. Gesundheitsamte*, Band iii. Heft 3.

1 "Programm der vierte Versammlung des Internat. Verbandes Forstlicher Versuchsanstalten zu Mariabrunn," 1903, p. 47.

were, in 1899, planted out in a wood (Loimannshagen) in the neighbourhood. In the autumn of 1902 the young trees were carefully measured, with the following results :—

Locality of Origin of the Seed	Height above Sea-level of the Mother-tree	Average Annual Height-growth of the Mother-tree	Average Height (1902) of the Young Trees		Average Growth in Height of the Nursery Trees in 1902
			In the Wood	In the Nursery	
	metres	cm.	cm.	cm.	cm.
Piesendorf, Salzburg ...	1400	24	62	85·2	34·7
,, ,, ...	1750	14	47	61·6	23·3
St Andrä in Kärnten ...	1420	25	57	71·1	27·1
,, ,, ...	1625	18	41	51·2	18·4
,, ,, ...	1650	15	35	39·1	14·2
Treibach, Kärnten ...	900	28	56	81·6	30·7
,, ,, ...	900	29	53	80·9	29·7
Achenthal in N. Tyrol...	900	31	64	87·9	29·0
,, ,, ...	1300	28	67	80·5	27·9
,, ,, ...	1600	26	50	62·2	21·8

These figures show—

(1) That where, in any particular locality, mature trees were measured at different elevations, the tallest trees, as was to be expected, were found at the lowest elevation.

(2) That where the seed of such trees was sown the height of the resulting trees, at the age of six years, was in close relationship to that of the mother trees.

(3) That where mother trees of approximately equal height from the same locality and the same elevation (Treibach) were selected, the resulting progeny were also of approximately equal vigour.

The differences in the height-growth of the young trees are so striking as to lead to the conclusion that the financial returns of Forestry operations may be profoundly modified by the origin of the seed, and it would apparently pay nurserymen and planters well to give their careful attention to this subject.

Joint or Cooperative Work.

In conclusion, I may be allowed to direct your attention to a prominent feature of experimental or demonstrational work which is found to exhibit itself in all countries of the world where serious attention is given to the improvement of agricultural production. While, no doubt, it is the individual who plants the germ of a new idea and fosters its growth until it is fairly established, it is by systematised cooperative effort that the practical value of the idea is tested, and that the knowledge is made available and acceptable to the workaday farmer. Various objections have been urged against field experiments, and it need not be denied that they are incapable of supplying a satisfactory answer to many scientific questions. Such experiments are exposed in no small degree to the disturbing influences of inequalities of soil, irregular cultivation, the attack of animals, and the vicissitudes of climate; but when reasonable precautions are taken to guard against these, and given a sufficient number of tests, the results of field trials are of the highest value as a guide to practice. Apart from attention to the preliminary details of the scheme, and to care in carrying it out, the main point to aim at in field-trials is to have them so frequently duplicated or repeated that the disturbing factors inseparable from field-work will be largely eliminated. Such duplication may take the form of repetition of the same test on the same area year after year, when one obtains some such series of results as those that have helped to make the reputation of Rothamsted. But however convincing may be the results of a series of experiments that have marched majestically on for half a century, they lack attractiveness for the investigator who desires to solve not one but many problems during his lifetime. For him, therefore, duplication in time gives place to duplication in space—in other words, he secures the same end, or an end that is in many respects equivalent, by repeating the test at several places in the same season, or in a short series of seasons. This method of work is, of course, by no means new. It was utilised with great advantage by the late Dr. Voelcker, and by our more recently departed friend Dr. Aitken, and it is a line that is still being followed by the two great societies with which these distinguished workers were so long associated. The method is also being practised extensively, chiefly through the agency of societies, in Germany, France, and other European countries, and it has taken firm hold in the United States and in some of our colonies. One of the largest and most successful agencies in cooperative demonstrations is to be found in Canada, where, during the past nine years, an average of 37,000 farmers have annually received small parcels of improved seeds through the Government experimental organisation directed by Dr. Saunders. It is claimed that the financial results to the country as a whole run to many millions of dollars, and there seems to be no reasonable doubt as to the accuracy of the statement.

I trust you will pardon my referring in this connection to a matter that is personal to a considerable proportion of this audience, and of saying that, in my opinion, one of the best pieces of work that has been done in this country in recent years is the preparation of the scheme of joint experiments by the Agricultural Education Association. The problems set for solution under that scheme are of the simple, direct, practical kind that field-work is thoroughly qualified to deal with. But the essence of success lies in the power of numbers, and the control of this factor rests with the members of the Association themselves. Now, most of the members of that Association are not only investigators but also teachers, and many of the institutions that they represent have recognised the advantages of keeping in touch with their past pupils through the agency of collegiate Associations. These old students, it seems to me, represent a large mass of most valuable material for carrying through cooperative experimental work of the class referred to, and I am convinced that the agriculture of the country would benefit in no small degree were this powerful agency fully utilised.

SECTION L.

EDUCATIONAL SCIENCE.

OPENING ADDRESS BY THE RIGHT REV. THE LORD BISHOP OF HEREFORD, D.D., LL.D., PRESIDENT OF THE SECTION.

I AM moved to begin this address with a word of personal apology, the strongest feeling in my mind, as I rise to deliver it, being that in the fitness of things some one of the many distinguished representatives of education in this University would have been the natural occupant of this chair on the present occasion; and for my own part I could hardly have brought myself to accept the invitation with which I have been honoured had I not been led to understand that on occasions of this kind it is preferred by the members of the University visited that some one from the outside should be invited as I have been.

Thus I have accepted, not without hesitation and misgiving, but with the more gratitude, as feeling that I am here because of the wish of the Cambridge authorities to have someone connected with the University of Oxford, and I desire that the grateful acknowledgment of this courtesy and kindness should be my first word as President of the Educational Section.

The inclusion of Education among the various sections of this Association for the Advancement of Science is sufficient evidence that a new educational era has begun in this country.

Whatever may be the defects of our educational system or want of system, whatever changes may be necessary to bring it, in the current phrase, up to date, the days of unthinking tradition are over.

Scientific method is entering on its inheritance, and it has begun to include the field of education along with other fields of life and thought within the sphere of its influence.

And scientific minds are asking on every side of us what is the end of true education, and are we on the right way to it?

True education, almost insuperably difficult in practice, has been often defined in words.

Plato told us long ago how it is music for the soul and gymnastic for the body, both intended for the benefit of the soul, how it is a life-long process, how good manners are a branch of it and poetry its principal part, though the

poets are but poor educators, how great is the importance of good surroundings, how the young should be reared in wholesome pastures and be late learners of evil, if they must learn it at all, how nothing mean or vile should meet the eye or strike the ear of the young, how in infancy education should be through pleasurable interest, how dangerous it is when ill directed, how it is not so much a process of acquisition as the use of powers already existing in us, not the filling of a vessel, but turning the eye of the soul towards the light, how it aims at ideals and is intended to promote virtue, and is the first and fairest of all things.

In this description, I take it, we most of us agree, though some of Plato's views would doubtless elicit differences of opinion amongst us, as, for instance, that education ought not to be compulsory, or that it should be the same for women as for men.

One of his statements may be soothing to our English self-complacency, for as is the habit of idealists in every age, he says that even in Athens they care nothing for educational training, one of the most brilliant of their younger statesmen pleading that it does not matter, because others are as ignorant as he.

Or again, our own Milton sums it up in fewer words, but very impressively, when he says true education fits a man to perform justly, skilfully, and magnanimously all the offices, both private and public, of peace and war.

It is a noble aim which he thus sets before us, to make our sons skilful, just, magnanimous, and every description of aims and methods can be little more than an expansion of it.

Of the importance of right aims and ideals there can, as Plato reminded us, be no question, because of the danger of ill-directed aims, and the lasting nature of early impressions.

What we learnt at school, when all the world was young to us, whether we learnt it with weariness or pain, or under happier influences with a quickening pulse and the glow of enjoyment, passed into the blood, as Stevenson said somewhere, and became native in the memory.

True education, then, as we all acknowledge, aims at cultivating the highest and most efficient type of personality, men not only appropriately and technically equipped for their professional business, but men endowed with the best gifts and inspired with high purposes, men who desire to follow the more excellent ways and to lead others in them, who love knowledge, truth, freedom, justice, in all the relations of life, whether individual or social, men marked by sense of duty and moral thoughtfulness, public spirit, and strength of character.

Such an education is the true basis of individual and national welfare, and experience has abundantly shown how necessary this is to save men from distorted views of history, from wrong conceptions of patriotism and public duty, from mistaken aims and disastrous policy.

Thus, for instance, a good and true education shows us that the true basis of life is moral and economic and not military, and the true aim of both individuals and nations is knowledge, justice, freedom, peace, magnanimity, and not pride, aggression, force, or greed.

Scientific consideration of our subject will of course deal largely with such details as the relative claims of the humanist and the realist, subjects and methods of instruction, the correlation of different grades of education, the adaptation of this or that system to special needs, and so forth; but through all this these fundamental requirements of the true education, as placarded before us by Plato or by Milton, must always hold the chief place, and all others must be kept in due and conscious subordination to these.

This very obvious remark calls for repetition, as we are so apt to lose sight of ideals amidst the dust of controversy about details or methods or practical needs.

How, then, does our English education stand when thus considered? And what signs are there in our life of our having fallen short or fallen behind, or missed the best that was possible in our circumstances?

It may, I venture to think, be fairly said that to a reflective observer various things are patent which seem to make it expedient that the subject of education should have its place in the proceedings of a scientific association like this, although there may be difference of opinion as to how it should be handled there.

In saying this I have to admit that some educational reformers seem to have doubts as to the propriety of its inclusion in your programme.

The element of personality is so preeminently vital in all education that some men say it cannot be treated as wholly scientific in the ordinary sense, and that there is serious risk in subjecting it too rigidly to the methods of investigation which naturally hold the field in the main departments of this Association, and that men who are wholly accustomed to such methods are not the best equipped for dealing with the problems involved in the education of the young.

If I endeavour in a few paragraphs to express what, so far as I understand it, is the ground of this fear in the minds of some thoughtful objectors, I trust I may not be thought to be wasting your time.

This Section is still in its swaddling-clothes. It has to justify its existence in the coming years. It is therefore of moment that it should be started on its course of early growth as free as may be from prejudice and with the sympathy and support of all who, whatever be their views as humanists or realists, as men of letters or men of science, as teachers of religion or men of practical affairs, desire to see the education of the young in our country advancing and expanding on the best lines.

On this account the misgivings or warnings of every thoughtful critic deserve our attention and may be helpful.

In what I am saying it will be understood, I hope, that I am not expressing views of my own, but endeavouring to act as the recording instrument, a very inadequate and old-fashioned instrument, of views which come to me from one quarter and another.

The inclusion of the study of education by the British Association for the Advancement of Science among its subjects of investigation is, they say, not altogether free from risk.

If you treat education too exclusively according to the analytic naturalistic methods of scientific men you incur the danger of unfitting teachers for the best part of their work, which depends on the inspiring influence of personal ideals breathing through all their lessons, on a vivid sense of the subtle element of personality in the pupil, and on their responsible exercise of the power of their own personality.

In giving the scientifically educated teacher the analytic knowledge of the dissecting chamber you may possibly rob him of the magnetic power of personal sympathy and influence. In this sense, at all events, you must not dehumanise him. The most eminent psychologists, the critics tell us, are beginning to recognise the danger, and they bid the educator beware of science which has a great deal to say about mental processes but takes too little account of the emotions and the will, and seems inclined to forget that men are personalities and not plants or trees or machines and that boys will be boys.

The combination of a living and fruitful experience, these critics assert, with systematic organised scientific methods and processes is more difficult in education than in any other realm of knowledge, because the data are so complicated and so subtle and elusive.

Hence, they say to me quite frankly, the risk of failure to do much that will be of real value in your Educational Section.

In particular I have the impression that they set no great store by presidential addresses, although the address to which you are now listening has at least one merit, that it has no claim to be technically scientific, but is wholly based, so far as any positive conclusions or recommendations are concerned, on practical personal observation and experience.

This section, say the critics, will do its best work by seeking first of all to determine and to set forth:—

(1) What field is to be covered when education is to be treated as a scientific study, and what are the limits of the field, taking care to give due regard to right ideals of moral and social progress as a primary part of the whole.

(2) What methods of investigation are appropriate and what are inappropriate to the study of education.

Such are some of the warnings with which we are asked to begin our discussions. The critics ask the men of science to remember that they are leaving their accustomed field of purely natural phenomena, and entering a field of investi-

gation which is largely, if not mainly, social, political, religious, moral, and lends itself only in a limited degree to those problems which men whose sphere is natural science are more accustomed to handle.

These are some of the criticisms which, as men of science, you have to meet, and I may safely leave them to your tender mercies.

For myself my attitude in the whole matter must of necessity be a humble one. For many years of my life I was a teacher, but entirely untrained, or rather self-taught, that is to say, relying for my instruction and guidance entirely on my own reading, observation, experience, and practice.

I belong to the pre-scientific age of Englishmen engaged in education. I grew up to my profession anyhow, like so many others; and now for some years I have ceased even to teach, and so even as an untrained teacher I am out of date.

It is due to this audience and to my subject that I should say thus much. It is my appeal for your kind indulgence.

As regards the critics whose views I have endeavoured to express, I may say at once that I do not go with them, because I am profoundly convinced that our English education needs the influence of more light and more thought from every quarter, and especially from those who are familiar with scientific methods. "Blessed are they that sow beside all waters."

Moreover, I hail the application of scientific intelligence and scientific methods to this subject, because, looking back, I am profoundly conscious that I should have done my own educational work far less imperfectly if in my youth I had undergone any rational scientific illuminating preparation for it.

In such a process I should have lost no personal gift or aptitude that I possessed, and I should have gained some early knowledge and confidence and power which would have saved me much discomfort and anxiety and some mistakes and failures, and would have saved my pupils some loss and possibly some distress.

When I turn with these thoughts in my mind and look out over the field of English life I see very strong and valid reasons why our education, its merits, its defects, its methods and results, should be seriously considered here, as also in very different assemblies elsewhere.

Above all, the persistently traditional and unscientific spirit that still pervades so much of it from top to bottom, its lack of reasoned reflection, demands our special attention.

"The want of the idea of science, that is of systematic knowledge," said Matthew Arnold, "is, as I have said again and again, the capital want at this moment of English education and English life. Our civil organisation (including our education) still remains what time and chance have made it."

This was written about thirty-six years ago, and it is, to say the least, a surprising thing that in an age of unusually rapid scientific development it should be, in the main, still so true, as it undoubtedly is, of a great part of our English educational system.

There is the lack of any systematic preparation for the business of teaching which still prevails throughout our middle and upper-class education, although here in Cambridge and in Oxford some excellent pioneer work is being done in the training of teachers.

There is the general lack of interest in education which is still so noticeable in a great deal of English society of all grades, the spirit of indifference to it, and even the tendency to depreciate the intellectual life.

There is the excessive influence of tradition and routine on our great schools and universities, and in some quarters an inert or suspicious conservatism.

There is throughout our middle-class education a state bordering on chaos, a country largely unexplored, a mixture of things good and bad, involving a vast amount of wasted opportunity and undeveloped faculty.

Even in elementary education, which has received the largest share of public attention, there is much that needs to be done in a more thoughtful and scientific spirit.

Party politics have to be eliminated as far as possible, especially ecclesiastical politics.

The fitness of a great deal of the teaching to the special needs and requirements of the children has to be considered afresh.

The tendency to overlook the interests and the attainments of each individual child has to be checked.

The wastefulness of our absurdly truncated system of elementary education stopping abruptly at about twelve years of age and then leaving the children to drift away into an unexplored educational wilderness has to be superseded by some rational system of continuation classes made obligatory. Truly the harvest is a plenteous one for those who desire to uplift our English life by helping forward the best modes of educating the rising generation in a scientific, or, in other words, a wise, intelligent, and large-minded spirit.

Much, it is true, has been done in almost every part of the educational field during the last half-century, but not nearly so much as ardent friends of education anticipated forty years ago.

I have already quoted some significant words from Mr. Arnold's illuminating Report on the Schools and Universities of the Continent as he saw them thirty-seven years ago. If that report had been turned to immediate practical account at the time, if some English statesman, like William von Humboldt, had been enabled with a free hand to take up and give effect to Mr. Arnold's chief suggestions, as Humboldt and his colleagues gave effect to their ideas in Prussia in the years 1808 onwards, the advantage to our country to-day would have been incalculable.

In our insular disregard or depreciation of intellectual and scientific forces actually working in other countries, we have undoubtedly wasted some of that time and tide in human affairs which do not wait for either men or nations.

But, putting regrets aside and turning to some of the practical problems that seem to confront us to-day, I venture to put before you for consideration such cursory and unsystematic observations or suggestions as my personal experience has led me to believe to be of practical importance. For more than this I have no qualification.

In the first place, the growth of crowded city populations and the conditions under which multitudes have for at least two generations been growing up and passing their lives in our great cities have set us face to face with the very serious preliminary problem of physical health.

If our physical manhood decays all else is endangered, so that the first business of the educator is to look well to the conditions of a healthy life from infancy upwards.

Hence the great educational importance of the petition presented by 14,718 medical practitioners, including the heads of the profession, to the central educational authorities of the United Kingdom.

This petition opens with these impressive words:—

"Having constantly before us the serious physical and moral conditions of degeneracy and disease resulting from the neglect and infraction of the elementary laws of hygiene, we venture to urge the Central Educational Authorities of the United Kingdom (the Board of Education of England and Wales, the Scotch Education Department, the Commissioners of National Education in Ireland and the Intermediate Education Board of Ireland) to consider whether it would not be possible to include in the curricula of the Public Elementary Schools, and to encourage in the Secondary Schools, such teaching as may, without developing any tendency to dwell on what is unwholesome, lead all the children to appreciate at their true value heathful bodily conditions as regards cleanliness, pure air, food, drink, &c. In making this request we are well aware that at the present time pupils may receive teaching on the laws of health, by means of subjects almost invariably placed upon the Optional Code. By this method effective instruction is given to a small proportion of the pupils only. This does not appear to us to be adequate. We believe that it should be *compulsory* and be given at a much earlier age than at present."

And it concludes as follows:—

"In many English-speaking countries, definite attempts are being made to train the rising generation to appreciate from childhood the nature of those influences which injure physical and mental health. Having regard to the fact that much of the degeneracy, disease, and accident with which medical men are called upon to deal is directly or indirectly due to the use of alcohol, and that a widespread ignorance

prevails concerning not only the nature and properties of this substance but also its effects on the body and the mind, we would urge the Board of Education of England and Wales, the Scotch Education Department and the Irish Education Authorities to include in the simple hygienic teaching which we desire, elementary instruction at an early age on the nature and effects of alcohol. We gladly recognise (1) the value of the teaching on this subject given in some schools in Ireland and in a proportion of the schools of Great Britain, by means of reading primers, moral-instruction talks, &c., and (2) the excellence of the occasional temperance lessons provided in certain schools by voluntary organisations: but until the four Central Educational Authorities of the United Kingdom include this subject as part of the system of National Education, it appears to us that the mass of the pupils must fail as at present to receive that systematic teaching of hygiene and of the nature and effects of alcohol, which alone we consider adequate to meet the national need. Finally, we would venture to urge the necessity of ensuring that the training of all teachers shall include adequate instruction in these subjects."

This petition, coming, as it does, with all the weight of the medical profession, as the expression of their experience and convictions, is, to my mind, one of the most important educational documents which have been published in our time, and it can hardly be disregarded without incurring the charge of folly.

It may be worth while to set it for a moment side by side with the fashionable cult of athleticism, as bringing into relief our curiously unscientific inconsistency in such matters.

On the one hand, in our absent-minded way, we have allowed these generations of town-dwellers, to say nothing of rural villagers, to grow up and live under insanitary conditions which inevitably produce a physically degenerate, enfeebled, and neurotic race of men and women.

On the other hand, in the upper and middle classes, we have been sedulously cultivating the taste for physical exercises, outdoor life, athletics, and sport, thinking nothing of such importance as the development of the body, admiring nothing so much as bodily prowess; carrying all this to such an extent that a natural and wholesome use of athletic exercise has been fostered into a sort of fashionable athleticism, with all its parasitic professionalism, possessing both soul and body.

And the result has been curiously significant; at one end of the scale neglect of the rudiments of sanitation, the loss of the *corpus sanum*, at the other end the idol worship of athleticism, the depreciation of the intellectual life, and the loss of the *mens sana*.

Are we not then in some danger of drifting into the ways of the Greeks, not in their best days but in their decadence, and of the Romans under the demoralising influences of the Empire?

The Greeks, as we are constantly reminded, in the great period of their creative influence, found nothing so absorbing as the things of the mind; a preeminent characteristic of their life was their love of knowledge, their fine curiosity, their enjoyment of the things of the imagination and of thought. It has been noted that what specially conciliated an Athenian voter was the gift of a theatre ticket; and this is a very instructive and significant fact when we bear in mind that the theatre was the great teacher of religion, morals, poetry, patriotism, all in one; that it combined the influences of Westminster Abbey, the plays of Shakespeare, and the heroic achievements of the race; whereas to an ordinary English voter these things are too often only as caviare to the general.

If so, our education has before it the task of doing what can be done to alter this; and from the Greeks we may derive both lessons and warnings. It was in the days when this decadence was beginning that their excessive admiration of the professional athlete, what we might call their athletic craze, called forth the bitter jibes of Euripides, and his impressive warnings and exhortations to admire and to crown with their highest honours, not those who happened to be swiftest of foot or strongest in the wrestling bout, but the man of sound mind, wise and just, who does most to guide others in the more excellent ways, and to uplift the life of his community:

ὅστις ἡγεῖται πόλει
κάλλιστα, σώφρων καὶ δίκαιος ὢν ἀνήρ.

Here we have a warning by no means inappropriate to our own life and its tendencies. It is, indeed, high time to bring serious and, let us say, scientific thought to bear upon the whole matter.

As I look with such thoughts in my mind over those portions of the educational field with which I have been personally familiar, I note various things which seem to call for both consideration and action.

Taking first the elementary school, it is to be noted that our system does too little to draw out and stimulate the faculties or to form the tastes of each individual child.

Classes are still in many cases far too large.

The system of block grants, being inadequately safeguarded or supplemented by inducements to individual children to apply and prepare for certificates of merit or proficiency, however attractive it may be to inspectors and teachers, needs to be very carefully watched in the interests of individual children. The individual child requires the hope and stimulus of some personal recognition or distinction, if its faculties are to be fully roused and its tastes properly cultivated.

Moreover, the aid of scientific thought and experience is needed to bring both the subjects and methods of instruction into closer and more vital relationship with the environment of the children and with their practical requirements, and more weight has to be given to specific ethical teaching, that moral and spiritual training day by day, which has for its end the development and strengthening of character, and taste, and issues in conduct, which is the greater part of life.

And seeing that it is of the essence of any rational or scientific system to avoid needless waste, it is time that our elementary education should no longer be left in its absurdly truncated condition, which allows a child's education to be stopped abruptly and finally at or about the age of twelve, when in the nature of things it should be only beginning. As things are at present, just when the parent of the upper classes is anxiously considering what school will be the best for his son, a vast number of the children of the poorer classes are left by the State to drift out into a wilderness where all things are forgotten.

In this connection, however, it is due to the Board of Education that we take note of the reminders lately issued in the Introduction to the New Code and the memorandum prefixed to the Regulations for the Training of Teachers.

This Introduction to the Code reminds every parent, school-manager, and teacher, very emphatically, that the purpose of the school is to form and strengthen the character and to develop the intelligence of the children, to fit them both practically and intellectually for the work of life, to send them forth with good and healthy tastes and the desire to know, with habits of observation and clear reasoning, with a living interest in great deeds and great men, and some familiarity with, at all events, some portion of the literature and history of their country; and this being so, the special charge and duty of their teachers is by the spirit of their discipline and of their teaching, by their personal example and influence, to foster in the children, as they grow up in their hands, habits of industry, self-control, endurance, perseverance, courage, to teach them reverence for things and persons good or great, to inspire them with love of duty, love of purity, love of justice and of truth, unselfishness, generosity, public spirit, and so not merely to reach their full development as individuals, but also to become upright and useful members of the community in which they live and worthy sons and daughters of the community to which they belong.

Hardly less valuable, as a contribution to education which shall be more thoughtful than hitherto, is the memorandum prefixed to the new Regulations for the Training of Teachers.

I confine myself to one significant quotation from this valuable document:

"Much of the instruction which is given in all subjects must necessarily be founded upon the statements and the experience of other persons; but every education which deserves to be called complete must include some training of the student in those systematic methods of inquiry which are necessary for any assured advance in knowledge, and which are the most truly educative of all mental processes.

"If this scientific spirit is to find its right expression in

the teaching given in elementary schools it must be made to imbue the whole study of the intending teacher during his course in the Training College. It must not be confined to any one branch of the curriculum. It is true that, partly as the result of tradition and partly from other reasons, the term 'scientific method' has come to be associated more particularly with the study of natural phenomena. But as a matter of fact, scientific method is of equal importance, and is indeed of ancient application, in the fields of history, literature, language, and philosophy; and wherever knowledge of these has made advance, it may be discerned that the essential processes of scientific inquiry have been employed. When Matthew Arnold declared in 1868 that the want of the idea of science, of systematic knowledge, was the capital want of English education and of English life, he was thinking of science as a method and not as a prescribed portion or subject of a curriculum. It cannot be doubted that this want has been seriously prevalent in a large portion of the education and training hitherto provided for elementary school teachers."

We might, indeed, widen the scope of these observations and say that this want of regard for scientific method has been and is a prevalent want in almost every department and grade of English education.

These unaccustomed utterances from Whitehall may very well prove memorable in the history of English education, as the words of William von Humboldt, quoted by Matthew Arnold, are so memorable in connection with the education of Germany: "The thing is *not* to let the schools and universities go on in a drowsy and impotent routine; the thing is to raise the culture of the nation ever higher and higher by their means."

Passing from the sphere of the elementary schools to that of secondary education, we enter on a sphere in which there is much greater need of careful study and the guidance of those who know.

Our secondary education has by the Act of 1902 been handed over very largely to county councils, excellent but heterogeneous bodies, and for the most part not only ignorant of educational needs, methods, and possibilities, but quite unaccustomed to their practical consideration—altogether unprepared and untrained for the responsible work now thrown upon them, and hampered by their besetting fear of the ratepayers.

Add to these difficulties the prejudice, so common in the ordinary English mind, against what is known as the "expert," that is, the man who knows from experience, and is therefore likely to be earnest for improvement, and to believe that wise educational expenditure will repay itself, and you see how manifold are the obstacles in the way of immediate progress.

These county authorities need first of all to be themselves instructed and persuaded as to the right subjects for their schools, the coordination or proportion of subjects in any scheme to be encouraged, the methods of instruction, the sort of teachers to be appointed, the wisdom of spending public money on good education, as exemplified in other countries, like Germany, Switzerland, the United States, Denmark.

Our local authorities feel and recognise that something is needed, but very often they seem to be like children crying in the dark. From lack of educational knowledge and educational experience they do not always know the difference between the right and the wrong method, or between the good and the bad school.

In our rural districts at all events it may be said further that one of our first needs is to persuade the local authorities by some convincing proof that expenditure on popular education higher than elementary is a wise economy, and that their bread cast on educational waters will come back to them, not after many days, but very soon and in their own homes. Thus my observation has led me to the conclusion that by way of preliminary to progress our new educational authorities need instruction or persuasion as to the importance of a sufficient provision for really good secondary education; and it would greatly expedite progress if the Government could and would offer more liberal secondary education grants to be earned by efficient schools, and initial grants towards buildings and scientific equipment, to be met by contributions from local rates or other local sources, public or private.

Many persons and localities would be ready to tax themselves with the view of securing a Treasury grant not available without such taxation. Meanwhile the wheels of our local educational chariots are tarrying on every side so far as higher education, whether general or technical, is concerned.

It would also stimulate our local educational authorities if they could be more fully informed as to the practical advantages which have been derived from a practical system of popular education in such a country as the United States of America; and still more if they had set plainly before them the wonderful results derived by a poor country like Denmark during the last twenty-five years, and in the face of every disadvantage, from the system of education initiated by Bishop Grundtvig and taken up by the Government.

And the need of our middle classes, especially that of the farmer and tradesmen classes, is very pressing. A great deal of the education they receive is given in schools of which the public know very little, whether as regards qualifications of the staff—moral and intellectual—equipment, or methods of teaching, or even sanitary arrangements; and it is to be feared that much of this education would on inquiry be found to be very poor, if judged by any reasonable standard of modern requirements.

When we pass to the class of schools generally spoken of as public schools, those that look to the ancient Universities as the goal of their best pupils, we enter on another very interesting and important field of study.

But for the beginning of our investigation we have to go behind these schools to the preparatory school, which has now assumed a definite place in secondary education, and therefore calls for serious attention. Some of these schools are very good, so far as the conditions under which they work admit of excellence; in others there is, it is to be feared, much room for improvement.

And such schools are now so largely used by parents that their condition becomes a matter of vital importance, as a boy's progress and prospects, his moral and intellectual future, are very frequently determined for good or ill by his experience in the preparatory school, by the bent which has there been given to his morals, tastes, ambitions, by the fostering of his intellectual gifts or the failure to foster them.

In the course of my own experience I have known many boys whose prospects in life were spoilt by their unhappy beginnings in some preparatory school, and who consequently entered their public school foredoomed to failure.

These schools are in most cases private-adventure schools, conducted for private gain. Their staff consists very often of young men untrained for the work of education, and sometimes underpaid. They are subject to no public inspection or examination; in fact, the general public have no knowledge of their condition.

Seeing how grave are the considerations involved, I hold it to be one of the things needed for the general improvement of our secondary education that every private school, of whatever kind, should be liable to public inspection and public report thereon; that a licence should be required for every such school; and that the staff and their qualifications, and the remuneration given to each of them, the sanitary condition, suitability, and educational equipment of the premises, should all be considered in connection with the giving or withholding of a licence.

As regards the curriculum of the schools preparatory to the public schools, the subjects taught, and the proportion of time allotted to each, it has to be borne in mind that they are not free agents. In this respect they are dependent on the requirements of the entrance examination at the public schools which they supply; just as those schools in their turn are dependent on the requirements of the university to which they send their pupils.

Thus, when we come to confer with the authorities of the public schools our first inquiry is whether their entrance examination is such as to conduce to the best system of education from infancy upwards.

Believing, as I do, that there is room for improvement, I would ask them to consider and come to a general agreement as to the subjects on which special stress should be laid. What place, for instance, is occupied in the Eton entrance examination by such subjects as English language and literature, English composition, spelling, handwriting,

and reading aloud? What weight is given to elementary drawing, or to an elementary knowledge of natural phenomena, so as to encourage in the preparatory school an interest in the mineral, vegetable, and animal world around us, and to stimulate in early years the habit of observation, and to impress the difference between eyes and no eyes?

Such subjects as these, it is now generally recognised, ought to be given a foremost place and equal weight with the modicum of arithmetic, French, and ancient languages, which have hitherto, as a rule, formed the staple of this entrance examination, and have consequently given an unnatural twist to the earlier education of our boys.

As regards the public schools themselves, if we consider them critically—though, on the other hand, I trust, by no means forgetting their many and great excellences—the points that invite attention would seem to be such as the following :—

There is undoubtedly a great deal of waste in these schools owing to the poor teaching of untrained masters, who in some cases cannot even maintain reasonable discipline, and in many more have no real knowledge or mastery of the best methods of teaching their subject, be it linguistic, or historical, or literary, or scientific, and have not acquired that first gift of an efficient teacher, the art of interesting their pupils and drawing out their faculties and their tastes.

It would, therefore, be reasonable, as it would certainly be stimulative and advantageous, to require that all masters should be bound to go through some system of well-considered and serious preparation or training for the teacher's work, or at the least a probationary period.

It should, I venture to think, be made a rule that no master could be placed on the *permanent staff* until he was certified and registered as having fully satisfied this requirement and given proof of his efficiency.

And here I would venture to point out to existing masters and mistresses in the leading schools how great a service they may do to the cause of good education if they themselves apply to be registered.

Seeing the advantages which registration is destined to bring to our secondary education by winnowing out inefficient teachers and otherwise, the higher members of the profession may fairly be expected to give their personal adhesion to it as a part of their duty to their profession.

We might almost say to them *noblesse oblige*.

Again, it must, I fear, be admitted that one of the chief defects in our public school education is still to be found in over-attention to memory work, and in the comparative failure to develop powers of thought, taste, and interest in the things of the mind.

And even in the teaching of languages attention has been too exclusively devoted to mere questions of grammar, as if to learn the language were an end in itself, whereas, in the words of Matthew Arnold, "the true aim of schools and instruction is to develop the powers of our mind and to give us access to vital knowledge."

For this end, as he reminds us, the philological or grammatical discipline should be more consciously and systematically combined with the matter to which it is ancillary, the end should be kept in view; whereas nine out of ten of our public-school boys seem never to get through the grammatical vestibule at all; and yet we agree that "no preliminary discipline should be pressed at the risk of keeping minds from getting at the main matter, a knowledge of themselves and the world."

This also was written by Mr. Arnold thirty-six years ago, and thoughtful critics are still repeating, and with some reason, that the majority of boys who grow up in our public schools seem hardly to have received an adequate training for many of the higher duties of life.

We hear much more than formerly about the public schools being the best training-place for good citizenship. Therefore, say the critics, it is reasonable to inquire how far their educational system, their ideals, their traditions, their fashions, and the pervading spirit of their life fit the mass of their pupils intellectually and otherwise for the duties of citizenship, and for grappling in the right spirit with the problems that will confront them.

"Any careful observer," says one of these writers, himself a loyal public-school man, and intimately acquainted with school life, "any careful observer, who has studied the political moods and opinions of the middle classes in this country during the past few years, can hardly have failed to notice two obviously decisive influences: an ignorance of modern history and a want of imagination. For both of these defects the public schools must bear their full share of blame.

"It may be doubted whether any other nation teaches even its own history so little and so badly."

The result is that "to the average public school and university man the foreign intelligence in his daily paper is of less interest than the county cricket; and though events of far reaching importance may be happening almost under his eyes he is in the dark as to their significance."

"As regards the duties and aims of citizenship in all the various affairs of his own country, political, social, economic, he goes out from his school almost wholly uninstructed by the lessons of history, or by any study of the life and the needs of our own times. Again, as it is urged, the lack of imagination is hardly less dangerous to us than lack of instruction in the lessons of history and the social conditions and needs amongst which we have to live and work. No doubt the gift of imagination is a natural gift—it cannot be created. But, given the thing in the germ, it can be stimulated and developed, or starved, stunted, or even crushed out. No system of education that neglects it is even safe. For, without it, principle becomes bigotry and zeal persecution. It is conscientiousness divorced from imagination that produces Robespierres. Now, it is precisely here that we should expect the public schools to be most helpful, for it is through literature that the faculty is most obviously cultivated, and they all profess to give something of a literary training. But though the intention is excellent the performance is often terribly meagre." Whatever may be thought of such criticisms as these, which come from within our public-school life, it is, I imagine, generally agreed by those who know both our national needs and the work and influence of our public schools, that there is much room for improvement in regard to methods of teaching, the cultivation of intellectual interests and tastes, and the stimulating habits of thought in the majority of their pupils. In close connection with these considerations there are two questions of practical importance which deserve a prominent place in any study of our public-school education.

The first of these is whether it is good for all boys alike to continue their life at school, especially at a boarding school, up to the age of eighteen or nineteen; and the other is whether more encouragement and pains should not be given to developing the best type of day school, or, to put it somewhat differently, whether the barrack life of the boarding school has not, through fashionable drift and class prejudice, become too predominant a part of our English education at the expense of the home life with all its finer educational influences.

As regards the first of these questions, it will be remembered that Dr. Arnold considered it a matter of vital importance to expedite the growth of a boy from the childish age to that of a man.

In other words, the boy should not be left to grow through the years of critical change from fourteen to nineteen without special regard to his growth in intellectual taste and moral purpose and thoughtfulness. His education during these critical years should be such as to rouse in him the higher ambitions of a responsible manhood.

Does, then, the actual life of a public school really conduce to this early development in the majority of cases?

My own experience has led me to the conclusion that it cannot be confidently held to do so.

The boys in any of our public schools may be said to fall into two classes—those who in due course reach the sixth form, and during their progress through lower forms have an ambition to reach it; and, on the other hand, a numerous class who do not expect to rise to the sixth, don't care about it, and never exert themselves to reach it.

For the first class, I doubt if any more effective preparation for life has been devised than that of our best English schools; but the case of the second class is somewhat different.

Many of these come to the end of their school time with their intellectual faculties and tastes and their sense of responsibility as men to a great extent undeveloped.

From sixteen to eighteen or nineteen their thoughts, interests, and ambitions have been largely centred in their

games and their out-of-school life, with the natural results that their strongest tastes in after life are for amusement and sport.

Some of these boys, after loitering at school to the age of eighteen or nineteen, go to the University as passmen, some begin their preparation for the work of a doctor or a solicitor, and many go straight from school into City life as men of business; and nearly all of them suffer from the lack of intellectual and moral stimulus during these later years of their school life.

Now many of these boys could without difficulty pass the entrance examination to the University at sixteen or seventeen, if well and carefully taught; and I have long held the view that such boys would greatly benefit by going to Oxford or Cambridge at the age of seventeen, or even sixteen, if suitable arrangements could be made.

It was with this conviction in my mind that I published a scheme showing how this experiment might be tried about twenty years ago.

The interval has confirmed me in the opinion that it would be a distinct gain to many boys to take advantage of such a scheme if made available. They would go out into the world from the University at the age of twenty far better equipped and prepared for life, both as regards knowledge and interests, tastes, and character, than by going straight from school at nineteen.

And looking to my own University of Oxford, I see no reason why such younger students should not be safely received.

There are at least three Colleges in that University which would find it easy to adapt their arrangements so as to secure this. Each of these Colleges has a hall in connection with it, well suited for the residence of a college tutor who might have special charge of these younger students, residing in the hall during their first year with somewhat stricter rules as to ordinary discipline and liberty, but in all other respects exactly on a par with the senior undergraduate members of the College.

On the subject of the day school, as compared with the boarding school, a subject which has not hitherto received the attention it deserves, I may venture to repeat here what in substance I have said on other occasions.

Many parents are so situated that they have no choice in the matter; but to the educational inquirer it is a question of much interest and importance.

The boarding school is admitted to excel in turning out strong, self-reliant, sociable, practical men of affairs, men who have learnt by early experience not to think or make too much of small injustices, to rough it, if need be, with equanimity and cheerfulness, and to count it a man's part to endure hardness in a manly spirit. It is a fine type of character which is thus produced, at its best; but the best is not always seen in the result, and the system too often produces an undue deference to public opinion, a spirit of moral compromise, and a loss of moral enthusiasm. The human soul in its finer parts is a very sensitive thing, and I do not think the barrack life of an average boarding school is always the most favourable for its healthy growth.

As I look back over the school days of my own pupils I feel that those of them had, on the whole, the best education who grew up as day boys in good homes at Clifton College. There they enjoyed all the advantages of the cultivated home, which I need not here enumerate, and at the same time, through the arrangements we made for them, all the best elements in the life of a great boarding school.

In the upper school of 500 boys, we had about 160 day boys living at easy distances from the school.

These boys were divided into two houses—North Town and South Town—about eighty boys in each house, and they were treated for school purposes just as if they were living together in a boarding house.

They were under the same rules as boarders in regard to hours of locking up, or the bounds beyond which they might not go without a note from their parents giving express leave.

Their names were printed in a house list, a master was appointed as their tutor, whose duty it was to look to their educational needs and progress, to their reports and conduct, just as if they had been boarders and he their house master. Each house had its own room or library on the College premises, with books of reference, and so forth, for spare hours, and took its part with the boarding houses, and held its own in all school affairs, games, and other competitions. And my experience of this system compared with others has led me to the conclusion that the form of education which may on the whole claim to be the best is that of a well-organised day school, in which it is clearly understood to be the duty of the masters to give their life to the boys in school and out of school, just as if they were at a boarding school, and in which the boys are distributed into houses for school purposes, just as if they were living in a boarding house. Under such a system they get the best of both worlds, home and school.

From the public school we pass naturally to the Universities, and the first question that meets us is the influence they exercise on school education, through their requirements on admission or matriculation and the bestowal of their endowments and other prizes.

On this part of my subject I have seen no reason to alter or modify what I said at Glasgow three years ago, and therefore I merely enumerate and emphasise the suggestions which I put forward on that occasion for the improvement of education both at school and college.

I hold that it would be equivalent to pouring a new stream of intellectual influence through our secondary education if Oxford and Cambridge were to agree on some such requirements as the following:—

(1) In the matriculation examination (*a*) candidates to be free to offer some adequate equivalent in place of Greek.

(*b*) An elementary knowledge of some branch of natural science, and of one modern language to be required of all candidates.

(*c*) A knowledge of some period of English history and literature also to be required of every candidate, and ability to write English to be tested.

(*d*) The examination in Latin and any other foreign language to include questions on the subject-matter of any prepared books offered, some questions on history and literature, and translation of easy passages not previously prepared.

(*e*) Marks of distinction should be given for work of superior merit in any branch of this examination, as, indeed, of every pass examination conducted by the University.

Candidates should not be excluded from residence before passing this examination, nor should they be required to pass in all subjects at the same time; but the completion of this examination would be the necessary preliminary to entry for any other examination required for a degree.

(2) On the question of endowments and the minimising of waste in the administration of them there is much to be said, and I would suggest for consideration:

(1) That, as a rule, open scholarships and exhibitions might be reduced to free tuition, free rooms, and free dinners in hall, or thereabouts.

(2) That every holder of an open scholarship or exhibition, whose circumstances were such that he needed augmentation, should, on application, receive such augmentation as the College authorities considered sufficient.

(3) That care should be taken to discourage premature specialisation at school.

For this end it should be required that no scholar should enjoy the emoluments of his scholarship until he had passed the matriculation examination described above; and a fair proportion of scholarships should be awarded for excellence in a combination of subjects.

The Universities might also do good service in the way of stimulating secondary education, if some small proportion of their entrance scholarships were distributed over the country as county scholarships, on condition that the county contributed an equal amount in every case.

In this way some equivalent for the endowments, so cynically confiscated by the Education Act of 1902, might be recovered and used for the benefit of poor and meritorious students.

Other reforms, which would, as I believe, be productive of valuable results, are the requiring from every candidate for a degree a knowledge of some portion of our own literature and history, and the encouragement of intellectual interests and ambitions by abolishing all purely pass examinations. A pass examination, in which the candidates are invited simply to aim at a minimum of knowledge or attainment, is hardly worthy of a university. The opportunity

of winning some mark of distinction in this or that portion of what is now a pass examination would frequently rouse some latent ambition in an idle man, and transform the whole spirit of his work.

Thus a modest reform of this kind might be of great practical benefit to the nation by helping in its degree to intellectualise the life of a great many of our young men, and draw out unsuspected interests, faculties, and tastes.

My observations have run to such a length that I must, perforce, conclude, leaving untouched other aspects of University education and training, whether in the old or the new universities, as also the whole subject of the higher education of women, and its proper relationship to traditional systems of instruction and study, framed and intended for men.

And my last word is a word of practical inquiry. How is this Section to be made of most value as an instrument of educational progress?

I leave the answer to this question to those more competent to give it, merely putting on record my own feeling that it may do a valuable service and supply one of our special educational needs, if the working committee of the Section, enlarged by the addition of various representative persons, makes it a duty to collect and publish year by year in succession a series of papers, the best that can be written by recognised authorities, on the chief branches of our English education, dwelling on its immediate and pressing needs, and how best to supply them. To do this the Committee should set to work systematically, commencing in October with monthly meetings, and formulating, without delay, the scheme or series of papers to be prepared and presented to the next meeting of the Association.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. H. BURROWS has been appointed to the post of lecturer and demonstrator of chemistry at the Sir John Cass Technical Institute, Aldgate.

A CONFERENCE of delegates appointed by the Welsh county councils to discuss the question of afforestation in the Principality was held at Swansea on September 7. Sir Charles Philipps, who presided, remarked that there was in Wales an enormous area which could be profitably afforested. It was necessary that professors of the subject should be appointed at the universities, and that practical demonstration areas should be set apart. The view was expressed, in course of discussion, that the establishment of a central school of forestry for Wales was of the utmost importance, and that such a school would become self-supporting after a few years. It was at length resolved that the members should urge on their respective councils the great importance of the study and practical application of forestry by providing lectures to be given at suitable centres and bursaries, enabling students to attend these lectures; also that a central school of forestry be established with example plants of three or more acres, and demonstration areas of suitable extent, and that the necessary expense be defrayed by the county councils on the basis of their respective rateable values, the whole amount now asked for not to exceed 5000*l*.

ADDRESSES will be given at most of the medical schools on the occasion of the opening of the winter session early in October. At Charing Cross Hospital, the session will be opened by the delivery of the fifth biennial Huxley lecture, on "Recent Advances in Science and their Bearing on Medicine and Surgery," by Sir William MacEwen, F.R.S. At the St. George's Hospital an introductory address on "Some Landmarks in the History of Medical Education" will be given by Prof. A. Macalister. The opening meeting of the Physical Society of Guy's Hospital will be held on October 8, when Sir Samuel Wilks, F.R.S., will preside. At King's College Hospital Dr. Thomas Buzzard will deliver an address on "The Future Relation of King's College to its Medical School and Hospital." At St. Mary's Hospital the introductory address will be delivered by Prof. A. E. Wright. At the Middlesex Hospital the session will open with an introductory address by Dr. F. J. Wethered. At University College, London, an introductory address will be given by Prof. J. Norman Collie, F.R.S. The introductory address in connection with the opening of the winter session of the London (Royal Free Hospital) School of Medicine for Women will be delivered by Miss Murdoch at the Medical School on October 3. At the Pharmaceutical Society the inaugural sessional address will be delivered by Prof. A. W. Crossley.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 9.—M. Mascart in the chair.—On a gaseous interrupter: K. R. **Johnson.** The interrupter consists of two plates of aluminium placed in a solution of an electrolyte. The heating effect of the current evolves a bubble of steam, which temporarily breaks the circuit; this is rapidly condensed in the upper part of the cell, and so causes a series of makes and breaks. It has the advantage of working independently of the dimensions of the metallic circuit, and even in the absence of an induction coil or a solenoid. Its disadvantage is that the frequency is rather low.—On a reagent for the hydrides of phosphorus, arsenic, and antimony: P. **Lemoult.** These gases, when diluted with an inert gas, react with a solution of the double iodide of mercury and potassium, giving characteristic crystalline precipitates, orange, yellow or brown in colour. They have been analysed, and correspond to the formula RHg_3I_3, in which R may be P, As, or Sb.—Benzopinacone and benzopinacoline: Amand **Valeur.** Evidence is given that the compound obtained by W. Dilthey and E. Last by the interaction of ethyl oxalate and phenylmagnesium bromide is a pinacone and not a pinacoline as supposed by them.—The synthesis of estragol and aromatic derivatives with an unsaturated chain: M. **Tiffeneau.**—On the reproductive apparatus of the Mucorinæ: J. **Dauphin.** Glucose, levulose, and galactose favour the appearance of sporangia; lactose and saccharose give only sporangia and chlamydospores; maltose and mannite give uniquely chlamydospores.—On macles: G. **Friedel.**—The relations between the blood circulation and the measurement of tactile sensibility: N. **Vaschide.** It is shown that there is an extremely close relation between the circulation of the blood and the tactile sensibility.

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