THURSDAY, SEPTEMBER 15, 1910.

BIBLIOGRAPHY OF ATLASES.

Library of Congress. A list of Geographical Atlases in the Library of Congress, with Bibliographical Notes. Compiled under the direction of Philip Lee Phillips. Vol. i., Atlases. Pp. xiii+1208. Vol ii., Author List; Index. Pp. 1209–1659. (Washington: Government Printing Office, 1909.) Price 2.35 dollars the two vols.

THOUGH making no claim to be a complete list of atlases, this work marks a very important step towards a much-needed annotated bibliography of such publications, nothing on a similar scale having ever been attempted before. The collection dealt with is important enough to represent a large proportion of the whole material in existence, and the information supplied, both in the form of general notes and of complete lists of the maps contained in the more important atlas, will be of great value to students. These lists are of particular service in the case of early works, often found incomplete or broken up into their constituent items, but of great interest from the point of view of the history of geography.

In such early works the present collection is comparatively rich. The set of editions of Ptolemy's "Geography," so valuable as presenting a view of the progress of knowledge, on the academic side at least, during the century and more following the discovery of America, makes a near approach to completeness. Ortelius is well represented, and in a somewhat less degree, Mercator, though there is no copy of the great Italian atlas of Lafreri, somewhat earlier in date. Nor do we find the *Speculum nauticum* of Waghenaer, the earliest example of a purely hydrographical atlas, though we meet with Dudley's "Arcano del Mare," and many later works of a similar kind. Most of the best modern atlases are, of course, included. As might be expected, works American, either in origin or subject-matter, decidedly predominate, the items under "United States" numbering about two-fifths of the whole.

Valuable as the catalogue certainly is, and great as has evidently been the labour expended upon it, it could hardly be that imperfections should not be noticeable in matters of detail. The entire absence of headlines giving an indication of the broad subdivisions of the subject is a drawback, as is also the reference in the index, not to the pages of the work, but to the *numbers* of the main entries, placed as these are in no very conspicuous position, and never repeated when an entry covers several pages. The general arrangement is somewhat illogical, *special* subject headings always preceding *general* ones, though special topographical headings again follow the latter. In the notes the vague references to authorities are irritating (*e.g.* "cf. Nordenskiöld," after a quotation from that author). There seems no very consistent plan as regards the choice of atlases for analysis; thus there is no full list of the maps in Nordenskiöld's "Facsimile Atlas," though, curiously enough, some of the maps find a place in the index, when borrowed by other authors. It is certainly useful to find all the publishers of atlases grouped under "Publishers" in the index, but this hardly justifies the omission of the individual names from their proper places.

Universal knowledge cannot, of course, be expected from the best of editors, but further expert assistance might have saved some errors, these being sometimes due to the unquestioning acceptance of statements by earlier writers. Thus the fifteenth-century editor of Ptolemy, Dom Nicolaus Germanus, still appears as "Donis." The statement that the 1598 Italian version of Ptolemy was due to Cernoti is correct only in regard to the new matter added by Magini. The famous fifteenth-century map of Nicolas de Cusa is ascribed to Nicolas "Cusana," and, stranger still, the sixteenth-century humanist, Loriti, or "Glareanus" (so named from Glarus, in Switzerland), appears as "H. Loritz de Gloria."

But these are, after all, small matters to be set against the undoubted value of the catalogue, both for purposes of reference and as a step towards a still more complete list of atlases which we may hope to see published some day.

LEAD AND ZINC PIGMENTS.

Lead and Zinc Pigments. By Dr. C. D. Holley. Pp. xix+340. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 12*s.* 6*d.* net.

OWING to various causes, the development of the paint industry in the United States has been of a very special and interesting character. On the one hand there has been a large demand for ready-mixed paints for the protection of the wooden buildings which are still so common in that country, and on the other the existence of large deposits of zinc lead ores has led to the preparation of sublimed whites, which are largely used in the making-up of ready-mixed paints. In addition, there is the tendency, which we find in all industries in America, to replace hand by machine methods, and thus develop new and modified processes. A book, therefore, on the manufacture of lead and zinc pigments, written by one so thoroughly familiar with all the processes as Dr. Holley, is of great interest to English readers.

In the first place, a detailed description will be found of the mechanical processes of white-lead manufacture which have been so successful in the United States, although they never seem to have succeeded in replacing the ordinary Dutch process in this country. Detailed descriptions of the Carter process, the Matheson process, and others will be found, evidently written by one who is thoroughly familiar with them, while the photographs of actual plant are of great interest. In addition, the preparation of sublimed lead pigments, which has become of such great importance in the United States, although used to a comparatively small extent in this country, including sublimed white and sublimed blue lead, the preparation of zinc oxide, and the preparation of the mixed lead

and zinc paints which are a big feature of the American paint industry, and are obtained by subliming mixed lead and zinc ores, and which contain various proportions of zinc oxide and lead sulphate, are fully described. The preparation also of the oxides of lead and lead chromes is dealt with, and the preparation and properties of zinc sulphide paints.

A very complete account is also given of the elaborate practical tests of various paints which are being made on special experimental stations in the United States at present, with the view of deciding which paints are most durable for outside use. These experiments are giving some very valuable results. For instance, the usual assumption in this country that white lead is the best pigment for protection of outside surfaces has apparently been quite disproved by these results. Zinc white, or mixtures of zinc white with white lead, prove to be more durable. These experiments are still being continued and the results published from time to time, and should be carefully watched by architects and engineers in this country, where similar experiments might well be carried out. The physical and chemical properties of these various whites and their analyses are also thoroughly dealt with; in fact, the whole book contains a great deal of very valuable information written from the American point of view, and should therefore be of special interest to all those connected with the paint industry in this country. A. P. LAURIE.

METEOROLOGICAL TABLES.

Tables for the Reduction of Meteorological Observations. Prepared by Dr. G. C. Simpson, under the direction of Dr. Gilbert T. Walker, F.R.S. Pp. ix+95. (Calcutta: Government Printing Office, 1910.)

THE present revised edition of Blanford's meteorological tables, prepared for the routine work of the Indian meteorological service, contains in all sixteen tables, of which the first and last pairs are for the interconversion of barometric heights and of temperatures in the English and metric systems. The remaining tables are in English units. The relationship 1 metre = 39·37079 inches, adopted from the international tables, is an example of fictitious accuracy which might be discarded in view of the values found by Rogers (1893), 39·370155, and Benoit (1902), 39·370113. The same criticism applies to the expressions for the corrections to the barometric height H, for the variation of gravity with latitude (λ), and altitude (h), viz. $0{\cdot}00259 \cos 2\lambda H$ and $5{\cdot}97 \times 10^{-8} h H$. The arrangement in table vii., for reducing the barometer to sea-level, or for finding differences of height, is excellent. The *logarithms* are tabulated, and the temperature and humidity terms have been combined by assuming a constant value for the mean air-pressure occurring in the latter; the result is that the complicated process involved in applying the Smithsonian or international tables has vanished, and the desired value may be obtained by a simple calculation as accurately as the observations ordinarily allow. It is, however, *not* necessary to apply the latitude correction to the barometer readings in finding differences of height.

The major part of the volume is devoted to humidity tables for reducing psychrometric observations for temperatures between −20° and 130° F., and for pressures 29·7, 27·7, 25·8, 23·4, 19·7 inches. Presumably 25·8, 23·4 were retained because they are approximately the mean pressures at altitudes of 4000 and 7000 feet respectively, but it seems inappropriate to determine the increments of the argument, *pressure*, by unequal increments of *altitude*. The tables are strictly applicable to observations taken in light winds only.

A useful little table gives the mean daily range of pressure determined from ten tropical stations.

The tables are well and carefully printed on good paper, but the volume might with advantage be made of a more convenient size. The adoption of the principle, common in logarithmic tables, of neither printing nor allowing space for unnecessary figures, would permit this without sacrificing clearness.

E. GOLD.

PLANTS AND GARDENS.

Sweet Peas. By H. J. Wright. Pp. xi+116. Price 1*s.* 6*d.*

Pansies, Violas, and Violets. By Wm. Cuthbertson, J.P., and R. Hooper Pearson. Pp. xi+116. *Present-Day Gardening*, edited by R. Hooper Pearson. (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 1*s.* 6*d.*

Die Hiede. By W. Wagner. Pp. 200. (Leipzig: Quelle and Meyer, n.d.) Price 1.80 marks.

Niedere Pflanzen. By Dr. R. Timm. Pp. 194. (Naturwissenschaftliche Bibliothek für Jugend und Volk.) (Leipzig: Quelle and Meyer, n.d.) Price 1.80 marks.

Das Holz. By H. Kottmeier and F. Uhlmann. Pp. iv+143. (Leipzig: Quelle and Meyer, 1910.) Price 1.25 marks.

Der Pflanzengarten, seine Anlage und seine Verwer kung. By Prof. F. Pfuhl. Pp. 152. (Leipzig: Quelle and Meyer, 1910.) Price 2.50 marks.

THE dictum as to the endless making of books may be applied with particular force to works relating to gardening and nature study at the present day. To such an extent has the gardening fashion seized the country that every class of plants must now have its own special treatise. The two books first on the list are the opening volumes of a series entitled "Present-day Gardening," produced under the editorship of the editor of the *Gardener's Chronicle*, and they appear to be excellent alike in their coloured illustrations and in the letterpress. The illustrations are remarkably good examples of colour printing, and it is only in the case of some of the lilac shades that some criticism might be made. The text is both interesting and practically useful, and the plan followed is similar in both volumes, opening with some historical notes, general culture, the value of the plants for decoration, an account of standard varieties, &c. If forthcoming volumes maintain the level of those

before us, the series should find high favour with the gardening public.

In "Niedere Pflanzen" and "Die Heide" we have two small German natural history books; the former deals with ferns, mosses, fungi, and algæ, and is a wonderfully compact and comprehensive little book, copiously illustrated with a frontispiece of Equisetum in colour. "Die Hiede" opens with an inferior coloured plate of Culluna, with attendant insects, but the letterpress demands full praise and the illustrations throughout the text are well executed. The history of the heath lands, the component plants, &c., are described in detail, and the biology of the flowers is also fully dealt with; a chapter is devoted to the trees of the heath land. The latter portion of the book gives an account of the animal life of the moor, and numerous figures are given of the various insects associated with this formation. Both volumes are practical and useful works, and the latter especially affords a model which might well be copied in England.

"Das Holz" is a short practical forestry manual, which, in small compass, gives a mass of useful information as to forestry matters in general, such as wood structure, measurement of timber, felling, haulage, &c., and of the industries connected with timber. A book on these lines would probably find a ready sale in England, and be of considerable value.

"Der Pflanzengarten" is concerned with the design and usefulness of a garden as a place for study, and is principally occupied in giving a description of the garden at the Kgl. Mariengymnasium, Posen, and with an account of the plants found therein.

OUR BOOK SHELF.

The Black Bear. By William H. Wright. Pp. vi + 127. (London: T. Werner Laurie, n.d.) Price 6*s.* net.

In this well-illustrated volume the author has done for *Ursus americanus* that which he accomplished so successfully for *U. horribilis* in its fellow (see NATURE, vol. 82, pp. 423–4, 1910). The first fifty pages are devoted to a young black bear reared and tamed by Mr. Wright, while in the remainder the distribution and habits of the species are discussed in a manner indicative of intimate knowledge. Indeed, the author's acquaintance with the black bear appears to be as close as with its larger grey cousin. "Cinnamon" bears, it is shown, may be either of the black or the grey species, and the author is disposed to regard the glacier-bear (*U. emmonsi*) and the white bear of Gribble Island (*U. kermodei*) as specifically inseparable from the former. From among a number of interesting notes, attention may be specially directed to the author's observations with regard to the extremely small size and imperfect development of newborn bears, especially those of the present species. The cubs of the black bear are at first "absurdly small and pitifully helpless, weighing only from 8 to 18 ounces each, according to the number in the litter, and are born about two months before the dam emerges from her winter quarters." An old bear will weigh about 400 lb.; and the pups of a 40 lb. dog will be as large as the cubs of a bear of this weight. To explain this, the author suggests that a hibernating bear, which, of course, takes no food, could not nurse cubs proportionately so large as those of the dog; and, whether or no this be the right explanation, there can be little doubt that there is some connection between the hibernating habit and the diminutive size of the cubs.

The book is pleasant reading, and full of hunting and forest lore. R. L.

Chemistry for Photographers. By Chas. F. Townsend. Fifth edition, revised. Pp. 129. (London: George Routledge and Sons, Ltd.; Dawbarn and Ward, Ltd., n.d.). Price 1*s.* net.

The more of chemistry and physics the photographer knows the better is he able to understand his work, to overcome difficulties, and to meet new contingencies. It is impossible to set forth the main facts of chemistry in so small a volume as this, even if the matter is restricted to those subjects that have an immediate bearing on photography; but it is possible to do something useful in this direction even within so few pages. The author commences with burettes and pipettes, and goes on, rather unnecessarily, to gallipots and jampots. We do not think that such expressions as "The iron, as it were, says to the silver, 'You've got my NO_3; drop it!' And the silver has to drop it," assist in representing the subject clearly, and in this case the description would appear to give an incorrect impression. From about the middle of the book the chemistry almost disappears in favour of practical and empirical formulæ, with short instructions for various photographic operations. Some of the author's statements are open to criticism. We read, on p. 62, that "all chemical reactions are reversible." That as, when a photographic plate is exposed to light "there is no outlet for the products of decomposition—the excess of bromide or other halogen set free on reduction in this case—a state of equilibrium is reached at a certain point. If decomposition is carried beyond this point, reversal sets in, which may go the whole way until the original compounds are re-formed." At p. 86 we read that carbon tissue is thin, and at p. 94, in the five and a half lines devoted to Dr. Smith's "Uto" paper, that "it is rendered colour sensitive by means of anethol." Other misleading or unpractical statements might be quoted. A photographer who wishes to know something about combining proportions, the general properties of acids and alkalies, and a few other elementary chemical matters, will probably find what he wants here, with a good many items of miscellaneous information added.

Die Aufzucht und Kultur der Parasitischen Samenpflanzen. By Prof. E. Heinricher. Pp. v + 53. (Jena: Gustav Fischer, 1910.) Price 2 marks.

Following upon his original investigations on Lathræa and other parasitic genera of the Scrophulariaceæ, Prof. E. Heinricher has prepared this small volume dealing with the propagation and cultivation of parasitic seed-plants that will appeal especially to gardeners charged with the supply of material for botanical laboratories. The notes refer to well-known European parasites and hemiparasites, and some less common genera, such as Tozzia, Osyris, and Phelipæa. One of the most interesting is *Osyris alba*, which flourishes and produces fine suckers on willows. *Phelipaea biebersteinii*, one of the Orobanchaceæ indigenous to the Crimea and the Caucasus, is worth growing for its flower; its natural host is *Centaurea dealbata*. Another novelty recommended by the author is a pot of *Melampyrum arvense*, which feeds on the roots of several shrubs and small trees.

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.]*

Lord Morton's Quagga Hybrid and Origin of Dun Horses.

WILL you allow me to suggest that some of the data which speculators upon the antecedents and the history of the horse have made much use of are not too trustworthy?

First, I would suggest that there is doubt whether Lord Morton's famous quagga hybrid is a hybrid at all. Agassé's portrait of it and of its sire and dam are to be seen in the museum of the Royal College of Surgeons in London. According to the portrait, the hybrid was a bay with black "points," the blackness mounting just to the pastern joint, as it does in many bays.

Chestnut has been shown to be recessive to all other colours; and a chestnut never has black "points." Prof. Cossar Ewart tells us that "in their body colour none" of his hybrids took after their sire, the Burchell zebra, a close relation to the quagga. Now, in Lord Morton's case, we have a chestnut mare producing a bay, a colour she certainly does not contain. Is that possible?

Again, we have a chestnut and a quagga, whose legs were white, or, at any rate, a dirty white, producing a foal with black "points." Is that also possible? Unfortunately, there is one disturbing element in what has just been put forward; but it is not serious. I understand that Agassé may have painted the "hybrid" from a drawing, not from the life. But in a case so critical, and with Lord Morton at least to keep him right, it is scarcely possible he could have given the "hybrid" a colour and "points" it did not possess.

Next, I would suggest that the dun colour in horses is not a reversion. In view of the fact that one of our greatest men believed in the dun reversion, and also that it led him and others to argue the primitive horse to be dun and striped, my suggestion may be held to be very presumptive. All the same, it must be made.

In April last, the Royal Dublin Society published a paper for me on "The Inheritance of Coat Colour in Horses," in which it was pointed out somewhat tentatively, because the evidence then at command was small, that dun is dominant to chestnut, black, bay, and brown, and recessive to grey; while its relation to roan was not clear. Since that time a considerable body of further evidence has been got, and it all confirms the original conclusion. Accordingly, a dun foal cannot be got unless one of its parents is either a dun or a grey or a dun roan. Greys are, therefore, the only colour that could throw dun "reversions."

My chief purpose in asking you to publish this letter is to beg for evidence on the points at issue from anyone who would be good enough to send it. What is wanted is evidence—

(1) As to the body colours and leg markings of hybrids between zebras (especially Burchell zebras) and chestnut horses, and

(2) As to the parentage of dun horses.

Perhaps it may be well to say that, if there is difficulty in distinguishing bays, duns, and chestnuts, the following can usually be relied upon:—Unless white "stockings" intervene, bays and duns have always black "points." In bays the colour of the nostril patch is nearly always lighter than that of the face, but in duns there is no distinct break between the colours of the nostril patch and the face. Chestnuts have not black "points"; their legs are coloured like their bodies.

JAMES WILSON.

Royal College of Science, Dublin.

PROF. WILSON thinks the "bay" filly which Lord Morton says he obtained by crossing a chestnut mare with a quagga was not a hybrid, because he assumes that a chestnut does not contain a bay colour, and that the offspring of a white-legged quagga and a chestnut mare would not be likely to have black "points." Prof. Wilson also thinks "that the dun colour in horses is not a reversion," and that the primitive horse was not, as Darwin and others believed, "dun and striped."

The prevailing colour of all the wild Equidæ now living in Asia is dun, and the wild horse (*Equus przewalskii*) has dark points and usually a light muzzle. As crosses between varieties of Burchell zebras with white "points," and crosses between zebras and ponies have, usually, dark patches at the fetlocks, and as the body colour of zebra-horse hybrids is usually yellow, rufous, or leather-dun, it may be assumed that the remote ancestors of the modern zebras only differed in their coat colour from Prejvalsky's horse in being more richly striped.

The drawing of Lord Morton's filly by Agassé might be said to represent a bay or a bay-dun—that the filly was a bay-dun rather than a bay may be inferred from Lord Morton saying that in her colour, as well as in her form, the hybrid filly afforded "very decided evidence of her mixed origin." A light chestnut Iceland pony mare in my stud produced a bay-dun with dark "points" to a yellow-dun Prejvalsky stallion, and a richly striped yellow-dun Highland mare produced first a dark bay with dark "points" and then a light bay (also with dark "points") to a chestnut thoroughbred (Diplomat). I am hence not surprised that Lord Morton's chestnut Arab produced a filly of a bay or bay-dun colour to a quagga.

It has hitherto, so far as I know, not been pointed out that there are two kinds of duns, viz.:—(1) duns without either a dorsal band, shoulder or leg stripes, and (2) duns *with a dorsal band* and, as a rule, more or less distinct bars on the legs—sometimes also with zebra-like markings on the face, neck, shoulders, and trunk, and spots on the hind quarters. Duns *without stripes* of any kind are now and again obtained when a grey is bred with a black or with a bay. The dun colour in these unstriped horses is apparently not a reversion. Moreover, the offspring of two unstriped yellow-duns may be bay or brown.

Yellow-duns with a dorsal band and at least vestiges of leg bars are, in all probability, either the descendants of a long line of dun ancestors or are reversions. Owing to the elimination of duns by breeders—the Arabs thought duns only fit for Jews to ride—there probably does not exist to-day a yellow-dun thoroughbred, but now and again one sees a well-bred yellow-dun hunter with distinct leg bars—a descendant, perhaps, of the dun mare or the dun Arab which figure amongst the ancestors of Touchstone.

That dun is latent in some bays and blacks was proved recently by a black Shetland mare from Unst producing to a bay Arab (Insaf), with a dorsal band and leg bars a richly striped yellow-dun. There are striped white, yellow, leather, and mouse duns. I have obtained a striped white dun from a red-roan Arab mare and a yellow-dun Norse stallion; a striped yellow-dun from a bay Sumatra stallion and a mouse-dun Shetland-Welsh mare; a striped leather-dun from a yellow-dun Highland stallion and a chestnut Shetland-Arab mare; and a mouse-dun from a yellow-dun Highland stallion and a black Highland mare.

My crossing experiments do not support the view that chestnut never contains bay or that yellow-dun is always dominant with chestnut, bay, brown, and black—they on the whole support the view that characters are "patent" or "latent" rather than, as Mendelians say, "present" or "absent."

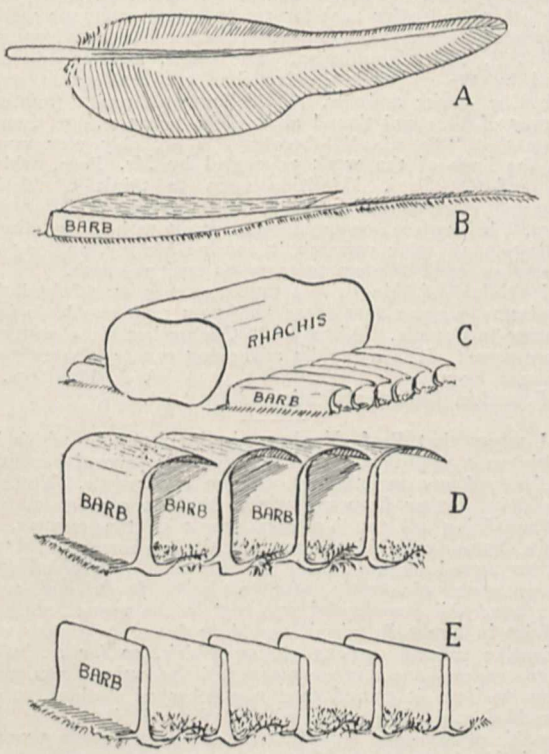
As to the colour of hybrids between a Burchell zebra and chestnut mares, I have little to say. A chestnut polo-pony mare produced three hybrids. In the first two (twins) the body colour at birth was of a rufous tint, and the stripes of a faint reddish-brown colour. When full grown, the body colour was of a leather-dun hue, the stripes being a slightly darker shade of the same colour. In the third hybrid the body colour, golden-dun at birth, was eventually a dark yellow-dun. The stripes in this third hybrid are of a brown colour, and extremely well marked on the neck and limbs. Dark-brown patches at the fetlocks represent black "points."

J. C. EWART.

An Undescribed Feather Element.

In all the European ducks, geese, and swans, and in certain game birds, there is a remarkable feature about the structure of the primary feathers that seems to be hitherto undescribed. The under surface of a feather from such a bird bears a distinct glistening "mirror" occupying that portion of the web adjoining the rhachis. It is quite visible to the unaided eye in any position of light, and may be readily detected by the finger-tip. A closer examination shows this area to consist of a series of narrow silvery (sometimes golden or brassy) membranes each closely overlapping the next distal barb. For illustration I have chosen the fourth primary of an adult Bewick's swan. In Fig. A the glistening area is left unshaded; in Fig. B a single barb is figured, with its membrane; Fig. C shows a portion of the rhachis with the web cut across to show the barbs with their membranes in section; Fig. D gives in transverse section four barbs with the curved membranes. This will be rendered clearer by a reference to the fifth diagram, which figures the barbs on a normal feather taken from a cormorant. In this bird the membranes are wanting.

So far as British birds are concerned, this feather



element is present only in the ducks and their allies, where it is always conspicuous; in the four British grouse, where it is again striking; and in the partridge and the pheasant. In certain exotic game birds (Lophortyx, Tragopan, Gallus, Catreus, &c.) it is quite absent, and this makes its uniform constancy in the Anatidæ all the more noteworthy. The total absence of the structure in the feathers of Steganopodes, Alcæ, Pygopodes, Gaviæ, and Tubinares suggests that it is not essential to the feathers of water birds; and it is, moreover, as conspicuous on the feathers of the Anatidæ with terrestrial habits as it is on those of the truly aquatic ducks. This leads one to look upon it as vestigial of some earlier structure, and as such it might be used for taxonomic purposes.

The diagram of the primary shows the emarginations or notches of the web that have been, and still are, used in the classification of birds—Circus, for example. The use or meaning of these notches has not been explained, so I may be allowed to point out that the shapes of the outer primaries are governed by the law of Avanzini. Prof. Roy, in Newton's "Dictionary of Birds," has shown how this law affects the general shapes of the wing feathers, but does not notice the notches. When the wing is fully extended, with the primaries spread out like the fingers of a hand, each feather must necessarily function as a separate wing or sail. As the position of the rhachis cannot be altered, the web is trimmed away to the necessary degree. The new feathers appear fully formed, but, in many cases, I have reason to suspect that the notching is increased by the subsequent wear of the adjacent feathers.

FREDK. J. STUBBS.

Stepney Borough Museum, E.

An Interesting Donkey Hybrid.

In his letter on the "Origin of the Domestic 'Blotched' Tabby Cat" (NATURE, September 8, p. 298), Mr. Vickers says, "after much diligent search I have been unable to find a single instance in which complete segregation has taken place in respect of all specific characters *when two well-defined species are crossed.*" Our knowledge of specific characters is too limited to make such a claim provable if put forward; but I have recently seen a hybrid between two very distinct species which, at all events, approaches that standard. This is a donkey belonging to Sir Claud Alexander, Bart., which he tells me was bred by Hagenbeck between a male dziggetai, or Mongolian donkey (*Equus hemionus*), and a female Nubian donkey (*Equus asinus*). Both these gentlemen are well acquainted with the species in question, which, as every zoologist knows, are very distinct forms. Yet, unless I had been told that the animal was a hybrid, I should unhesitatingly have identified her as a pure-bred African donkey. Her colour is grey, her legs are strongly barred with black, and she has a sharply defined black shoulder-stripe and black mottling at the base of the long ears. All these characters belong essentially to the African, as opposed to the Asiatic, species.

In one point an approximation to the Asiatic type is shown. This is a widening of the spinal stripe towards the croup, a feature which is certainly more marked than in any African donkey I have seen. Still, the stripe is not nearly so wide as in the dziggetai; and, seeing how variable is the width of this stripe in quaggas belonging to the same local race, I do not feel sure that its width in the donkey in question is not an individual peculiarity independent of inheritance.

It is quite true, as Mr. Vickers says, although he expresses the fact somewhat differently, that the progeny of two distinct species usually combines the characters of the parents in such a way as to be describable as intermediate between them. The notorious case of Ward's zebra may be quoted as an instance in point. Until its history was known and its true nature ascertained, this animal was regarded as a distinct species intermediate between Chapman's quagga and the mountain zebra. It is, in reality, as I have elsewhere shown, a hybrid between the two; and I cite the case here for comparison with that of the donkeys. Whereas the two striped species of Equus produced an "intermediate" when crossed, the two nearly self-coloured species gave a very different result, thus proving the impossibility of foretelling what the progeny will be like when two well-defined species interbreed. It may be claimed, moreover, I think, that this remarkable hybrid donkey weakens the force of Mr. Vickers's contention that the "blotched" and "striped" tabby cats can hardly be representatives of distinct species because their kittens are not intermediate between the two types when crossed.

R. I. POCOCK.

Zoological Gardens, September 1.

British Marine Zoology.

It is possible to have a considerable amount of sympathy with Mr. S. Pace and also with his critic, Prof. MacBride, and at the same time to differ from both on some points. Mr. Pace aims high in both:—(1) his "bibliography of all works dealing with the biology of the European seas," and (2) his "exhaustive faunistic survey of the marine life at one or more points on our coasts," and marine biologists must wish him all possible success in his venture; but the doubt remains whether he has not under-

taken more than he can carry out, and whether it would not require the libraries and the staff and all the other resources of one or more scientific societies to produce the first, and the united work of the marine laboratories and other investigating organisations round the coast to deal adequately with the second object.

But even if Mr. Pace falls short of his ideal, he may still produce much—both bibliographical and faunistic—that will be of use in marine biology. This is a case where the success will depend entirely upon the proved utility. If Mr. Pace's bibliographical "Contributions," as they are called, give us something substantial that the other "Records" do not, we shall all use them and be thankful, and that is probably all Mr. Pace desires.

In regard to the "exhaustive and continuous systematic biological survey," one cannot but doubt whether Mr. Pace quite realises the magnitude of what he has set before him. I have been attempting for some years—with considerable support from others—to make a systematic survey (I do not think I ever imagined it would be exhaustive) of one small part of the coast in one little section only of marine zoology—viz. plankton—and I have found that the resources of a university laboratory and a fairly well-equipped biological station, a special steamer with expensive apparatus and a good many assistants, are all required to provide, and to deal with, sufficient data; and I believe that others, both in this country and elsewhere, have had much the same experience.

But still Mr. Pace, with a movable biological station of "relatively simple and inexpensive equipment," may do good faunistic work on parts of the coast not at present covered by the existing marine laboratories; and I must dissent from Prof. MacBride's attempt (NATURE, p. 253) to discourage such work. Every new biological station becomes a centre of useful work, brings in its contributions to knowledge, interests its local public, obtains support for scientific work, and rears up young naturalists, both professional and amateur. Prof. MacBride rightly alludes to the foundations laid by "the splendid amateurs of the last generation." I agree with him that "a great service to science would be accomplished if we could resuscitate this race"; and I believe that local biological stations are the most hopeful influences working in that direction.

Nor can one agree with Prof. MacBride in his evident desire to see one marine station at Plymouth monopolising the marine biological investigations of the whole country. Even if such a state of affairs were possible, the single station could not overtake all the functions of the half-dozen—such as Cullercoats, St. Andrews, Millport, Port Erin, &c. For example, take the needs of local universities. How could Plymouth be to St. Andrews what the Gatty marine laboratory is, or serve Newcastle as the Cullercoats laboratory does? In Liverpool, again (to take the case I know best), the zoology school has had about twenty senior students each year lately who have required a vacation course of marine biology, and have obtained it at very little expense at Port Erin. These students could not have gone to Plymouth: the distance and the expense are prohibitive. Or take the needs of local sea-fisheries authorities. Could a single marine station anywhere on the south coast serve adequately the Northumberland or the Lancashire districts?

Prof. MacBride says, "we should therefore regret very much to see another 'station' started." It reminds one of the opinions expressed some years ago that the number of universities in England should not be increased. Fortunately, such views did not prevail, and the provincial universities of England are justifying their existence. It will be the same with those centres of marine investigation which we call "stations." Each new one properly established in a suitable locality, and wisely directed, will have its own functions to perform, and will attract students and supporters—and each, I believe, will receive the support it deserves. I have long thought there ought to be a fine biological station in the Firth of Forth in connection with the great University of Edinburgh; surely there ought to be one on the south-east coast within easy reach of London, and possibly South Wales or the Bristol Channel might have another. That would not be too many for England. There are more than that number in America, although Prof. MacBride writes as if Wood's Hole alone served the zoological schools of that country as he suggests Plymouth should do here.

I cannot understand Mr. Pace's contention that the intrusion of the economic motive "must arrest, if it does not entirely hinder, scientific research"—and Prof. MacBride seems to approve the view. Has it done so in the case of the Kiel "Kommission," or of the International Organisation for the Exploration of the North Sea in the interests of fisheries exploitation? The reviews in NATURE from time to time of the scientific publications of the Scottish Fishery Board and the Irish and other scientific fisheries departments sufficiently show that scientific research is greatly promoted by these bodies with "economic motives."

Prof. MacBride does not, of course, intend to mislead us in any way, but the incompleteness of his statement in regard to Wood's Hole may give the erroneous impression, to those who do not know the facts, that there is no economic work carried on at that celebrated centre of fisheries investigation and cod and lobster hatching! The fact is that there are two well-equipped laboratories working side by side at Wood's Hole—the one for teaching and research, under the direction of Prof. Frank R. Lillie, and the other (and older one) for research and economic work, belonging to the Government Fisheries Bureau, formerly the U.S. Fish Commission. The latter, although dominated by the economic motive, has produced much good scientific work; and Dr. F. B. Sumner's recent faunistic survey of Vineyard Sound and neighbouring waters, issued from that "fisheries" laboratory, is probably very much on the lines of the work advocated by Mr. Pace, which he and (?) Prof. MacBride seem to think would be arrested or hindered by such an environment. For my part, I believe the economic environment to be most stimulating to scientific research in marine biology, so long as there is perfect freedom to carry on such research.

I think Prof. MacBride's final sentence would lead the reader to suppose that there was now only one biological station in Canada. When I left Quebec last October there were three! It is a rapidly advancing country: there may be more now. W. A. HERDMAN.

Port Erin Biological Station, August 28.

I THINK that Prof. Herdman in his letter in which he criticises a recent article of mine in this journal has misunderstood my meaning in one or two points. Nothing could be further from my wishes than to see one station monopolising all the biological work of the country. I quite agree with him that biological science would be better served by a multiplicity of stations, *provided that these were adequately equipped with funds and with workers.* All I contended was that in the present state of affairs in Great Britain it would be better to concentrate scientific support on one station which, so far as buildings and appliances are concerned, is adequately equipped, than to have it spread over a number of stations poorly provided with funds and with staff, and, *ipso facto*, incapable of affording opportunities of really first-class work. Prof. Herdman thinks that each new station will attract local support and enlarge the number of the devotees of marine zoology. I sincerely trust that he is right; but my experience has been that a poorly equipped station comes to be regarded by the local friends of education as an expensive toy, which they soon tire of supporting. Mr. Pace's appeal was primarily to the professional zoologists, and as the support of these is at present not sufficient to keep one station in proper financial health, I did not see how they could be expected to support two.

Prof. Herdman is mistaken in supposing that I agree with Mr. Pace that economic work necessarily "arrests, if it does not hinder, scientific research"; but I am sure he will agree that a station the sole aim of which was scientific would be the ideal one, and I must point out that his accusation of "incompleteness" in my statement that Wood's Hole was such a station is entirely unjustified. It is true, as Prof. Herdman says, that there are *two* stations in Wood's Hole, one supported by the Federal Government and devoted entirely to economic work, and the other supported entirely by zoologists; but the station which has attained world-wide fame, owing to the quantity and

quality of the research which has issued from it, is the second and purely scientific one. I never maintained that Wood's Hole was the sole station in the States, but the number of stations there is far less in proportion to the number of universities than it is in this country. Prof. Loeb and the senior Chicago students for years spent every summer in Wood's Hole, although Chicago and Wood's Hole are 1000 miles distant, a striking commentary on Prof. Herdman's complaint of the distance of Plymouth as a bar to its usefulness to Liverpool students.

One word, finally, as to the Canadian stations. Prof. Herdman states that when he left Quebec last October there were three stations, not one as I had led readers of NATURE to suppose. As for ten years I was a member of the board under whose charge these three stations were placed, I can claim to know something about them, and I reiterate my statement that there is only one properly equipped station in Canada, which is situated in St. Andrew's, New Brunswick, and which was constructed in 1907 as the successor to a movable station which for seven years had been moved from place to place in eastern Canadian waters. Of the other two stations, one is situated on Lake Huron, and is very insufficiently equipped, and no work of any consequence has as yet been done there. The third is on Vancouver Island, and when last I heard of it (in the spring of 1909) it consisted of a wooden shanty, a boat, and one local naturalist, but all three stations were supervised by one board, an ideal far, as yet, from attainment in Great Britain.

E. W. MACBRIDE.

The Origin of the Domestic "Blotched" Tabby Cat.

SINCE writing my previous letter I have had an opportunity of seeing Mr. Pocock, and was glad to hear that he himself had brought the question of the origin of our domestic cats before the Mendelians.

Mr. Pocock has also brought to my notice an instance in which complete segregation has taken place in the first generation in the case of a cross between the Nubian donkey (*Equus asinus*) and the dziggetai (*E. hemionus*), in which the offspring was *practically* indistinguishable from the African species, with this exception, that the dorsal stripe was rather broader. There seems to be a general tendency for ass hybrids to resemble one parent more closely than the other. Curiously enough, I have myself since come across another such instance in the Chrysomelid genus Leptinotarsa.

Mr. W. L. Tower (Biol. Bull., Wood's Hole, xviii., 1910, p. 296, Pl. iv.), in experimenting with *L. undecemlineata* × *L. signaticollis*, discovered that under certain conditions of temperature the individuals produced in the first generation were indistinguishable from the female parent, and, what is stranger still, when interbred continued to produce this type for six generations! Different conditions of temperature gave different results; for instance, one experiment involving the same parentage gave "a single class of adults intermediate between the two parents, a mid-type." No consistency of gametic behaviour is here observable as is the case with our domestic cats, except in so far that certain conditions of temperature are always associated with one particular result.

Previous discussion on the origin of our domestic cats has certainly been concerned more with the *sylvestris* type, and the present interest in the *catus* type is entirely the result of Mr. Pocock's work in this direction; at the same time, the same writer says (Proc. Zool. Soc., 1907, p. 146), "of 'tabby' cats, as fanciers well know, there are two kinds." From the first I have appreciated the difference between dimorphism of colour and pattern, and the case of the leopard was brought forward as comparable "in its gametic behaviour" to the case of the "blotched" and "striped" tabby, though I freely admit this may not have been very clearly expressed in my letter.

The question of greater variation under domestication than in a state of nature rests more on botanical than on zoological evidence; I do not, however, push the inference further than being of some conditional value. Conservation of type is, however, an important factor in nature. We must, I think, for the present concur with Mr. Pocock in having an open mind and preserving an agnostic attitude on this subject. H. M. VICKERS.

81A Princes Street, Edinburgh, September 10.

THE REFORM OF OXFORD UNIVERSITY.

IN the course of last year, Lord Curzon, as Chancellor of the University of Oxford, published a weighty memorandum on the "Principles and Methods of University Reform." The various proposals therein contained have formed the subject of exhaustive deliberations by the Hebdomadal Council, some of the results of which have been from time to time made public in the *Oxford University Gazette*. The committees entrusted by Council with the task of considering in detail the measures of constitutional and administrative reform suggested by the Chancellor's memorandum have in nearly every instance presented their report; and these reports, having been fully discussed, and accepted, with modifications, by Council, are now published in a volume which has lately been distributed to all members of the Congregation of the University.[1]

The conclusions arrived at by Council, which now await the verdict of the larger legislative bodies, Congregation and Convocation, are summarised by the Chancellor in an ably written introduction, couched in moderate and statesmanlike language. The changes advocated, though not revolutionary, are far-reaching in character, and bear evidence of very careful consideration of all the various interests and conditions involved. The first matter dealt with is the constitution of the University. On this head it is proposed to abolish the arrangement by which Council, the body which has the sole power of initiating legislation, is composed, as to its elected members, of heads, professors, and members of Convocation in equal proportions. The election is in future to be thrown open without distinction of "orders." Congregation is to be made more completely representative of the teaching and administrative elements in the University and colleges by the doing away with the qualification of mere residence. Convocation, the ultimate legislative authority, is to remain, as at present, the general assembly of all members of the University who have taken the M.A. degree and retained their names upon the books. The powers of Convocation are to be in some respects restricted, but it is provided that fuller opportunities of exercising the franchise shall be accorded than at present exist.

An important series of proposals, which have been embodied in a draft statute, relates to the reconstitution of the existing faculties and the creation of a general board of faculties which shall relieve Council of much of its present business with regard to examinations, and shall control the administration of the Common University Fund at present managed by a special delegacy. The changes suggested under this head, if carried out, will have the effect of limiting to some extent the independent action of the colleges, and of putting greater power, under the general supervision of the University itself, into the hands of the whole body of teachers in a given subject. It is a serious attempt towards improved co-ordination.

A measure which is likely to be discussed with much keenness, and to meet in some particulars with vigorous opposition, is the suggested establishment of an entrance examination to be passed before coming into residence; with which provision there is linked an assertion of the principle that Greek should no longer be required as a necessary subject for a degree in arts. It is perhaps not generally realised that although each college exacts its own requirements, differing in different cases, there exists at present

[1] Principles and Methods of University Reform. Report of the Hebdomadal Council, with an introduction submitted on behalf of the Council by Lord Curzon of Kedleston, Chancellor of the University. Pp. xli+98. (Oxford: Clarendon Press, 1910.)

no examination qualifying for entrance to the University. "Responsions," with its several alternatives, has gradually assumed the virtual position of such an examination; but there is still, so far as the University is concerned, no obligation to pass any one of these examinations before matriculating. The scheme outlined by Council provides for making either Latin or Greek optional, and allowing as substitutes certain modern languages, together with other subjects, such as elementary history, politics, chemistry, and physics. This provision is to apply to the existing Responsions, pending the establishment of a regular entrance examination.

A subject which has engaged the attention of Council at considerable length is that of the admission of a poorer class of students. The report is unfavourable to the project of a distinctively working-man's college within the University, but apparently not to the foundation of halls and hostels for students of narrow means, should endowments be forthcoming for such a purpose.

On the general question of finance, the report advocates the constitution of a new finance board, chosen partly from Council and partly from members of Convocation, both resident and non-resident, charged with the duty of advising the University as to its financial policy, and of reviewing the published accounts of University and colleges. The Chest Office would remain as an account office, an estates committee and office of works for the University; but the delegacy of the Common University Fund would cease to exist, its functions being transferred to the proposed general board of the faculties.

In dealing with the subject of fellowships, scholarships, and exhibitions, Council has been to a great extent limited by the fact that these matters are, under existing conditions, largely the private concern of the various colleges. Many recommendations have, however, been made, several of which there is reason to think are not unacceptable to the majority of the bodies concerned. It is proposed that scholars should have the option of resigning some or all of their emoluments, while keeping the name and status of scholar, the money thus saved going to the exhibition fund of the college, or being directly applied for the benefit of necessitous students. Exhibitions, it is thought, should be chiefly or entirely eleemosynary, and freedom should be allowed, under reasonable conditions, for scholars to pursue some other subject than that for which they were elected. The system of prize fellowship receives a modified degree of approval, and the bestowal of fellowships on a large scale expressly for research is discouraged. On the whole, the system of these pecuniary aids to learning would remain, even if all the suggestions of Council were adopted, very much as it is under present conditions. Many will think that the interests of learning and research, as distinct from routine teaching, have here received insufficient recognition.

Other matters which have come under consideration are the establishment of a diploma to suit the special requirements of a business career, the length of the academical year, the reform of the electoral boards for certain professorships, and the admission of women to degrees. Further steps are promised in all these directions.

In the foregoing remarks the aim has been to give a general idea of the proposals which have commended themselves to the Hebdomadal Council, under the presidency of the energetic Chancellor of the University. Criticism has for this purpose been avoided, but it is certain that opinions will greatly differ as to the merits of many of the measures advocated in the Chancellor's introduction and Council's report. All, however, we venture to think, will sympathise with Lord Curzon in bespeaking the serious consideration of Congregation and Convocation for the result of so much thought and labour. The spirit in which the work of reform has been taken in hand could not be better expressed than in the concluding words of the Chancellor's introduction, words which we here take the liberty of quoting:—"We have made no attempt to build a new Oxford on the ruins of an old. We have too profound a conviction of the part that is still capable of being played by the older universities, and, as we think, by our own in particular, in the life of the nation, to wish in any degree to impair either its essential character or its inspiring influence. We want Oxford to remain what it is, but to become, if it may be, better; still to keep alive the transmitted flame, but to see that it illumines every corner of the temple of knowledge and is accessible to all sections of the community; above all, since our University is an imperial training ground for character and intellect, to arrange that the scheme of life which produces the former is worthy and sound, and that the scheme of instruction which develops the latter is comprehensive and efficient." F. A. D.

MEDICAL EDUCATION IN THE UNITED STATES AND CANADA.

THE Carnegie Foundation has a dual function, to provide pensions for the profession in the United States and Canada, and "to encourage, uphold, and dignify the cause of higher education." It is in connection with the latter that the trustees have undertaken a study of medical education in these countries. The report, prepared by Mr. Abraham Flexner, a trained chemist, is in many respects a remarkable document, the publication of which, we are not surprised to hear, has caused a great sensation. There is no country in the world with medical schools at once so good and so bad as the United States. It would be hard to parallel in Europe conditions so favourable to the study of medicine at Harvard or the Johns Hopkins. On the other hand, a very large number of the medical schools are on a purely commercial basis, and offer an entirely inadequate education.

The report is divided into two parts. The history of medical education in the United States and its present status are set forth; the story is then told of the gradual development of the commercial medical school (a distinctly American product), of the modern movement for the transfer of medical education to the universities, and of the efforts to improve the standard of preliminary education. The present condition of medical studies is then fully discussed, and a forecast of the possible future is attempted.

The second part of the report gives in detail a description of the medical schools in each State, and in each province of Canada. Attention may be directed to chapters ii. and iii. of the report, dealing with the proper basis of medical education, and the actual basis, as containing much that is of interest to us in this country. The sections, too, on the laboratory branches and on the hospital and the medical school are very instructive; the first section is, in fact, an exceedingly able presentation of the whole subject of medical education. It is urged that the 155 medical schools at present existing should be reduced to thirty-one by abolition and consolidation.

The second part of the report is a critical analysis

[1] "Medical Education in the United States and Canada." A Report to the Carnegie Foundation for the Advancement of Teaching. By Abraham Flexner, with an Introduction by Henry S. Pritchett. (Bulletin Number Four.) Pp. xviii+346. (New York, 1910.)

of every medical school in the United States and Canada under the heads of "Entrance Requirements," "Attendance," "Teaching Staff," "Resources Available," "Laboratory Facilities," "Clinical Facilities." The condition of some of the commercial schools is scarcely conceivable, and Chicago is well called, in respect to medical education, the plague-spot of the United States. Englishmen will read with interest the report on the condition of medical education in Canada, and it is nice to hear that in point of construction and equipment the Toronto and Montreal laboratories are among the best on the continent. Praise is meted out to the medical school in the comparatively new city of Winnipeg.

It is the purpose of the Foundation to proceed at once with a similar study of medical education in Germany, France, and Great Britain, "in order that those charged with the reconstruction of medical education in America may profit by the improvements in other countries." We understand that Mr. Flexner will be in this country early in October to pursue his work. The report cannot but be most helpful. It is thoroughly well done; perhaps the only legitimate criticism is an insufficient appreciation by its author of the extraordinary progress which higher medical education has made in the United States in the past twenty-five years.

THE SHEFFIELD MEETING OF THE BRITISH ASSOCIATION.

THE meeting of the British Association at Sheffield concluded with the usual votes of thanks on Wednesday of last week. The attendance of members from outside was quite up to the average, but the influx of new local members was small, with the result that the year was a lean one for grants for research, and it was found necessary to draw on the balances from former years. Notwithstanding, however, the small local support of the association itself, the reception accorded was a very warm and hearty one, and the arrangements left little to be desired. A special feature of the meeting was the visits to the large works, the magnitude of the operations carried out, and the combination of science with practical organisation making a great impression on the association as a whole. Indeed, the hearty co-operation of city and University, and the way in which science is applied in all the large industries, has been a matter of constant reference amongst members, whilst the natural beauties of the surrounding district have come as a surprise to all. With the possible exception of one or two sections, the scientific level of the papers read was high, and although no startling new discoveries were announced, there were many papers showing very real progress on old lines. Possibly the meeting may be remembered as that at which the achievement of at last isolating the positive electron was announced by Sir J. J. Thomson.

The constitutional question of the relation between the sections and their constitution has been very fully discussed, but with no final result. The matter is a difficult one. The multiplication of sections tends to overweight the association, as well as to increase the difficulties of the locality to provide the accommodation required for additional section and committee rooms with their assortment of lanternists and attendants. It is becoming increasingly difficult for a large town of the second rank adequately to house the association. It was admirably provided for in Sheffield—a city of close on 500,000 inhabitants—but the number of towns comparable with it can be counted on the fingers of the two hands. On the other hand, it is difficult to see to what already existing action a new subject, such, for example, as agriculture, could be attached as a sub-section. Some think no new branches should be admitted; others suggest that the papers on such a branch should be distributed amongst existing sections according to their affinity; whilst yet another suggestion has been made that the papers should be read at a joint meeting of several sections interested, *e.g.* agricultural papers at a joint meeting of sections B, K, and F. At the recent meeting, however, the sub-section of agriculture has been a very successful and live one, managed in all respects as a separate section, and with a full complement of good papers.

At this year's meeting the attempt to bring together men of science of different categories working in allied subjects has been tried to a larger extent than in former years. There have been quite a large number of joint meetings of sections for the discussion of definite questions. It cannot be said that the result has been so generally successful as could be desired. Everybody acknowledges theoretically the value of such meetings, and most of those who have attended them their practical failure—at least, with certain brilliant exceptions, which merely show what they might be. The truth is that the conditions of success for such meetings have not been grasped by the organisers or the openers. It would be good policy on the part of the council to call a meeting of past recorders and sectional presidents to discuss this particular question. The complaint is very general that insufficient time is allowed, and no doubt there is some basis for this, but such discussions are apt to die out earlier than arranged, with consequent waste of time unless the whole discussions with set speakers is prearranged. Many of the most interesting discussions have been those arising spontaneously on some single paper. Not being reported, a speaker feels able to throw out half-considered suggestions or impressions of the moment, which strike fire and kindle the imagination of others, while all would hesitate to publish them in set form. Such discussions are really useful to the experts, and always interesting to the general audience. The failure of set discussions is as often as not due to the speaker who introduces the subject. Not a few feel called on to read a long paper of an hour's duration, taking the edge off the attention of their hearers and distracting them with a mass of details, instead of succinctly laying before them the definite points which require discussion. These remarks have been illustrated by special cases at the recent meeting. The joint discussions might be made so valuable that it is to be hoped the Council will take some steps to ensure that they are.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY PROF. A. P. COLEMAN, M.A., PH.D., F.R.S., PRESIDENT OF THE SECTION.

The History of the "Canadian Shield."

CAN there be any greater contrast than Pleistocene Boulder Clay resting on Archæan gneiss, the latest of rocks covering the earliest, with almost the whole known history of the world in the interval between? It is a fascinating occupation for a geological dreamer to sit on some hillside in Scotland or Finland or Northern Canada, where the schists and gneisses rise in rounded ridges or bosses through Boulder Clay, and ponder on all the strange happenings that separate the clay from the rock beneath.

The clay, melting from its enclosed boulders under the frosts and rain, seems the very emblem of the fleeting things of yesterday; while the Archæan gneiss and greenstones are the type of the solid, imperishable framework of the earth, on which all the later rocks rest.

The Boulder Clay recalls the white surface of a

Continental ice-sheet with summer blizzards sweeping across it like those of the Antarctic tableland, while the gneiss beneath tells of a molten magma cooling during millions of years beneath miles of overlying rock.

It is the meeting-place of the geological extremes, and their contact marks the greatest of all discordances.

One thing the clay and the gneiss have in common—both were long neglected by geology; the Pleistocene beds because they were not rocks, but only "drifts," confused and troublesome things, hiding the real rocks, the orderly stratified formations; the "basal complex" because its schists and gneisses were fossil-less, complex, and mysterious products of the dim beginnings of a world still "without form and void." The molten sphere, with its slowly consolidating crust, belonged rather to the astronomer than the geologist.

Geology has, of course, long lost that attitude, and now finds some of its most seductive problems in these once neglected extremes of the earth's history. Those who distrust the "glacial nightmare" are now very few in number; but there are still revered veterans, like Prof. Rosenbusch, who speak of the Archæan gneisses as parts of the earth's *Erstarrungskruste*, and who frame theories of the earth's cooling and wrinkling in its hot and furious youth.

Over more than half of Canada the field geologist is forced to occupy himself with both the Pleistocene and the Archæan, since the two are almost everywhere together, while the fossil-bearing beds of the vast intervening time are absent. The seemingly unnatural conjunction is not entirely without advantages, for the Pleistocene has furnished the clue to certain very puzzling problems of the Archæan, as will be shown later.

The geologists of the world have long known the broad outlines of the Canadian Archæan or pre-Cambrian area through Suess's masterly portrayal of the "Canadian Shield," and through Dana's account of the "V Formation," about which the North American Continent was built up.

It must be remembered, however, that, though most of the territory has been roughly traversed by Bell, Tyrrell, Low, and other explorers, only a few districts in the south have had their geology worked out in detail, because of their valuable deposits of silver, nickel, and iron ores. It is only in these districts, and comparatively recently, that the succession of pre-Cambrian formations has been determined with certainty. In the wide spaces of the north only the most general relationships are known.

It is intended to bring together here our knowledge of the most ancient chapters in the history of North America as disclosed by recent field work.

Physiographic Features.

In its physiography, the Canadian Shield shows the features that might be expected from one of the oldest and most stable land areas of the world. It was reduced in very early times to a peneplain, but later was elevated, permitting the rivers to begin a process of dissection. This process had a recent interruption by the Pleistocene Ice Age, which blocked many of the valleys with moraines and gave rise to the most extensive tangle of lakes in the world. Physiographically, as well as geologically, the region shows a dramatic mingling of extreme youth with extreme old age.

The best account of this rejuvenated peneplain has been given by Dr. A. W. G. Wilson,[1] who shows that the gradients are very gentle, and suggests that two or more facets can be distinguished as having slightly different inclinations and as having been carved at different times. Here it will be unnecessary to take the matter up except in a general way.

The peneplain has been unequally elevated, parts standing 3000 or 4000 feet above the sea, and other parts sinking beneath its surface. Only at two marginal points can the Archæan surface be said to rise as mountains—in the Adirondacks, projecting south-east into the State of New York, and in the Nachvak peninsula, just east of Ungava Bay.

To the south-west and south the shield sinks, almost imperceptibly in many places, beneath the older Palæozoic rocks, and the same is true around the central depression of Hudson Bay. Toward the south-east the shield breaks off suddenly along the great fault of the Lower St. Lawrence, and apparently the precipitous north-east shore of Labrador indicates faulting on even a larger scale. It has been suggested that Greenland, the Highlands of Scotland, Scandinavia, and Finland may have been parts of a single great shield, now separated through the settling down of the sea-bottoms.

In detail, the region is full of variety of hill and valley, waterfall, river, and lake; but, on the whole, it is monotonous to the ordinary traveller from the constant repetition of similar forms, since there are no real mountain ranges and few outstanding "monadnock" hills to break the sky-line. The sweep of horizon from every hilltop seems horizontal, the summits around seldom rising more than 200 or 300 feet above the valleys, and all reaching nearly the same elevation.

The geologist finds, however, that this impression of general flatness is deceptive. In reality, the rock structures are usually more nearly vertical than horizontal, as in most Archæan regions. The schistose rocks, which form so much of the surface, commonly show dips of more than 60°, so that it is clearly a mountain region planed down to its foundations. The arrangement of valleys, ridges, and hills generally follows more or less closely these ancient rock forms.

Geological Structure.

Until recently, most of the geological work done in this northern territory has been track surveys following Indian canoe routes. Here and there moraines or old lake deposits hide the rocks for a space, but usually the geology is admirably displayed as one's canoe threads the intricate waterways of sprawling lakes spilling over from one irregular basin into another. On entering a new district there seems a hopeless confusion of pinkish gneiss and grey-green schist, but presently orderly forms take shape upon the map as the numberless bays and islands are explored, and the ground plan of vanished mountain ranges begins to show itself. Dr. Andrew C. Lawson, in his brilliant study of the Lake-of-the-Woods and Rainy Lake regions in 1884 to 1888, first brought out distinctly the relationships, and later work has added greatly to our knowledge of these ancient structures.

The typical arrangement is that of rounded or oval batholiths of gneiss, or of granite merging at the edges into gneiss, with schists dipping steeply away from them on all sides. Where the batholiths approach one another the green schists occupy narrow troughs between. As shown by Lawson, they are evidently the bottoms of synclines nipped in by the rising areas of granite and gneiss. Round these eruptive masses the schists have a strike parallel to the edge of the gneiss, so that they do not form ordinary synclines, but widen and narrow and swing in curves to adjust themselves to the varying relations of the batholiths. The meshes of green schist are often not complete, the curving ends feathering out to a point. In such places erosion has eaten the surface down below the bottom of the syncline.

The batholiths in Western Ontario are of all sizes, from a mile to sixty miles or more in diameter, and they are commonly somewhat elongated from west to east or from south-west to north-east. They do not always follow one another in orderly succession, but may lie scattered irregularly, almost like bubbles on foamy water. Yet on the large scale one can recognise a general trend in the direction of the longest axes of the batholiths, and the average strike of the schist in the various regions lies between 50° and 80° east of north, conforming to the same direction. This general east-north-east trend of the basement structures doubtless reveals the axial relations of the Archæan mountain ranges.

It is sometimes stated that the so-called V formation of North America was made up of two ranges converging toward the south, the easterly arm of the V parallel to the Appalachian mountains and the westerly one to the Rocky Mountains. The structural arrangement just outlined does not confirm this view, but suggests irregularly parallel chains, cutting the direction of the Rockies about

[1] "The Laurentian Peneplain," *Journ. Geol.*, vol. xi. No. 7, pp. 615–659.

at right angles and that of the Appalachians at an acute angle.

Of what kind were the mountains erected on these bubble-like foundations of gneiss, set in meshes of schist? In many places they do not seem to have formed continuous ranges such as those of the Rockies, but rather groups of domes of various sizes. Some of them were comparatively low; others seem to have been lofty, though broad. Of the low ones, the best known is that of the Grande Presqu' Isle in the Lake-of-the-Woods, an oval of gneiss eighteen by thirty-two miles in dimensions. Here the up-swelling could not have been great, since the schists dip away from the gneiss at low angles all round, and patches of green schist, remnants of the roof, or perhaps of unusually large blocks stoped from above, are found here and there in the interior.

On the other hand, the Rainy Lake batholith, thirty by fifty miles in dimensions, must have risen as a lofty dome, since the surrounding schists dip away at high angles (60° to 90°). The arch of which they were the bases must have swung thousands of feet above the present surface of the batholith. Passing inwards from the Keewatin, one finds at first immense slabs of the schist shifted a little and enclosed in gneiss, then bands of green material with softened edges, and finally darker cloudy streaks in the gneiss, representing more perfectly digested bands. As Lawson has shown, the outer edge of the batholith is of greyish hornblende syenite gneiss or hornblende granite gneiss, while the interior is of ordinary mica granite gneiss. The outer part has absorbed a certain amount of basic Keewatin material.

One cannot doubt that this zone of green schist fragments, followed by greyish hornblende rock, originally extended over the dome as well as round its edges. In the middle there is now a width of ten or twelve miles of the ordinary Laurentian gneiss. This implies, of course, that the upper part of the dome, afterwards removed, was several miles in thickness, and that the mountain mass rose correspondingly above the synclinal valleys. It must not be assumed that the dome had a regular surface, nor that it was unbroken. Such a batholith as that of Rainy Lake was not made by a single sudden up-welling of granite, but by a long succession of slow inflows from various quarters. Meantime, the rocks above must have been stretched and fractured during the long ages of elevation, and must have been exposed to the usual destructive forces, which may even have kept pace with the elevation during its late stages when differences of level became pronounced.

The coarse-textured granitoid gneiss making up the batholith must have cooled at great depths and exceedingly slowly.

The Raising of the Domes.

Some curious dynamical problems are involved in the raising of the domed mountains. It is conceivable that fluid lava could be forced by the unequal pressure of shifting mountain blocks through a suitable system of pipes into cisterns, so as to form laccolithic domes, but no such mechanism seems possible with batholiths. The granite of the batholiths was plastic rather than fluid, as shown by its having been dragged into the gneissoid structure. The areas affected covered sometimes 1000 square miles. We know of no system of dykes to serve as pipes or passages, of no solid floor beneath, of no faulted blocks to provide the pressure. It is generally assumed that the protaxial granites and gneisses in great mountain ranges have risen because of the relief from pressure beneath anticlines due to lateral thrust. It is doubtful if these irregularly scattered ovals, sometimes thirty miles across, can be adjusted to any system of anticlines.

Some years ago I ventured another explanation. Granite is specifically lighter than most of the greenstones and schists of the Keewatin, and molten granite, even if not at a very high temperature, is lighter than the relatively cold rocks above it. If the rocks above were unequally thick, so that some areas were less burdened than others, it is conceivable that these differences in gravity might cause the granite to creep slowly up beneath the parts with the lightest loads, while the overlying rocks sagged into synclines in the heavily loaded parts.[1]

Whatever their cause, these oval batholiths enclosed by meshes of schist are the most constant feature of the Canadian Archæan, though in many places erosion has cut so deeply that the meshes have all but disappeared, leaving only straight or curving bands of hornblende schist enclosed in the Laurentian gneiss. Very similar batholithic relations of the Laurentian with the Grenville series of Eastern Ontario are described by Drs. Adams and Barlow, though the batholiths are generally much smaller. Batholithic mountains were typical of the Archæan in North America, and, at least in some cases, also of Archæan regions in other parts of the world.

Subdivisions of the Canadian Pre-Cambrian.

Until recently the rocks of the Canadian Shield were usually divided into three parts—the Laurentian, the Huronian, and the Animikie and Keweenawan, the last two being only doubtfully included in the pre-Cambrian. These three divisions are still the only ones shown on the latest general map prepared by the Geological Survey. Lawson's separation of the Keewatin as a lower group than the Huronian was generally recognised as valid, but in practice the subdivision of the two in mapping was difficult, and was only carried out in detailed surveys. His proof that the Laurentian was eruptive and later than the Keewatin was accepted.

As the classification adopted by the American geologists in the Lake Superior region differed from that used in Canada, a Correlation Committee was appointed five or six years ago to draft a compromise, which runs as follows:—

Keweenawan
Unconformity
Huronian { Upper (Animikie)
Unconformity
Middle
Unconformity
Lower }
Unconformity
Keewatin
Eruptive Contact
Laurentian

This compromise system is now generally in use in Canada, though if Canadian relationships alone were considered the Animikie would be separated from the Huronian and placed closer to the Keweenawan, and the Laurentian would be treated as consisting of eruptive rocks frequently later in age than the Lower Huronian.

The most natural classification for Canada would be as follows:—

Keweenawan
Unconformity
Animikie
Great Unconformity
Huronian { Upper
Lower }
Great Unconformity
Keewatin
Laurentian = post-Keewatin or post-Huronian granite and gneiss.

The laccolithic domes described on previous pages were formed partly in the interval between the Keewatin and the Lower Huronian, but mostly later than the Lower Huronian. Over much of the shield, however, our knowledge of the relations is not sufficient to separate the mountain structures of the two ages.

Let us now consider the history of the region during the successive periods suggested above.

Conditions during the Keewatin.

One naturally asks what the conditions were in Keewatin times before the earliest known laccolithic mountains were raised. The granitic texture of the eruptives implies very slow cooling under great pressure. The old interpretation of these rocks, following the usual conception of the nebular hypothesis, made them parts of the

[1] Bull, *Geol. Soc Am.*, vol. ix. pp. 223-238.

earth's original crust, which cooled under the tremendous weight of an atmosphere including everything volatile at red heat, an atmosphere 200 or more times heavier than at present. We know, however, that this cannot apply to the Laurentian gneisses of Canada, since they push up eruptively through great thicknesses of older rocks—the Keewatin in the north and west, and the Grenville series in the east, including large amounts of water-formed deposits. Though these older rocks are now found only on edge in synclines protected on each side by domes of gneiss, there can be no doubt that they once spread out wide and flat on the surface of the earth.

The eruptives of the Keewatin have received most attention, but sedimentary rocks occur in it at all levels and with thicknesses of hundreds or thousands of feet. They include Lawson's Couchiching, with its great areas of mica schist and gneiss formed from what were originally muddy and sandy sediments. In other places quartzites and arkoses, slates and phyllites, represent less metamorphosed clastic materials. The slate is often black with carbon. In the north-west there is little limestone or dolomite, but the Grenville and Hastings series of the east, which are probably in part of Keewatin age, contain thousands of feet of limestone. All the ordinary types of sedimentary rocks were being deposited on the Keewatin sea-bottoms, and one type unlike modern sediments—the banded silica and magnetite or hematite of the "iron formation." The rock last mentioned belongs to the top of the Keewatin, and is very widespread. Its crumpled jaspers have attracted much attention because of their association with iron ore, but in reality the other varieties of sedimentary rocks are present in far greater amount both as to thickness and extent.

In almost every part of the western region there are associated with the sediments great sheets of basic lavas, agglomerates, and ash rocks, as well as smaller amounts of quartz porphyry, &c., showing that the Keewatin was one of the periods of great volcanic activity in the world's history. It is somewhat puzzling to find these predominantly basic volcanics in the Keewatin, while all the underlying eruptives of the Laurentian are decidedly acid, chiefly granite or syenite in composition.

The extensive sedimentary and eruptive rocks of this earliest formation imply that the ordinary geological processes were at work at the very beginning of known geological time, before the Archæan mountains came into existence. There must have been broad land areas where rocks like granite or gneiss weathered to mud and sand, probably under a cool climate, for the greenish arkoses and slates charged with carbon suggest cold rather than heat.

In the north-west volcanoes were active, but the east was comparatively free from eruptions. Both volcanic ash and ordinary clay and sand seem to have been spread out on the sea bottom in the Lake Superior region, and probably seaweeds throve in the mud. In the Grenville region the waters seem to have been clearer, and limestones were deposited on a very large scale, sometimes pure, but often muddy and mixed with a good deal of carbon, so that fucoids probably flourished here also.

If we reconstruct the conditions of the Keewatin, we must then assume continents which have entirely vanished, on which weather, rain, and rivers worked, sweeping sediments down to the shallow or deeper seas to be spread out on a bottom which has also disappeared. The sediments and lavas and tuffs may be said to rest on nothing, for the once fluid or plastic Laurentian gneiss, cradling their synclines and pushing up from beneath them, could not have been the foundation on which they were laid down. Though the floor on which they once rested has nowhere been found, one may be certain that its materials included silica, alumina, and alkalies in the right proportions to fuse into a granitic magma, and this is practically all that is known of the pre-Keewatin world in Canada.

Rise and Fall of the Early Laurentian Mountains.

After the work of the volcanoes, of rain and frost and rivers, of winds and tides and currents, had piled up miles of rock in Keewatin times, there came a great upheaval of mountains over thousands of square miles of the early Archæan surface. Possibly the earth was already shrinking through loss of volcanic material and of the steam and gases that exhale in eruptions. The Atlantic floor may have been settling down, thrusting inwards from the south-east, pushing up the weakened earth's crust beneath the shield into mountain rows; or it may be that some other cause must be sought for the somewhat haphazard domes which arose over such wide areas.

It may be suggested that the many thousands of feet of lava and stratified materials had so blanketed the lower-lying rocks that the heat from beneath crept up into them, softening and semi-fusing them, until in the slow lapse of time they began to flow sluggishly, ascending to form the wide-based domes of the Laurentian mountains. The source of the internal heat need not be discussed here. Uranium, with its various progeny, may have been as active then as now, or a more rapid axial rotation may have kneaded the discrete particles of a mass of planetesimals, and so warmed them up to the heat of fusion.

Then followed the deliberate and almost complete destruction of the great mountain system during a long period of time, which has left no known Canadian record. The sediments derived from this destruction may have been piled on the bed of the Atlantic as it sank. It is possible that Sederholm's Bottnian in Finland may partially fill the gap.

Whatever disposal was made of the débris, several thousands of feet must have been carved from the mountains and swept out of view during the immense interval which separates the Keewatin and early Laurentian from the Lower Huronian, for the next series of rocks rests with a great discordance on the upturned edges of the synclinally disposed Keewatin schists and the truncated domes of Laurentian gneiss.

The Huronian.

The Lower Huronian has very different relationships from the Keewatin. Where least disturbed, as north of Lake Huron and in the Cobalt region, the floor beneath it is often well preserved. Dr. Miller has shown that at Cobalt the surface of Keewatin and Laurentian was hilly or hummocky before the basal conglomerate of the Lower Huronian was deposited; and Prof. Brock, in describing the Larder Lake district to the north, refers to "the clean-swept and often rounded surface of the older rocks on which it is frequently laid down."[1]

The basal conglomerate of the Lower Huronian contains pebbles and boulders of all the Keewatin and Laurentian rocks that went before, and among them are found beautifully striated stones. It is the oldest known Boulder Clay or tillite. The vast period of subaërial destruction that carved away the early Laurentian mountains ended in a glacial period, the ice-sheets of which covered many thousands of square miles of North America, just as the last great period of peneplanation ended with the Pleistocene ice-sheets.

It is not a little impressive to see modern till resting on the Huronian tillite, and including fragments of it as boulders. It is possible to break out from the modern glaciated surface stones the underside of which received their polish and striæ in the Lower Huronian, while their upper surface has been smoothed and scratched by Pleistocene ice movements.

At Cobalt the tillite is accompanied by slate, which may be compared in all essential characters except hardness with the stratified clay of adjoining lake deposits of Pleistocene Age. The most recent and unconsolidated beds make clear the origin of some of the most ancient and, in appearance, most different rocks in the world.

In the Lake Huron region the action of ice was probably followed by an invasion of the sea, for the tillite is succeeded by thousands of feet of quartzite, arkose, and conglomerate, and by a few hundred feet of limestone. Possibly much or all of the limestones of the Grenville and Hastings series, which Dr. Adams reckons among the great limestone formations of the world, were formed at about the same time.

The Middle Huronian (Logan's Upper Huronian) is separated by a basal conglomerate, possibly glacial, from

[1] "Bur. Mines, Ont.", 1905, p. 31.

the Lower Huronian; but the break does not seem very profound, and the rocks do not differ much from those just described.

The least changed parts of the Huronian extend as a wide band for 200 or 300 miles north-east of Lake Huron, and in this area the uneven surface of Laurentian and Keewatin beneath the Lower Huronian Boulder Clay preserves for us a portion of the earliest dry land, the earliest peneplain known in America, and possibly in the world. This band has remained comparatively stable, while, so far as our information goes, all other parts of the Canadian Shield have undergone violent changes.

Rise of the Late Laurentian Mountains.

The Lower Huronian tillite has been found in many places throughout the Archæan region, over a stretch of 1000 miles from east to west, and 700 miles from north to south, so that in all probability deposits like the Pleistocene till covered most of the surface.

Everywhere, however, except in the band extending north-east from Lake Huron, it seems to have been involved in later mountain building, and has been so sharply folded in with the Keewatin as to destroy the appearance of unconformity. It is instructive to note that so long and momentous an interval was entirely overlooked by geologists or treated as of small importance until a few years ago. There is usually no angular discordance to be observed, and the secondary schistose structures of Keewatin and Huronian are similar and parallel. The Huronian boulder conglomerate has often been rolled out to a schist in which only the harder boulders can be recognised as lenses; and sometimes even they are lost entirely, so that no evidence of discordance remains.

It is evident that the invasion of the later Laurentian granites and gneisses was accompanied by very important dynamic and metamorphic effects. Most of the batholithic domes of North-western Ontario are post-Lower Huronian, and date perhaps from the Middle Huronian or the interval between it and the Upper Huronian (Animikie).

The granites and gneisses of this second time of mountain building have not been distinguished in mapping from those of the first in most places, and as they are both of precisely the same habit, it will probably never be possible to separate them completely. Thus far both have been included under the name Laurentian, which must be considered as representing a lithological facies rather than a geological period. It may be, however, that the formation of batholithic mountains never really ceased from the end of the Keewatin to the end of the Lower Huronian. As the rocks called Laurentian are entirely eruptive, they should not be limited to a definite time, but only to a definite set of conditions as to composition, rate of cooling, and amount of pressure.

As in the earlier cycle, the period of mountain-building was followed by a period of destruction, ending in a peneplain of very wide extent.

The Animikie or Upper Huronian.

The interval between the lower formations and the Animikie is of great magnitude, perhaps even greater than that between the Keewatin and the Lower Huronian, and Lawson has suggested for it the name of the Eparchæan Interval. The Animikie has not been found resting on the Middle Huronian in Canada, so that this formation may partly bridge the chasm. Unless the Middle Huronian quartzites include part of the products of erosion, we have no evidence as to the disposal of the many thousands of cubic miles of materials removed from the later Laurentian mountains.

The Animikie begins in most places with a thin basal conglomerate lying almost horizontally on the upturned edges of the previous schists and gneisses. Above this come chert, black slate, and other sediments, sometimes to the extent of 8000 or 10,000 feet. The slate often contains carbon enough to make an important coal region if collected in definite beds.

The whole no doubt implies a transgressing sea, which ultimately must have covered a very large part of the Canadian Shield, since rocks of this age are found over wide surfaces north-west of Lake Superior, near Lake Mistassinni, in the heart of Labrador, on the east side of Hudson Bay, and near Great Bear and Dubaunt lakes. These rocks are found in Labrador up to 1575 feet above the sea. This level, if extended in all directions, would submerge three-fourths of the Archæan peneplain.

At present these areas, though large, are widely separated; and it may be rash to assume that even soft, easily weathered rocks, like the Animikie slate, could have been completely removed from the intervening spaces. It is probable, however, that less than half of the Archæan then remained as dry land.

The Keweenawan.

There is an interval marked by a small discordance and a basal conglomerate between the Animikie and the Keweenawan, but the break in time was apparently not great. The two groups of rocks often occur together, though in many places the Keweenawan sediments overlap on to the Archæan, as in the neighbourhood of Lake Nipigon. Most of the Keweenawan sedimentary rocks are of shallow-water varieties, such as sandstone and conglomerate. At various places on the north-east shore of Lake Superior a coarse basal conglomerate is found as remnants preserved in small valleys or ravines in the granite. The ancient surface is now in process of resurrection by erosion, and the boulders once rolled on a Keweenawan shore are being freed from their matrix and once more set in motion by the waves of Lake Superior.

The Keweenawan, like the Keewatin, was a time of vigorous volcanic activity, and in post places the lava-sheets and laccolithic sills of diabase connected with their eruption far surpass the sediments in amount. The volcanic rocks are generally basic in character, and probably most of the diabase dykes widely found in almost all parts of the Canadian Archæan are of this age. The important deposits of copper, nickel, and silver in Northern Canada are closely bound up with the Keweenawan basic volcanic rocks or with deeper-seated diabases, probably of the same origin.

Here, as in the Keewatin, we are confronted with floods of basic lava coming up from unknown sources through the acid Laurentian gneiss. Do these basic lavas represent heavier segregations settling to the bottom during the slow movements of the granitic magma as it climbed into the Archæan batholiths? One might imagine these heavier and more liquid parts sinking beneath the lighter, more viscid, magmas of the domes, and remaining fluid until the mountain masses above had become completely solid. The supposed thrust from the Atlantic basin to the south-east might then bring strains to bear on the solid crust, more or less shattering and shifting its masses, squeezing up the still molten diabase through all the fractures and pores.

Several remarkable basins were formed in the Archæan peneplain by the ascent of these lavas, permitting the massive roof which formerly covered them to collapse by block faulting or by the formation of an irregular syncline. The basin of Superior seems to be of this nature. It is still rimmed by the Keweenawan lavas, sometimes accumulated to the thickness of 50,000 feet. Just to the north is the smaller basin of Lake Nipigon, with its edges and islands of biabase sheets, and to the east, near Sudbury, is the extraordinary synclinal basin, with which the great nickel mines are connected. These basins seem to have resulted from the collapse of the solid crust because of the removal of support when basic eruptives ascended from beneath.

Palaeozoic History.

The exact relation of the Keweenawan to the Cambrian is somewhat in doubt, though most geologists make it pre-Cambrian. The St. Mary's, or Lake Superior, sandstone, which rests upon the Keweenawan with a slight discordance and overlaps upon the Archæan, is generally called Cambrian; it contains no fossils, and occurs only along the shores of Lake Superior and St. Mary's River, so that its position in time is uncertain.

Potsdam sandstone, either Upper Cambrian or Lower Ordovician, rests upon the planed-down Archæan surface at the Thousand Islands and other points in Eastern Canada, often with a conglomerate at its base; and undoubted Ordovician limestones feather out upon the

Laurentian all the way from Saskatchewan and Manitoba on the north-west through Ontario to the city of Quebec on the east. These limestones represent an important transgression of the sea upon the Canadian Shield. Apparently the old hummocky surface was often pretty cleanly swept, so that limestone with very little fragmental material rests immediately upon the gneiss, but in other cases there is arkose or a basal conglomerate of Laurentian materials.

Occasionally Archæan hills rise island-like through the shaly limestone, which tilts away quaquaversally, as if the hill had protruded through the sediments. This appearance is probably due to the settling and shrinking of the mud in its consolidation to rock. Drill-holes east of Lake Ontario show that there were valleys hundreds of feet deep between these Archæan hills, so that in this region the peneplain was far from complete. These inequalities may be considered foot-hills of the Adirondack mountains farther east.

There is reason to believe that before the close of the Ordovician the sea crossed from the region of Lake Winnipeg to Hudson Bay, flooding all the lower parts of the shield; but probably most of Labrador and part of Franklin, north-west of Hudson Bay, remained as dry land.

The Silurian follows on the Ordovician without a discordance, and at this time the sea probably submerged an even larger part of the shield, since the Silurian limestone of James's Bay is only 250 miles from that south of the Great Lakes, and there are two outliers between—on Lakes Nipissing and Temiscaming. It may be added that the highland of Silurian limestone crossing Southern Ontario, with a bold escarpment facing north-east, rises hundreds of feet higher than the watershed towards Hudson Bay. The escarpment facing the Archæan "old land" corresponds to the Scandinavian "glint," and has a similar relation to the lakes of the Archæan border.

The Devonian Sea also encroached south of James Bay and along the south-west side of the shield from Clear Lake, in Saskatchewan, to Great Bear Lake.

What took place on the Archæan continent while the coal forests flourished on the lowlands to the south and to the far north is unknown, since no Carboniferous rock has been found on its surface.

Mesozoic and Cenozoic History.

Early Mesozoic times are a blank, but a few small outcrops of Cretaceous rocks resting on the Archæan toward the south-west show that portions of its rim were once more under water. Dr. Wilson believes that an important facet of the peneplain should be dated from the Cretaceous, since planation was going on in parts of the United States at this time; but no positive evidence of this is at hand.

Nor is there any evidence as to its history in the Tertiary before the oncoming of the Ice Age of the Pleistocene, when its whole surface was scoured more than once by great glacial sheets. The mantle of decayed rock which must have accumulated during the long dry land stage was almost completely swept away, leaving the rounded surfaces of ancient rock fresh and clean beneath the Boulder Clay.

In an important inter-Glacial interval and in post-Glacial times much of the morainic material was assorted in great lakes the shore and deep-water deposits of which cover large parts of the surface. With the departure of the ice, the sea once more transgressed upon the lower parts of the shield, but the land has been rising since, leaving a belt of marine deposits up to about 500 feet around the shores of Hudson Bay, the St. Lawrence, and the Atlantic.

How much of the Shield has been Covered?

It is generally stated that the Canadian Shield has been dry land since the Archæan, and hence that erosion has been taking place ever since that time. This is probably true for part of the north-eastern portion of the shield, and perhaps also the north-western, but much of the area, especially toward the south, was buried in early days under Palæozoic sedimentary rocks, and so protected from further destruction. These sediments are still being slowly stripped from the Archæan in many places.

This may account for the greater proportion of Huronian and Keewatin rocks in the south as compared with the north. It is probable that in the unprotected northern parts weathering agencies have eaten the higher Archæan rocks completely away from the Laurentian gneiss beneath. Before asserting this positively, however, it may be well to await more thorough exploration of the little known north.

It is possible, but not very probable, that the whole area was at one time covered with Ordovician or Silurian shale and limestone. If so, all traces of this capping have been removed from hundreds of thousands of square miles of its surface.

There is one very impressive feature of the Archæan as found beneath the later rocks. The peneplain, with its rounded, hummocky surface, seems exactly the same when one strips from it recent Boulder Clay, early Palæozoic shale or sandstone or limestone, Keweenawan eruptives, or even Lower Huronian tillite, where this has remained undisturbed. It is as though all the millions of years of destruction since the Middle Palæozoic had made only unimportant changes in the pre-Cambrian peneplain. When it is recalled that peneplanation took place twice in the pre-Cambrian, before the Lower Huronian and before the Animikie, one is almost driven to think that pre-Cambrian time is far longer than post-Cambrian.

Relation of the Shield to the Palaeozoic.

Except toward the east, the Canadian Shield sinks gently beneath Palæozoic beds, in most cases retaining its character as a peneplain. How far does it continue to the south and west beneath the sedimentary rocks, and to what depth does it extend?

The results of drilling at Toronto, eighty miles south of the contact, show gneiss and crystalline limestone at a depth of 1200 feet below the surface, or 940 feet below sea-level. Near Lake Erie, 130 miles to the south of the contact, the Archæan is reached at a depth of 3300 feet—2700 feet below sea-level. Its slope to Toronto is at the rate of 20 feet per mile, and from Toronto to Lake Erie at the rate of 35 feet per mile. This corresponds fairly well with the dip of the overlying Palæozoic rocks.

As the peneplain rises more than 1300 feet above sea-level at the watershed 300 miles north of Lake Erie, there is a difference of 4000 feet in a north and south direction, and if comparison is made with the Adirondack mountains 250 miles to the east, the difference even amounts to 6600 feet. It is probable, however, that the Adirondacks were a residual group of mountains never reduced to the general peneplain level. It is clear that the pre-Palæozoic peneplain has been greatly warped in later ages, perhaps as a result of the increasing load of sediments piled on its southern edge.

One is apt to think of these ancient crystalline rocks as an exceedingly solid and resistant block of the earth's crust, likely to undergo little deformation, so that this evidence of warping or doming of the surface comes as a surprise. In reality, shiftings of level under changes of load are normal in every region, and have been going on along the southern border of the Canadian Shield all through Pleistocene times, and perhaps continue now.

The proof of this is to be found in the differential elevation of the shore-lines of the great post-Glacial lakes, which ascend with an increasing grade toward the north (N. 20° E.). In the case of Lake Iroquois, the difference in level between the two ends of the earliest shore is more than 500 feet, and the grade toward the north even rises to 6 or 7 feet per mile. If we add 230 feet of deformation of the marine beaches, which followed Lake Iroquois toward the north-east after the final melting of the ice, there is a known change of level amounting to 730 feet within late Pleistocene times. There is reason to believe that similar changes of level took place during the inter-Glacial period recorded at Toronto and to the north.

The Pleistocene sinkings and risings are naturally accounted for by the piling up and removal of the thousands of feet of ice in the Glacial periods, though probably isostatic equilibrium was not reached in these movements.

We know that the ice was more than 4000 feet thick, since it passed over the tops of the Adirondack mountains.

This thickness of ice is equal in weight to about 1600 feet of rock, while the greatest known elevation since the removal of the load is not much more than 700 feet, implying that a weight of 900 feet of rock can be supported by the shield. It may be, however, that in the interior of Labrador, where no beach-lines give evidence as to changes of level, the doming is much greater than the amount suggested.

It is of interest to note that these adjustments to change of load take thousands of years to accomplish. The rise due to the melting of the Labrador ice-sheet may be going on slowly now, 30,000 or 40,000 years after the load was lifted.

These sinkings and risings must be accomplished by plastic flow outwards from beneath the loaded area or inward toward the area relieved of its load.

Instead of a rigid, unyielding shield, we must conceive a stiffly flexible covering over a plastic substratum, where during thousands of years adjustments of level, amounting to hundreds of feet, may take place; and during millions of years of removal of load by erosion, or of piling on of load through sedimentation, changes of level of thousands of feet can be accomplished. Such changes have taken place on the southern and western sides of the shield without any known rupture, while on the east the adjustment has been accomplished in part by great faults.

Has the Archæan, which is supposed to underlie the stratified rocks in all parts of the world, undergone the same vicissitudes?

Summary.

The history of the Canadian Shield begins in pre-Keewatin times, with land surfaces on which weathering took place, and seas in which mud and sand were deposited. If the earth were ever molten, that stage had long been passed before the Keewatin sediments were laid down, for they include carbon, probably derived from fucoids, which could not have lived in a hot sea.

The pre-Keewatin land surfaces and sea bottoms have totally disappeared, so far as known to Canadian geology. Apparently they have been fused and transformed into the gneisses of the Laurentian.

The Keewatin was a time of great volcanic activity, lava streams and ash rocks surpassing in amount the thick sheets of sediments. At the end of the Keewatin the thousands of feet of volcanic and clastic rocks were lifted as domes by the up-welling of batholiths of early Laurentian gneiss.

Then followed a profound gap in the record, during which the mountains were levelled to a hummocky peneplain. This gap represents a very long period of weathering and destruction on a land surface, ending in glacial action on a large scale.

The Lower Huronian begins with the deposit of a thick and widespread Boulder Clay, followed up by a transgression of the sea in which mud and sand, and also limestone and chert, were deposited.

After a short break similar processes went on in the Middle Huronian. During the Middle Huronian, or in the interval between it and the Upper Huronian (Animikie), mountain-building was renewed on a grand scale, many synclines of Keewatin and Lower Huronian rocks being caught between the rising batholiths of late Laurentian gneiss. A broad central band of the Lower Huronian escaped this process, however, and has preserved its original attitude on a floor of Keewatin and Laurentian.

The Animikie or Upper Huronian sediments which rest on the planed-down floor of upturned Lower Huronian, Laurentian, and Keewatin rocks, consist largely of chert and carbonaceous slate or shale, which lie nearly horizontal and have undergone very little change.

The Keweenawan follows the Animikie with only a small break, and includes shallow water-beds of sandstone and conglomerate, accompanied by immense outflows of lava. As a result of the outpouring of lava, great basins, like that of Superior, resulted. It is probable that during the Animikie and Keweenawan most or all of the Canadian Shield was covered by the sea.

The Keweenawan is generally held to mark the close of the Archæan (or Algonkian or Proterozoic). Low reports portions of these formations as having been caught in mountain-building of the Laurentian type in Labrador, but commonly they have not been disturbed.

During early Palæozoic times the Canadian Shield was more than once encroached upon by the sea, though probably much of the peninsula of Labrador, and perhaps a region north-west of Hudson Bay, escaped.

From the Devonian to the Pleistocene the shield seems to have remained dry land, and part of the Ordovician and Silurian capping of sediments was removed during this long period.

The succession of Pleistocene ice-sheets completed the work of denudation, and at the end of the Ice Age many thousands of square miles of the lower portions were once more beneath the sea.

Last of all, the region has been rising at unequal rates in different parts, as shown by the warping of marine and fresh-water beaches.

The surface of low hills and rounded knolls of gneiss and schists beneath the Pleistocene Boulder Clay resembles in every way that beneath the flat shales and limestones of the early Palæozoic, or the nearly horizontal sediments of the Animikie, or even the undisturbed parts of the Lower Huronian Boulder Clay. It may be that much of the surface has been covered with sediments and restored to daylight by subaërial erosion several times in succession. The greater part of the carving-down seems to have been done before the Animikie—*i.e.* within pre-Cambrian times—and the pre-Huronian surface seems as mature as any of the later ones. The bearing of this on the length of early geological time is evident. Pre-Huronian time includes the laying down of thousands of feet of Keewatin sediments, the elevation of early Laurentian mountains, and the levelling of these mountains to a peneplain. It may be as long as post-Huronian time.

NOTES.

PROF. F. W. DYSON, F.R.S., Astronomer Royal for Scotland, has been appointed Astronomer Royal in succession to Sir William Christie, K.C.B., F.R.S., who is to retire on October 1.

AT the age of seventy-eight years, and in his native place, Lunel, Eugène Rouché, the well-known mathematician, recently passed away. He entered the École Polytechnique in 1852, and on completing his course there devoted himself to teaching, in which he was very successful, and the composition of text-books, which quickly obtained a high and deserved reputation. The treatise on geometry which he wrote in partnership with Charles de Comberousse may be fairly called a classic, and is an excellent example of what such a work ought to be; many teachers in this country must have found it a most useful source to draw upon, both for theorems and for examples. Engrossed as he was by these occupations, Rouché found time to write a number of original notes and papers, and his talents received fitting recognition in 1896, when he was elected a free member of the French Academy of Sciences in succession to Baron Larrey. Friends who knew him intimately bear witness to his personal charm and vivacity, and the academy, on August 22, passed a vote of sympathy with his widow and family, after hearing a brief account of his career from the president, M. Emile Picard.

IN the death, in his seventy-seventh year, of Prof. Friedrich von Recklinghausen, of Strassburg, pathology loses one of its most distinguished investigators. Working along the lines marked out by Rokitansky and Virchow, v. Recklinghausen played a conspicuous part in building up our knowledge of pathological anatomy during the second half of the nineteenth century. His researches threw a great deal of light upon many aspects of disease of the circulatory system, especially the phenomena of thrombosis

and embolism, well described in his great "Handbuch der allgemeinen Pathologie des Kreislaufs und der Ernährung," published in 1883. He devoted great attention to the study of "fibroid" tumours of the uterus and other pathological conditions of the female genital system, which formed the subject of another of his treatises. He also added greatly to our knowledge of general bone-diseases, such as rickets, osteomalacia, and acromegaly, and especially of the pathological changes in the form of the skull caused by rickets. His observations on the nature of a curious frog-like swelling under the tongue called "ranula," on hæmatogenous pigmentation of the skin, and on the heart condition he called "segmentatis myocardii," are well known; but perhaps his discovery of the association of multiple fibrous tumours of the skin with the distribution of cutaneous nerves is that most usually associated with his name as "Recklinghausen's disease."

MR. C. A. BRERETON, whose death, at the age of fifty-nine years, occurred on Monday last, was for many years associated with Sir John Wolfe Barry, K.C.B., F.R.S., in important engineering enterprises, such as the construction of the Barry Docks and railways, the Middlesbrough Docks, Surrey Commercial Docks, and the new bridge across the Thames at Kew. He also did a good deal of engineering work for the Caledonian, North-Eastern, Metropolitan, Metropolitan District, Whitechapel and Bow Railways, parts of the Great Northern and Piccadilly Tube, and for the Government of Natal. In recent years he was in business on his own account.

THE death is announced, in his fifty-ninth year, of Mr. William Earl Dodge Scott, curator of the department of ornithology at Princeton University. He was the author of "Bird Studies," "Story of a Bird Lover," "Birds of Patagonia," and many technical papers in scientific journals. Mr. Scott had done field work for the British Museum, the American Museum of Natural History, and other institutions.

DR. ROBERT AMORY, a well-known American writer on physiology and therapeutics, has died at his summer home at Nahant, Mass. He was born in 1842, graduated in medicine at Harvard in 1866, and was appointed in 1869 lecturer at Harvard on the physiological action of drugs. He was afterwards professor of physiology at the medical school of Bowdoin College.

THE death is announced, at the age of seventy years, of Mr. John Langton, consulting surgeon to St. Bartholomew's Hospital, and a former Hunterian professor of pathology and surgery at the Royal College of Surgeons. In 1900 he was Bradshaw lecturer.

IN connection with the fourteenth Flemish Congress of Natural and Medical Science, an International Scientific Exhibition will be held in Antwerp on September 17–25 next. The exhibits are to be classified as under:—Section i., physico-chemical sciences: including new apparatus and inventions, laboratory installations, lanterns, microscopes, and the scientific applications of photography; collections of chemical productions, geological specimens, and crystals. Section ii., biological science: apparatus for experimental research and demonstration, zoological and botanical collections, fossils, microscopical preparations, and photomicrographs. Section iii., medical science: experimental apparatus, pathological specimens, radiograms, surgical instruments and appliances; operation-room, sanatorium, and hospital furniture; electro-medical and X-ray apparatus. Section iv., scientific books and reviews.

THE twenty-seventh convention of the Association of Official Agricultural Chemists is to be held at Washington on November 10–12, when communications on the following subjects are to be given:—Phosphoric acid; nitrogen; potash; soils; inorganic plant constituents; insecticides; water; food adulteration; dairy products; foods and feeding stuffs; sugar (chemical methods and molasses methods); tannin; drugs and medicinal plants.

AN International Congress of Tuberculosis is to take place in Rome on September 24–30 of next year. Prof. Guido Baccelli is to be the president, and Prof. v. Ascoli, of Rome, the general secretary.

THE statue (by Mr. Bruce-Joy) of Lord Kelvin which is to be erected in Belfast is, according to the *Westminster Gazette*, in an advanced stage of completion. Lord Kelvin is represented as holding in his right hand the design of a gyroscope, and by the side of the effigy is a model of the Kelvin compass. The statue is to be cast in bronze, and will stand on a pedestal 12 or 13 feet high.

A GRANITE obelisk erected in the parish churchyard of Forfar to the memory of George Don, the Scottish botanist, was unveiled last week by Mr. G. Claridge Druce, who gave an address on Don's achievements as a botanist.

ACCORDING to the *Lancet*, the remainder of her estate (in addition to a million francs already bequeathed) has been left to the Pasteur Institute in Paris by the widow of the Marquis de Beauregard de Maubreuil d'Orvault.

THE New York correspondent of the *Times*, writing on September 12, states that Prof. Macmillan, who accompanied Commander Peary on his last voyage, reports from Labrador that he has made a successful exploration of the region westward from Davis Inlet to George River and the home of the Nasquapee Indians. Three lakes, the largest of which, called Misternipi, was twenty-five miles wide, were discovered.

THE American Philosophical Society gives notice that in December next it will award its Magellanic gold medal "to the author of the best discovery, or most useful invention, relating to navigation, astronomy, or natural philosophy (mere natural history only excepted)." Candidates for the award, who may be of any nationality, must send their claims (in English, French, German, or Latin) to reach the society in Philadelphia by November 1, but the award will not be made for any communication already published or for which a prize has been given elsewhere. Each MS. must bear a motto, device, or other signature, the author sending the society a sealed letter giving his real name and address in addition to the motto, &c., upon his essay.

A REUTER message from Paris states that a private conference of the official delegates of the various Governments at the Pure Food Congress has arranged to make certain methods of analysis international, with the consequence that when any food is in future submitted to an analytical test it will have to conform to that international standard.

IN the June issue of the *Philippine Journal of Science* Messrs. R. B. Bean and F. S. Planta publish the third of their studies of Filipino racial types at Taytay, this portion of the memoir being devoted to women. In measurements of the body, the greatest differences appear between the Primitive and the Iberian types, the women approximating to the former and the men to the latter. Between these comes the Australoid type, which in the crural index resembles the Negrito. In head measure-

ments, the women have relatively broader heads, faces, and noses than the men; in other words, they are more Primitive than the local men or the women of Siberia, with whom a useful comparison is made. We now possess some materials for disentangling the complex racial elements in the population of the archipelago. As is usual with the work of this school of anthropology, the memoir is provided with elaborate statistical summaries and excellent photographic illustrations.

In our article on "Malaria Prophylaxis in India" (August 25), we remarked upon the somewhat discouraging fact that no instance of a drainage scheme with successful result was put before the recent Malaria Conference at Simla. Since then, however, we have received the report of an interesting lecture on the prevention of malaria by Dr. Malcolm Watson, of the Federated Malay States (Selangor). As is well known, Dr. Watson has long been conducting, with the assistance of the Government and Dr. Travers, the senior medical officer, an extensive campaign against malaria, principally by the method of drainage, and his lecture gives a brief but very interesting account of the work done. In two large stations, Klang and Port Swettenham, the disease has been almost entirely banished by drainage alone, with a saving of more than 400 lives per annum. As the case mortality of malaria is only about 1 per cent., this saving of mortality means an enormous saving in morbidity, which doubtless the inhabitants are able to appreciate. A similar improvement has been made in all the flat rural areas in the State, especially in many of the rubber plantations. Here the disease is carried by *Myzorhynchus umbrosus*, which does not breed easily in any running water; so that mere open surface drains suffice to banish the insect, especially when accompanied by removal of jungle. In the hilly land, however, *Nyssorhynchus willmori* appears to be the carrier —an insect which breeds readily in rapidly running streams—with the result that the ordinary drainage ethods will probably be useless, closed pipe drains and other methods being required. Dr. Watson's energetic and long-continued campaign demonstrates not only the utility of drainage, which he maintains is the fundamental method against malaria, but also the fact that it must be intelligently carried out. It is probably neglect of this latter principle which has caused most of the reputed failures. Many other points are referred to in the lecture. For example, rice fields are found to be almost free from malaria, owing to the fact that, for some unexplained reason, the malaria-bearing species of Anopheline cannot thrive in their waters. Dr. Watson strongly emphasises the necessity for research on this point, and urges that a time may come when we may be able to deal with malaria at much less expense than by any method known at present—"we will be able to play with species of Anophelines, say to some 'go' and to others 'come,' and abolish malaria with great ease, perhaps hardly at any expense." We understand that a book by Dr. Malcolm Watson on "The Prevention of Malaria in the Federated Malay States" will shortly be published by Major Ross, with the aid of subscriptions from a number of rubber plantations collected for the purpose by Sir Frank Swettenham, the distinguished founder of the Federated Malay States. It seems a pity that Dr. Malcolm Watson was not invited to attend the malaria conference at Simla.

The Proceedings of the Royal Physical Society of Edinburgh (vol. xviii., No. 2, July) contain an interesting note by Prof. Graham Kerr on the presence of a posterior vena cava in Polypterus. The author points out that this vein, which forms so characteristic a feature of the higher vertebrates, is made up of two elements, being formed anteriorly by the primitive hepatic vein and posteriorly by the hinder portion of the posterior cardinal (inter-renal). The manner in which this has come about is indicated by the condition of the lung-fishes, Lepidosiren and Protopterus, in which the posterior extremity of the liver has become fused with the anterior extremity of the right kidney, and a venous anastomis has been established between these two organs, the large hepatic vein forming a direct channel for the passage of blood from the right kidney to the heart. It is interesting to find in the ganoid Polypterus that, while the primitive hepatic vein is developed into a large posterior vena cava which joins the fused posterior cardinals posteriorly, the anterior ends of the posterior cardinals still persist in a well-developed condition, though much larger on the right side than on the left. Polypterus in this respect combines the condition met with in higher vertebrates with that which is characteristic of fishes generally.

According to the report for 1909 and the first half of the current year, further particulars with regard to the movements of turbot and plaice have resulted from the investigations undertaken by the officials of the Northumberland Sea Fisheries Committee. A turbot, for instance, liberated at Skate Roads in August, 1907, was retaken nearly two years later about fifty miles from Aberdeen, while a plaice returned to the sea at the former locality in July, 1907, was recaptured in the following December near the Bell Rock. Experiments in artificially breeding lobsters have proved unsuccessful.

No. 2 of the tenth volume of the *Museums Journal* is chiefly devoted to a report of the conference held at York in July last, when the president, Dr. T. Anderson, devoted his address to volcanoes and their treatment in museums. Photographs are regarded as the best means of illustrating volcanic phenomena in public exhibition, as models and sketches alike nearly always show an exaggeration of the vertical scale, while the first-named of these are costly.

In the May issue of the Proceedings of the Philadelphia Academy Mr. T. Barbour relates the history of the discovery of the Chinese alligator, and the gradual acquisition of fuller knowledge of the species. It is stated that only a dozen specimens are known in collections, only one of which, and that recently acquired, is in America. The species appear to have a very limited distribution in the Yang-tse valley, most of the twelve specimens having been obtained near Wuhu and Chinkiang, although records exist to Poyang Lake and Nankin.

Zebras and zebra-hybrids form the subject of an illustrated article by Dr. E. Trouessart in *La Nature* for August 27, in which reference is made to the proposal to regard the members of the *Equus burchelli* group as specifically inseparable from the quagga.

As an appendix to the description of a new species of Platysaurus, Mr. J. Hewitt furnishes, in the Annals of the Transvaal Museum for November, a useful key to the genera of South African lizards.

It will be within the recollection of most botanists that Messrs. James Backhouse, of York, promoted a scheme in 1899 for the supply of botanical material to colleges and schools for demonstration and research, although recognising that for some time, at any rate, the venture would not be self-supporting. Subsequently the interests were transferred to the British Botanical Association, of which Dr. A. H. Burtt became the director. After ten years,

notwithstanding the expansion of the original scheme and the increased demands due to the extension of nature-study, it has become apparent that the institution cannot exist as a private venture, and therefore it is proposed to enlist the help of individuals interested in the aims of the association and convert the undertaking into a public association of subscribers. This decision was formulated at a meeting of botanists and others, and an executive committee was elected to proceed with the enrolment of members and associates. As the institution exists purely for the preferment of botanical study and research, it is to be hoped that sufficient subscribers will be forthcoming to ensure its permanence.

THE seventh part of the *Prodromus Florae Britannicae*, an elaborate and critical revision of the British flora that is being prepared by Mr. F. N. Williams, has now been published by C. Stutter, 110 High Street, Brentford, and the author announces that the next part will conclude the Sympetalæ and the first volume. The present part enumerates thirty-five genera, beginning with Plantago and ending with Vaccinium, but the sequence of families is unusual. Two species new for Britain are recorded under Plantago, while five species only are admitted under Mentha, as the author follows the views elaborated by Malinvard, that several species generally accepted are merely hybrids. Among the numerous interesting notes attention is directed to the remarks on the oxlip, the occurrence of two blue pimpernels, and the use of the word "anthemia" for the whole mass of flower clusters of *Stachys arvensis*.

A NOTE on the protection of timber against white ants appears in the Transactions of the Royal Scottish Arboricultural Society (vol. xxiii., part ii.). Three processes are described, of which one is a contrivance for destroying white ants by pumping a poisonous smoke through their galleries, while the others are timber-treatment measures. Details of the Powell process are not disclosed, but "blue oil" is the specific which apparently has received recognition at the War Office.

DR. SVEN HEDIN contributes a short paper to the July number of *Petermann's Mitteilungen* in which he summarises the scientific results of his journey in Tibet during the years 1906–8. Preliminary notes on the meteorological observations and the geological collections are added by Dr. Nils Ekholm and Dr. Anders Hennig. The Swedish Government has voted a sum of 75,000 kroner, to be paid in equal instalments in 1911, 1912, and 1913, towards the cost of publication of the detailed reports, which are to consist of three volumes of memoirs and an atlas in two volumes. The text, which will extend to about 1500 pages, will consist of reports on geographical discoveries and observations, memoirs on the physical geography of Tibet, and special papers by Dr. Ekholm on meteorology and hypsometry, Dr. Olsson on astronomical observations, Dr. Hennig on geology, and Prof. Lagerheim, Dr. Ostenfeld, and others on botany. A map of Tibet on a scale of 1 : 1,000,000 will appear in 1912.

THE last number of the *Sitzungsberichte* of the Bavarian Academy of Sciences contains a communication from Prof. A. Rothpletz on the cause of the Californian earthquake of 1906, in which he points out that the triangulation of the central area of the region affected by the earthquake shows that it has undergone an extension amounting to about 1 in 30,000. This expansion may be explained by one of three hypotheses:—(1) as the result of the relief of tangential pressure in the earth's crust; (2) by a transference of heat and change in position of the isogeotherms; or (3) by magmatic intrusion; the first two being excluded as not fully accounting for the observed displacements, the third is accepted. The earthquake is, therefore, regarded as belonging to the class called cryptovolcanic by Prof. Hörnes, which Prof. Rothpletz prefers to call "injection" earthquakes; and as the San Francisco earthquake is considered to be due to movement along the San Andreas fault, indirectly caused by deep-seated intrusions, it becomes an injection-fissure earthquake.

THE eleventh "Review of Mining Operation in the State of South Australia," for the half-year ending December, 1909 (Adelaide, 1910, 26 pages, 3 plates), reports that the mining industry was hampered by the strikes at Broken Hill and of the New South Wales colliers, and by the low price of copper, the most important mineral in South Australia. Further progress is reported in boring for coal in the Permo-Carboniferous rocks of the Northern Territory, but only three inch seams of inferior coal were found during the six months reported. The most novel mine in South Australia is that being opened in the Carnotite lode, near Olary, and the report includes a short account of the mining operations in progress, and an analysis of the ore made under the direction of Prof. Dunstan. The ore is to be worked for radium. An attempt is being made to supply the tube mills at Broken Hill with flints from the local beaches. The flints now used are sent from Europe, and are said to come from Iceland, but as they are shipped to Australia as ballast, they have hitherto held the market against the local supply.

IN vol. vii., No. 1, of the fifteenth series of the Palæontologia Indica (Mem. Geol. Surv. India), Mr. F. R. C. Reed describes and illustrates a series of Cambrian fossils obtained by an officer of the Indian Survey from the Bhabeh rocks of Spiti, which, from the evidence of very scant remains, were provisionally assigned by the late Dr. Stoliczka to the Lower Silurian. A large proportion of the fossils consists of trilobites, none of which, so far as the condition of the specimens admits of forming an opinion, can be identified with European or American types; consequently, a number of new names appear in the memoir.

THE Rev. Dr. A. Irving writes to say that the letters of Messrs. Deeley and Lamplugh on "Stagnant Glaciers" in NATURE of September 8 (p. 297) "seem to overlook the important causal factor of solar radiation in connection with the question," and directs attention to an article of his, entitled "Solar Radiation and Glacier Motion," in NATURE, vol. xxvii., April 12, 1883, in which a series of laboratory experiments on the subject, with deductions, is given. The article in question was supplementary to a paper by the author on the mechanics of glaciers, which appeared in the Quarterly Journal of the Geological Society for February, 1883.

WE have received the report of the Hydrographer on Admiralty Surveys for the year 1909. The report shows that during the year extensive revisions of the charts of home waters were made by four vessels, the largest areas sounded being off the west coast of Scotland. Very important additions to our knowledge of British Columbian waters were made by H.M.S. *Egeria*, the increase in size and number of ships using the Edye, Beaver, and Schooner passages making the surveys of these channels specially valuable. H.M.S. *Mutine* carried out a number of important lines of soundings off the west coast of Africa, and

in Australian waters H.M.S. *Fantôme* laid a line between Thursday Island and Cartier Island, the latter being formally annexed by Captain Pasco on March 17.

THE connection between non-periodical variations of rainfall and famines in German East Africa is discussed by Dr. E. Kremer in No. 1, year 1910, of *Aus dem Archiv der Deutschen Seewarte*. Normal annual rainfall values can only be safely calculated from thirty to forty years' observations, and monthly values require a much longer period. These are not available for the district in question; the author directs attention to the fact, but he makes the best possible use of the short series at his disposal and of the information obtainable from travels and expeditions. The German colony extends from latitude 1°–12° S., and longitude 29°–40½° E., and the rainfall may be divided generally into one rainy period in the south and two rainy periods in the north. The greater part of the country has less than 40 inches of rain per annum; only the central and northern coastal districts and the mountainous parts receive more, while the whole of the interior tableland, to about longitude 33°, receives less than 30 inches. The author discusses the possibility of predicting famines or scarcity on the lines successfully followed in India, and shows, *e.g.*, that scanty rainfall, or its unfavourable distribution, in Zanzibar is followed by famine over a large part of the East African coast, and further that the distribution of atmospheric pressure in the months preceding the rainy periods is intimately connected with the amount of subsequent rainfall.

THE Royal Meteorological Institute of the Netherlands has issued a paper, by Dr. P. H. Gallé, in which a large number of wind and current observations, chiefly from the Indian Ocean, are examined with the special purpose of testing the theories of Nansen and Ekman with regard to the effect of the deflecting force of the earth's rotation in changing the direction of drift currents and to the speed of current set up by wind action. Dr. Gallé finds that when the drift influence is alone at work in producing surface current, the angle between the wind and the resulting current is between 40° and 50°, substantially in agreement with the theoretical values. A wind velocity of 1 metre per second produces an average speed of current of between 4 and 5 centimetres per second.

MR. H. T. FERRAR contributes an interesting paper on "The Creation of an Artificial Water-table in Egypt" to the July number of the Cairo *Scientific Journal*. The author is of opinion that the modern irrigation constructions in themselves have had little direct effect in raising the level of the subsoil water in the Nile delta, but he deals specially with the changes induced in the irrigation system of Lower Egypt by the works of Mohammed Ali Pasha, who in 1820 excavated a number of deep perennial canals capable of discharging the low-level summer supply of the Nile. Observations made at more than one hundred and fifty experimental tube wells support the view that there are two water tables in Lower Egypt: (1) a natural water-table, which is independent of the works of man except locally where extra permeability allows a constant supply of irrigation water to be added; and (2) an artificial water-table which was created by the act of the introduction of perennial irrigation by Mohammed Ali Pasha. It is thought that the artificial water-table (2) has gradually become higher, owing mainly to excessive watering of crops, until at the present day it has a deleterious effect upon the fertility of the soil. Mr. A. Lucas offers some criticism of Mr. Ferrar's conclusions in the August number of the same journal.

The *Journal de Physique* for September contains the full text of a communication made to the French Physical Society in March last by M. C. Féry, describing a spectrograph with a prism having spherical faces so designed that the image of the slit is in focus on the photographic plate. Both faces of the prism are concave to the incident light, and the back surface is silvered so as to reflect the light. The slit, the centres of curvature of the two faces, and the spectrum produced are on a circle which has the radius of the first surface of the prism for diameter. With a prism of quartz a metre from the slit and screen, the spectrum photograph obtained is 22 centimetres long, and the definition is very good throughout. Like the Rowland concave grating, the apparatus is astigmatic.

A NEW form of colorimeter has been sent for our inspection by Messrs. E. B. Atkinson and Co., Hull. The liquid to be tested is placed in a rectangular glass cell of a few cubic centimetres capacity, by the side of which works a vertical hollow glass wedge filled with a standard coloured solution. By means of a screw the wedge is raised or lowered, thus bringing various thicknesses of the standard colour into the same field of view as the cell. Both liquids are viewed horizontally through a slit against a white background, and the position of the wedge is adjusted until a depth of tint is found equal to that of the liquid under examination. A graduated scale shows how much the wedge has been raised, and by reference to a chart the corresponding proportion of colouring ingredient in the liquid is obtained. Wedges calibrated for certain purposes—*e.g.*, the colorimetric determination of iron, copper, ammonia, hæmoglobin, iodine—are supplied by the makers; but the user can himself readily calibrate the instrument for his own particular purposes. For example, a medical man could with little trouble construct a standard hæmoglobin chart for his own district. Other advantages claimed for this "universal" colorimeter are (1) saving of time, a reading requiring only about a minute; (2) exactness, since the two colour surfaces compared are contiguous; and (3) economy of cost. The apparatus appears to be especially suitable for operations involving a number of colorimetric estimations of the same type.

THE fifteenth number (No. 3 of 1910) of the Italian review *Scientia*, now in its fourth year, is largely occupied with philosophy. The ideas of Poincaré, Bergson, Einstein, and the Pragmatists naturally form the text of discussions, such as that by F. Severi on "Hypothesis and Reality in Geometrical Science," or Chwolson's "Can we apply Physical Laws to the whole Universe?" or F. Enriques's criticism of Pragmatism. The theory of two star-streams interpenetrating one another is described by Mr. A. S. Eddington, of the Royal Observatory, Greenwich. M. Guignebert sketches the rise of Christianity in accordance with the sifted conclusions of recent research. Mr. Abegg's article on "Chemical Affinity" has a pathetic interest, from the fact that while it was in the press the author met his death in an aëronautic accident. The useful *rassegne* of various sciences are continued; Mr. E. S. Russell reviews the claims of epigenesis *versus* evolution. The advantages of a "mnemonic" theory of heredity, in accordance with the suggestions of Semon, Rignano, and Francis Darwin, involving an "interiorisation of external stimuli," is well put. M. Landry supplies his annual review of economic research. M. le Comte de Baillehache defends his system of electric units—a dimensional system—put forward last year in his "Unités électriques." Reviews of scientific periodicals, notes of scientific meetings, and critical notices of books, make up an issue that is very level in quality. The books reviewed

are worth noting, viz. E. Borel, "Elements de la Théorie des probabilités"; Marcel Landrieu, "Lamarck, le fondateur du transformisme"; Georges Bohn, "La naissance de l'intelligence"; Georges Dwelshauvers, "La synthèse mentale"; W. Lexis, "Theorie der Bevölkerungs und Moralstatistik"; A. Solmi, "Storia del diritto italiano"; H. Bouasse, "Bachot et bachotage."

We welcome the first annual number of the Journal of the Bedales School Scientific Society. This society has been in existence for some years, holding meetings of the kind familiar in schools; and its members have also been engaged on pieces of experimental work, some touching the edge of new inquiry. This year the society prints accounts of certain members' work, as well as reports of the meetings, and the Journal shows that at Bedales science is at once a favoured pursuit in free time, and a well-treated part of the curriculum. The subject-matter is limited to physics and chemistry; next year, perhaps, biological notes might be included—Hampshire is an interesting county—and short articles as well as longer papers may suitably find a place in such a periodical. Of the papers, that by D. Jarintzoff on the rare earths is worthy of mention, as a painstaking attempt to grapple with the separation of metals of the cerium group, and shows careful reading as well as experimenting. A paper on coherer-action shows resource and ingenuity; the writer is rash, perhaps, in criticising a paper by Robinson, whose work was watched by Drude himself. A word of praise is due to the society's committee for the careful preparation of the Journal.

The Thermal Syndicate, Ltd., of Wallsend-on-Tyne, has sent us a reproduction of a photograph of the remains of their exhibit of "Vitreosil" laboratory apparatus at the Brussels Exhibition, from which it is evident that the fused silica ware successfully resisted the great heat to which the pieces had been subjected; some of the larger pieces had, however, been broken by the falling of heavy girders.

The ninth volume of the *Journal of Experimental Zoology* is, according to *Science*, to be a memorial to Prof. W. N. Brooks, prepared by his former students at Johns Hopkins University, and will be issued in four parts towards the end of the present year. It will contain a biographical sketch by Prof. H. V. Wilson, accompanied by three portraits in heliotype.

A useful list of binoculars and telescopes has reached us from Messrs. F. Darton and Co., 142 St. John Street, E.C., copies of which may be obtained from the address given.

OUR ASTRONOMICAL COLUMN.

Metcalf's Comet, 1910*b*.—No. 4440 of the *Astronomische Nachrichten* contains new elements and a daily ephemeris for Metcalf's comet. The elements were calculated by Dr. Kobold from places observed on August 11, 17, and 25, and give the time of perihelion as August 26·04673 (M.T. Berlin). The following is an extract from the ephemeris:—

Ephemeris for 12h. (M.T. Berlin).

1910	α (1910·0) h. m.	δ (1910·0) ° ′	log *r*	log Δ	Mag.
Sept. 14	15 30·4	+17 13·9	0·2862	0·3442	11·4
,, 18	15 29·2	+17 22·8	0·2877	0·3578	11·5
,, 22	15 28·4	+17 31·8	0·2895	0·3701	11·5
,, 26	15 27·9	+17 41·4	0·2916	0·3815	11·6
,, 30	15 27·8	+17 51·7	0·2939	0·3919	11·7

From this we see that the comet is now apparently nearly stationary about half-way between τ' and ι Serpentis. A note from Prof. Pickering states that when discovered, visually, by the Rev. J. H. Metcalf on August 8, the comet was of about the eighth magnitude.

A Suspected New Planet.—On examining a plate taken for Halley's comet on June 6, Prof. J. Comas Sola found the trace of an unknown, but undoubtedly real, object, which he suspects to be a tenth-magnitude minor planet. During an exposure of one hour the motion was apparently nearly due N. and S., making an angle of about 50° with the ecliptic; the following approximate position depends upon the position of the nucleus of Halley's comet according to Prof. Seagrave's ephemeris:—1910 June 6, 9h. 20m. (G.M.T.), R.A. = 10h. 13m. 22s., N.P.D. = 90° 40·5′; the motion in N.P.D. was of the order of +45′ *per diem* (*Astronomische Nachrichten*, No. 4440).

Definitive Elements for Comet 1852 IV.—A comprehensive discussion of the orbit of the comet discovered by Westphal, at Göttingen, on July 24, 1852, is published by Herr Adolf Hnatek in Nos. 4438–9 of the *Astronomische Nachrichten* (pp. 345–87). The final result confirms the period of sixty-one years, the actual value being 61·5554 years, and this comet should return in 1913.

A Suggested Volcanic Origin of Martian Features.—The theory that the various features and variations on the surface of Mars may be due to volcanic action is advocated by Dr. Wilhelm Krebs in No. 4439 of the *Astronomische Nachrichten*. During the opposition of 1909 various new features were observed, and these are held to indicate volcanic action, while the network of "canals" is compared with the network of seismic and volcanic tectonic lines met with in the earth's crust.

The Passage of the Earth through the Tail of the 1861 Comet.—In the September number of the *Bulletin de la Société astronomique de France*, M. R. Baer, of Rouen, describes the phenomena observed by him at Horbourg (Alsace) at the time of the earth's passage through the tail of comet 1861 II. He points out that the vertical pillar of light then seen by him at the northern horizon was analogous to that described by recent observers as being visible during the predicted passage of the earth through the tail of Halley's comet.

The Spectrum of Cyanogen.—No. 6, vol. xxxix., of the *Memorie di Astrofisica ed Astronomia* contains a note in which Comte de Gramont and M. Drecq discuss some results recently obtained by them during a research on the spectra of various mixtures of salts. They find evidence that the chief "cyanogen" band (3883·6) may be produced under conditions where the presence of the cyanogen compound is unlikely, carbon and nitrogen being present, however. Thus they suggest that the function of cyanogen may be simply to supply carbon and nitrogen, and that the appearance of this band does not necessarily imply the presence of the poisonous compound. Further, they point out that if this result be established, the passage of the earth through the tail of a comet such as Halley's, in the spectrum of which the band at 388 was prominent, becomes still less likely to produce any evil effects.

Researches on the Colours of Stars.—Employing the *réseau* method devised by M. Henry, M. Östen Bergstrand examined the spectra of a number of stars to compare the effective wave-lengths radiated by different spectral types and by different classes of coloured stars. The results are published in vol. ii. (series iv.), No. 4, of the Proceedings of the Royal Society of Sciences of Upsala, and embody several important conclusions. Among other things, M. Bergstrand finds that the stars may be sharply divided into white and yellow, with a marked discontinuity between the colour classes G.W.+ and W.G.−. For the white stars, the effective wave-length is, in the mean, about 420 $\mu\mu$, and for the yellow stars it ranges from about 435 to 450 $\mu\mu$; the corresponding spectral classes are B and A and K and M respectively. The effective radiation of pronounced red stars is about 460 to 470 $\mu\mu$. The intermediate classes, G.W.+ and W.G.− of the Photometric Durchmusterung of MM. Müller and Kempf, and the spectral classes F and G of Prof. Pickering, are relatively rare. It is also pointed out that as the effective

wave-lengths vary between 411 and 470 $\mu\mu$, the employment of the same coefficient of refraction for all stars is inadmissible.

"MOCK SUNS."—From Mr. James F. Ronca we have received an account of the appearance of the phenomenon usually known as "mock suns," or "parhelia," which was observed by him at Eastbourne between 12.55 and 1.55 p.m. on September 10.

Mr. Ronca did not see the commencement of the apparition, but states that at 12.55 p.m. there was a slight haze, and some very thin clouds, distributed fairly uniformly over the sky, and, symmetrically described about the zenith, there was a brilliant circle of white light on the circumference of which lay the actual sun; two other points on this circle stood out as exceptionally brilliant spots. Then, with the sun as its centre, there was a much fainter, small circle, tangential to which there appeared a brilliantly coloured band intersecting the large circle at two points equidistant from the sun. This coloured curve could be traced only with difficulty beyond the confines of the large circle, but at the points of intersection with the latter the colours were of extraordinary brilliancy, the red in all cases being nearest the sun.

Mr. Ronca's account shows the phenomenon to have been of an extraordinary brilliancy, which was maintained for twenty minutes after he first saw it, and did not disappear finally until 1.55 p.m.

THE RELATION OF SCIENCE TO INDUSTRY AND COMMERCE.[1]

THE subject of this paper is so comprehensive that there will be no difficulty in understanding that attention has been restricted to one or two aspects of it only, and chiefly (since the paper is written by one engaged in educational administration) to that relation which exists between the scientific and technical education provided at higher institutions in this country, and the after careers of students. Even that relation cannot be treated in anything like an exhaustive manner within the limits assigned to me. My attention was specially directed to this matter some eighteen months ago by an opportunity which presented itself of reading some 150 letters written by past students of universities or of institutions of university rank. The letters were representative of an entire body of students whose education had been assisted. They came from students, men and women, who had taken degrees or diplomas in varying numbers during each of the last fifteen years. Four months ago, when, at the invitation of the committee of this section, I undertook to read this paper, steps were taken to extend the field of information. Some five hundred letters of inquiry were addressed to teachers of repute at home, in France, Germany, and America; to representative firms of employers, mostly at home, some abroad; and to thirty of His Majesty's consuls in Europe, Asia, and the two Americas. There have been before me also the written views of the presidents of vast industrial and commercial concerns in the United States, views collected in 1903 when I visited America as a member of the Mosely Commission. On the whole, my letters of inquiries have been treated with much sympathy, and I have had to examine a very considerable body of evidence of all kinds. I owe a great debt of thanks to the many distinguished men of science, and to many well-known leaders of industry and commerce, who have so generously given attention to my inquiry and have been kind enough to give me their views, some of them at great length.

I have endeavoured in what follows to reflect as faithfully as I can the different sets of views, and to add to them some views and suggestions, the result of my own experience.

Evidence from 150 Graduates.

First, as to the views of the 150 past students. These students all belong to the class for whom the earning of a living is imperative, and in the main they represent Oxford and Cambridge, and the London institutions of university rank.

[1] A paper read before the Educational Science Section of the British Association at the Sheffield meeting, by Mr. R. Blair.

Among minor points made by them are these:—The engineers emphasise the need of workshop practice under commercial conditions, finding that their future is in danger of being marred by lack of "works" experience, and some of those who have become industrial chemists express the need for five years' training: three for degree and two for research. The view of the engineer students needs no elaboration, for nowadays there is almost universal agreement that some form of the "sandwich" system affords the best possible method of training. The views of the chemists will be referred to later.

The students also complain that posts are obtained not on merit, but through influence. This contention is pointedly illustrated by a university college professor, who states that he knows one man who holds a most important berth, and is undoubtedly a first-class man in every sense of the word. This man took his university training as a mechanical engineer, and graduated with first-class honours, and did this after having had works' training extending over some eight years. On leaving college the man approached every mechanical firm of importance in Scotland in the hopes of getting a start. He found it impossible to do so. Finally, *through influence*, he did manage to obtain a junior berth, and is now the head of an important concern.

The most striking feature of the present occupations of the students is that only 10 per cent. have found their way into industry or commerce; another 10 per cent. have entered the higher ranks of the Civil Service, including technical posts. Some half-dozen are in the Church; another half-dozen are practising medicine; the remainder have taken to teaching, and it is clear in a fair number of instances that selection of a profession was not a matter of choice, but one of necessity. Many a man, towards the end of his university career, discovers for the first time that he has nothing to offer in the industrial or commercial market in return for a salary. If he has no technical knowledge or skill, he is, so far as his education helps him, in the same position as a secondary schoolboy, even if he is not handicapped on account of his greater age. Of those, also, who possess technical knowledge or skill, such as students of engineering or chemistry, a good many find themselves offered terms which pride, or poverty, or both, forbid them to accept. With pride I have no concern and no sympathy. Poverty is a different affair. When a man has spent his last penny in completing his university career, and when there is also pressure from home, there is no real choice between teaching, which is obtainable at 2*l.* or 3*l.* a week, however inadequately equipped the man may be for this purpose, and an office or a workshop at anything from, say, 10*s.* to 30*s.* per week. Sometimes the factory, shop, or business-house offers nothing, and occasionally a premium is required. It will easily be understood that in such circumstances an appeal is made by the students for more help in finding posts for university honours men, who are not eligible for the Civil Service, and who do not care to turn schoolmasters, and it will not be difficult to appreciate that at the critical point in his career—the selection of a means of earning a livelihood—a man is apt to write harshly of some of the slackness of university life, and to complain, as one of the most successful of them has done, that he wanted to be made a chemist, but his university insisted on his wasting his time on Divinity and did not even ask for German!

Evidence from the Staffs of Universities and of Technical Institutions.

A great change in the relations of the university and the market has occurred during the last quarter of a century. The general advance in the standard of education has produced a larger sympathy on the part of the market for educational institutions and their products; and the movement in favour of technical education has widened the range of objects of university education and the social classes from which university students are drawn, and has perhaps compelled the universities to have regard to the diversities in the world's work and to the functions they should discharge in preparing their students to live. During the period referred to a large number of technical institutions have sprung up all over the United Kingdom, and within quite recent years there have been strong influences at work to bring about coordination, if not incorporation of

the greatest of the technical institutions with the universities within the area of which they have emerged. The danger in the process of amalgamation is that it may be premature. It may come about before the realisation of what each institution in its own way, and in its own time, has had to contribute to national problems, and before it has been fully recognised that the annexation of a technical school is not merely the end of a rival, but the beginning of a new public responsibility, and that in the result the vitality and, if you like, the harsh industrialism and commercialism of the technical institution may be too much submerged by "academic control."

The evidence placed at my disposal shows, on the whole, a tone of great hopefulness. The hopefulness of tone to which I have referred is common. It is displayed by the newest of the large municipal technical institutions in the heart of a great industrial centre, and by some of our oldest universities. It is becoming evident that the institutions are recognising that, however much the market, in its quest after cheapness, has failed to distinguish the real from the spurious article, the institutions have been without much blame for placing inefficient machines on the market. An eminent professor of chemistry tells me that his whole "professional life is strewn with examples of the unwillingness of industry and commerce, the State, and municipal authorities of this country to take advantage of the services of young men who have received the highest technical training as chemists." But, he adds, "there is a tolerably rapid improvement taking place," and "we who are urging the importance of employing these highly trained young men have to remember that there has been a great lot of poor stuff turned out from the universities and technical colleges, and that the British manufacturer has a good deal to say in his own defence."

Agriculture and Allied Industries.

It is in connection with the agricultural colleges that there appears to be the least difficulty in showing that the students have found posts in agriculture or in allied industries. The case of agriculture may be somewhat exceptional. There has been so much development in this industry in recent years that there was bound to be a considerable demand for trained men. Moreover, many of the young men who have undergone a course of training in agriculture have done so in order to fit themselves for farming, or otherwise dealing with land as land agents or farm managers, on their own account. Further, it has for a fair number of years now been obvious that study in the agricultural colleges had to be combined with practice on the farm. The agricultural colleges also report that there is a considerable demand for their students in various branches of foreign and colonial land development work, such as tea, coffee, cotton, and rubber planting, management and extension of irrigation colonies, forestry, stock farming, and so on. A certain number of students trained at agricultural colleges are in demand for commercial undertakings in businesses associated with agriculture. For example, the German Potash Syndicate has a number of men representing their interests in various parts of the world who were educated at one of our oldest agricultural colleges, and the Permanent Nitrate Committee and the Sulphate of Ammonia Committee have also appointed agents or representatives who have gone through a similar course of training. The principal of the college attributes this preference for men who have received a college education instead of those who have had a business training only to the fact that the work undertaken by these representatives combines a large propagandist element with ordinary business management.

In Ireland the State directly organises the application of scientific education and of scientific knowledge to agriculture and allied industries. The Department of Agriculture and the county committees alone take advantage of young men who have received the highest technical training in agriculture. Since 1903 some sixty or seventy men have passed through the faculty of agriculture in the Royal College of Science, and all have been employed by the department or by the county committees. Farmers in Ireland operate on too small a scale to warrant them in employing experts as is done by large industrial concerns. Those who want expert assistance can get it through the county committees, or, for special work, from the department. In this way the faculty of agriculture is exerting a strong influence on agricultural practice. Leading farmers—those of the best education—make most use of the expert, and the smaller men follow them. In this way the influence of the Royal College of Science is far greater than is usually supposed to be the case. The college course fits men to take up the important positions of itinerant and special instructors, and the whole course has been designed specially for the one purpose. Moreover, the instructor and expert, after leaving college, are kept in touch with the work of the college and with that of instructors in other counties than their own or those adjacent. If the college taught, so to speak, in the air, and was not, as it is, part and parcel of a great organised system, it would do little good. No students of agriculture attend except those selected to become teachers and experts under the department and the local authorities. For such teachers and experts there is always a demand, since some of those who have been trained and who have worked as experts for a time leave—some to business, others go abroad to take up work as teachers or experts in the colonies.

In addition to this main work, the college trains experts in forestry, horticulture, and creamery management, and in these branches of Irish industry the trained men perform the same functions towards these industries as the agricultural expert does to agriculture proper. While no one who intends to become a farmer takes the Royal College of Science course—since this last would be out of all proportion to the capital invested in even the larger farms in Ireland—quite a number now attend shorter and less expensive courses at the Albert Agricultural College and elsewhere. There are thus other channels through which the higher technical training at the Royal College reaches those engaged in the agricultural industry, since these local colleges, stations, and winter schools are staffed by Royal College men who keep in touch with the central institution. The lesson which Ireland has to teach is that the faculty of agriculture in the Royal College of Science is part of a great organisation directly serving the interests of the agricultural industry, and not an independent institution pursuing knowledge for its own sake, or educating students without certainty of their profitable employment.

Engineering.

The evidence from the engineering colleges and institutions is also, on the whole, satisfactory. Here and there may be found somewhat doleful notes to the effect that the large majority of State departments and local authorities do not lay themselves out to take advantage of technically trained men, and in one case a view that has much popular currency has been put to me in fairly strong terms. It is to the effect that employers, especially those who have not very large and important undertakings, but who, nevertheless, would have their businesses improved by securing technically trained men, have an ignorant prejudice against such assistance. It is suggested as the possible explanation of their attitude that the employers fear that if they engaged men of greater attainments than themselves, they would simply be raising up possible opponents in their own line of business. There may be much truth in this view, which does not, of course, apply to first-class firms. But there is, I think, another worth full consideration: that the size of the business concern (the amount of capital sunk in it) has much to do with the employer's attitude. The employer does not possess the faith that will enable him to risk the addition of another salary to his working expenses; and no one, without a fair trial, is able to give him the mathematical demonstration which he seeks that the salary might often be saved merely out of the waste of materials which exists owing to the absence of scientific knowledge on the part of his men of the materials they are handling, and to their having to feel their way by experiments that are more in the nature of guesses. Such firms will be converted only by the example of others.

There is abundant evidence, however, that there is much less prejudice than formerly; that there is a growing tendency on the part of State and municipal authorities to secure for their services engineers who have received the highest training; and that this attitude is especially true of certain industries, the success of which depends absolutely upon highly competent, trained scientific experts, as,

for example, the steel industry. I suggest that the growth of this attitude corresponds generally in time with increased recognition on the part of the teaching institutions that engineers cannot be wholly made at college. The colleges have at length realised that the student must from the first learn the limitations of practical engineering, and that this can be done by the introduction of a practical atmosphere, and without sacrificing any of the physical principles of engineering already well taught at the colleges.

One of our ancient universities says, "We have not now much reason to be dissatisfied with the attitude of employers towards our (engineering) students." Several of the largest of the technical institutions say they have no difficulty in placing their best students, and one university college states that there is a standing demand as soon as the college year ends, from several of the heads of engineering establishments within the neighbourhood of the college for the best students. But these heads of firms demand the "best," and are willing to pay a living wage right off to youths who have never before been in works, and have only their college training as qualification. It is added that second- or third-rate men are in very little demand, and there is often a difficulty in not being able to recommend youths of sufficiently high standard to fill vacant posts. This case recalls other colleges where students (the "best," at all events) have no difficulty in securing places owing to the personal connection established between the heads of the neighbouring works and the head of the engineering department.

The return issued by the Appointments Board of the University of Cambridge in February of this year is specially interesting. This return shows that the number of candidates for the mechanical sciences tripos whose names appeared in the honours lists of the years 1894 to 1906 inclusive was 252, that the Board obtained information as to the posts held by 176 of these men; of the 176, only 23 were engaged in teaching, while 122 were engaged as engineers in some manufacturing or commercial concern or in the public service at home or abroad. The return is the more satisfactory in that 133 of the names belong to the years 1902 to 1906, and in that most of the men have to spend at least two years as probationers of some form in works before they can secure a definitive appointment of any kind.

It has been pointed out to me, both by professors and the heads of large engineering firms, that there is still a defect in the college training of young engineers which ought to be immediately remedied. The view is so well presented by one of the colleges that I give it *in extenso*. "There are certain defects in the average college training. I consider that the question of cost in design, and the commercial side generally, receive quite inadequate attention in most colleges. Practically all engineering firms exist for making profit. Modern competition makes economic design, good efficiency, and cheap upkeep absolutely imperative. The employer wants men who can in their designs give the most for the money. It is therefore insufficient to teach design on physical principles alone. Methods of production, ease of repair, depreciation, even conditions of transit in large machines, all these and more must be considered in effective design. Such limitations as these should, I think, be brought before the student in greater measure than they are attempted at present. This will tend to 'practicalise' the student while his mind is still formative."

Chemistry.

The case of chemistry is more difficult. There is, unfortunately, no room for doubt that the British chemical industry has suffered largely by foreign—chiefly German—competition; and possibly no section of British manufacturers has been so severely lectured as those in whose processes applied chemistry was capable of playing a large part. The chemical manufacturers were told to follow their German rivals by enlisting the assistance of the chemist trained in the scientific laboratories at our leading institutions, and that the industrial face of Great Britain would be changed. The manufacturer did not apparently grasp the meaning of the arguments or the appeal: he may possibly have comforted himself with the feeling that as things had been, so would they be; he may even have looked at the works that needed reconstruction, at the state of the Patent Laws, at the character of the supplies of raw material, at labour, at capital, at agents, markets and means of transport, and may have come to the conclusion that the professorial lecturers understood none of these things; he may have chosen a chemist from an analyst's office or from a medical school, and have failed to discover that chemists were of any value. Whatever he did, and for whatever reason he did it, it has been stated in the papers before me that he did not give much heed to the scolding from the professorial chairs: he could not be persuaded that scientific education was essential to his business. And so in time the penalty had to be paid, and that, unfortunately, by many who had no choice in the matter. Perhaps, after all, the chemical manufacturer merited less odium than has been heaped on him. It is a human quality to believe in your fortifications until they are reduced to ruins at your feet. It may be true, also, that the chemical manufacturer was not tactfully wooed; and it certainly is true that under the name of chemist enough rubbish was supplied to him to break down his faith in the panacea. Twenty years ago the research chemist qualified for industrial work could scarcely be obtained from English laboratories. He had to be imported from Germany. The English schools turned out only analytical machines. The influence of a few well-known chemists and of the 1851 research scholarships has changed all this, but the manufacturer has not yet recovered from his early disappointment.

It is gratifying to find evidence of change. The public may not yet believe that "scientific activity is the real and solid basis of national prosperity," and all manufacturers may not yet be fully prepared to endorse the view that "industrial development is ultimately dependent on scientific development," or everywhere to demand chemists trained in *research* writ large, but they are learning or receiving lessons sometimes in ways not altogether creditable to British intelligence. One of our most distinguished chemists, and a man of large experience inside and outside of the college laboratory, says:—"I am very clearly of opinion that, with very few exceptions, the State and municipal authorities do not lay themselves out to take advantage of men from twenty to twenty-two years of age who have received the highest technical training as chemists. Municipal authorities require the services of men who have had a specialised training as chemical experts in connection with the working of the Food and Drugs Acts, and there is a tendency on their part to prefer the services of men who are willing to take underpaid positions. This does not conduce to the efficiency of the working of the Food and Drugs Acts, and the general community suffers in consequence of the lax administration of these Acts. Municipal authorities occasionally require the services of engineers and chemists in connection with municipal undertakings, as in gas and water supplies. As regards the chemists they employ in connection with such undertakings, I think, on the whole, the community is adequately served; the chemists employed, for example, in the manufacture of gas are, as a rule, well trained and competent to discharge their duties. As regards private employers, I am of the opinion that British manufacturers, as a body, are not yet fully sensible of the advantage which they might obtain by the employment of skilled chemists in manufactures in which chemistry plays a prominent part. There are, however, exceptions. Some of the best equipped works of this country—usually wealthy concerns—strive to keep in the forefront of industrial progress. We have in this country an increasing number of men of foreign extraction who are engaging in chemical manufacture, and it is significant to note that such employers are far more prone to enlist the services of expert chemists than are the rank and file of our own manufacturers. I think this is due to the circumstance that the advantages of a university training have come home to these people more directly than to our manufacturers, and they are more quick to perceive the material advantages of the application of the highest training in pure and applied science to their industries. I could give a number of illustrations of this fact by pointing to the existence of foreign firms who have secured for themselves in this country a pre-eminent position."

The statement as to the increasing number of men of

foreign extraction engaging in chemical manufacture in England who are far more prone to enlist the services of expert chemists than are the rank and file of our own manufacturers points a lesson which is well illustrated from two other quarters. The secretary of the Cambridge Appointments Board says (*Empire Review*, January, 1905):—"A feature of the lists of matriculations (at Cambridge) for the years 1880–95 is the recurrence of German names, with the note, 'Now assisting his father in business.' From this it would appear that the representatives, naturalised in England, of the nation which has, more than any other, astonished the world by its industrial progress, have deliberately chosen for their sons a University career as a preliminary to business life."

The other illustration comes from British business life. Only one letter from a British manufacturer emphasises the need of research, and that is signed by a chemical manufacturer with a German name. As to evidence of change, one of the largest technical institutions says:—"We are fairly sure of placing at once all the best men who have taken a graduating course in any branch of applied chemistry." Another technical institution—probably the largest—states:—"We have been unable, during the last three or four years, to meet all the demands upon us for trained chemists, and at this moment we are unable to make nomination to two or three most important posts for which trained chemists are required because all our men are satisfactorily placed." From one of our oldest universities comes the statement:—"There is no difficulty in placing chemists of the highest rank in first-rate technical posts. By highest rank I mean people with approximately fellowship standing and great originality." Sir William Ramsay writes:—"Some months ago I had the curiosity to pick out from my class-lists, back to about 1890, one hundred names of men (and women) whose subsequent history I know. The result was, roughly: 60 in industry (analysts, private or in works, managers, proprietors of works, &c.); 25 in teaching posts (assistants in universities or university colleges, schoolmasters and a few professors—about 6); and 15 given up (married women, men who have changed their profession or dead)." The most gratifying fact about this analysis is that it suggests that 60 per cent. of Sir William Ramsay's students are pursuing industrial chemistry for a living.

An examination of the after-careers of the 1851 exhibitioners reveals the following results. It will be remembered that science scholarships are awarded annually by the Commissioners of the 1851 Exhibition. The scholarships are awarded for research in the experimental and observational sciences bearing upon industries. The nomination of scholarship holders is made by the authorities of twenty universities and university colleges within the British Empire, and, with rare exceptions, these nominations are confirmed by the Commissioners. The scholarships are of the annual value of 150*l*. a year, and are ordinarily tenable for two years. Between 1891 and 1906 there were awarded 262 scholarships. Of the holders, 145 are now engaged as professors, assistant professors, lecturers, or assistants in science colleges or other educational institutions; 76 hold positions in manufacturing firms or in public departments, and the remainder may be conveniently classified thus: scholars recently retired, 6; continuing research in private capacity, 12; engaged in professional pursuits, 10; deceased, 6; occupations unknown, 3; no longer engaged in scientific work, 4, of whom 3 are ladies. I find on further analysis that, of 112 scholars whose branch of science was chemistry, 50 are, or have been, engaged in industrial chemistry.

I am not able to provide more statistical details. As a rule, universities, university colleges, and technical institutions have not kept records of the after-careers of their students, and until quite recently most of the universities (and some not yet) have not had any organised means of giving assistance to students who may be seeking posts at the end of their college career.

Looking at the matter quite broadly, I see no reason for believing that the number of highly trained chemists who find their way from colleges into industrial chemistry is anything else than insignificant, compared with similar figures for Germany or the United States of America. The following facts may aid in understanding the conclusion of "insignificant" which I have reached. In 1904 and 1905 an average of 400 chemists received the doctor's diploma or the technical high school diploma in Germany; with the materials at my disposal I have been unable to convince myself that there were in 1908 300 students of all faculties of applied science taking a fourth-year day course in British universities and technical colleges.

For some of these results our system of degree-giving is denounced in no measured terms. An able university professor says:—"The fact is, the whole thing—university teaching of chemistry—is turned upside down. Much of our university work is simply good secondary work. A pass B.Sc. degree, for example, is about the standard of a school-leaving certificate in a civilised country. Universities lay down syllabuses, time-tables, hours of work, and spend a large proportion of their energies in examination grinding. They teach for examinations instead of teaching for the diffusion and advancement of scientific knowledge. When a man arrives at a university he has a 'curriculum,' in other words, simply a glorified school syllabus, laid out for him, and is promised a degree in three years if he is a good boy. They do not do that in Germany. We are not," he continues, "really quite so bad in this country as regards our so-called 'honours' degrees, but the centre of gravity is wrong for all that. . . . The centre of gravity of the English system is still in the examination hall, even though a good man does stay on for several years of research afterwards." Others, who have clearly devoted themselves to a study of the matter, demand a five years' course for the making of a chemist, three for degree and two for research.

One of the most thoughtful memoranda sent to me by a university professor shows:—"On entering the research laboratory the graduates are rarely independent thinkers, and their knowledge is essentially 'book knowledge.' When freed from the necessity to attend lectures or to work for examinations they seem to pass through a stage when they actually have to struggle to develop their resources, and often the students with the best degrees make the poorest research workers. . . . Again, the business faculties of the students at this stage are poor, and their knowledge of modern languages as applied to scientific or commercial work is quite inadequate. These are deficiencies which I have to make good in the research department. . . . Students at this stage are not qualified to take up positions of responsibility. The graduate of twenty-two has, however, many latent possibilities which may be successfully developed by a course of research work." The time spent by the graduates in research work in the university laboratory is from two to three years, and the average age of the students on leaving is twenty-four to twenty-five. "Taking an average case," the professor continues, "I can say that at the end of the first year the research student has commenced to think for himself, to anticipate difficulties, and to overcome them when encountered. He begins by suggesting new working methods, and finally proposes new topics of research. He has a working knowledge of scientific and technical French and German, knows the original literature of his special topic, and is generally conversant with modern research thought. His business style has also improved greatly. A considerable advance in these respects takes place during the next year, and in most cases a two years' course is sufficient to produce a man who has had a good education and who knows how to use it. It is my experience that when students with this training enter technical work they master the literature of their new subject very quickly and effectively. They seem to be able in a short time to form an estimate of the present position and future possibilities of the new subject and to bring their speculative faculties into play. I therefore regard the time spent at research as a necessary part of scientific training if university graduates are to enter the field of technical work, and men thus equipped make most valuable officials, even taking into account the fact that they have no previous experience in the supervision of workmen, and have generally no knowledge of chemical engineering." But the British parent does not care to afford to keep his sons at the university until they are

twenty-four to twenty-five years of age, especially as a period of probation has afterwards to be served in works, unless he sees that his money is going to be a good investment. And so we come back again to the manufacturer.

Other Subjects.

As to many of the other subjects in which the universities and higher technical institutions touch industry and commerce—architecture, biology, economics, and modern languages—there is little to be said on the side of the institutions. Biology is comparatively an unploughed field; the opportunities for economics are not yet fully developed. Railways, banks, insurance companies, and great business houses might, say the colleges, pay more attention to the really able economist. At the School of Economics a course of lectures in administrative subjects was arranged in the autumn of 1906 in order to equip officers for the higher appointments on the administrative staff of the Army and for the change of departmental services. This course is now annually attended by thirty officers selected for the purpose by the War Office. In order to provide the teaching required by candidates for the degree of B.Sc. in the faculty of economics and political science with honours in transport, the department of the school dealing with this subject has been developed. The lectures in this department, besides being open to students in the faculty, are attended by some 300 students engaged in railway administration. These students are drawn mainly from the staffs of the following railway companies:—the Great Western, the Great Eastern, the Great Northern, the London and South-Western, the Great Central, and the Metropolitan, their fees being in many cases paid for them by their companies. The lectures are also attended by members of the staffs of the other London railways, and occasionally by officials of Indian, colonial, and foreign railways, and other persons.

As for modern languages, it is alleged by the teaching institutions that the fundamental business attitude of England is entirely wrong. It will be seen later that this last view is amply confirmed from important and well-informed sources.

One further point of view of the colleges. Personality is by far the greatest factor; no amount of training can produce an exceptional man out of a man whose initial natural qualities are only second class.

VIEWS OF INDUSTRIAL AND COMMERCIAL FIRMS.

Answers to my inquiries have been received from a considerable number of large shipowners, from a few large shipbuilders, from nearly all the great railway companies, from a good many banking and insurance companies, from manufacturers of all kinds, and from employers' federations representing very large interests.

Elementary School Training.

Almost all explain their preference for elementary-school boys in such a way as to pay a well-deserved compliment, directly to the adaptability of the elementary-school boy, and indirectly to the existing system of elementary education. A good many speak in high terms of the value of evening schools, including technical institutes and schools of art. Banks and insurance companies almost invariably (but other firms as well) seek for the secondary-school product. There is some call for the man trained at the highest institutions, but this call is so much confined to firms the works or business of which require technical skill, that it is fully evident that the others do not yet feel the need for such men, nor know how to use them. There appears, also, with some frequency, the traditional fling at the public schools and at the universities.

Catch the boy as he leaves the elementary school, and induce him to attend evening classes; add to that the training of the workshop or the business house, and you have the fairly common plan of training those who will rise above the rank of "hands." From the best of these come the foremen; from those in turn the sub-managers are selected, and so on. It is interesting to see, however, that the possibility of a change is not unforeseen. "It happens," says one of our greatest industrial leaders, "that at the present moment all the men who fill the positions of responsibility in our office come from elementary schools. Naturally, they belong to a period when secondary schools were not so accessible as now, and probably the same remark may not be applicable to their successors."

There is much dissatisfaction with the existing system in those trades or industries in which apprenticeship was once common. "Time off" is occasionally allowed to attend day technical classes. But there is evidence that such a plan of training would not be generally acceptable, and I am told by one representative of a large set of interests that "the whole question of the method of teaching boys their trade in and on the works, seems in need of reform, . . . it is hardly possible for anything to be done in this way except by some compulsory scheme affecting all employers"; and by a representative of another vast set of interests that "As a matter of fact, the whole question of technical education is so unavoidably mixed up with the apprenticeship question in such a form as to make it impossible to deal with one without the other. Furthermore, the apprenticeship question is so clouded by the conflicting interests of the various unions, the unsatisfactory state of the law as regards employers, and other difficulties, that nothing short of a far-reaching Parliamentary scheme is likely, so far as my experience goes, to materially alter the situation."

The markets call emphatically for the "practical" man. A view more sympathetic with higher education, and not altogether uncommon, may be stated thus:—A man with practical training alone can do much; a man with technical training alone can do little; a combination is, therefore, essential. If only one can be had, which would be regrettable, that must be the practical man.

While, as I have already said, employers generally express the highest appreciation of the value of evening schools, technical institutes, and schools of art, as supplementary to the workshop, the factory, and the office, there is a good sprinkling of severe criticism. It is alleged that the schools are not practical, and that teachers of art as well as of science display much ignorance of the manufacturing process and of the limitations imposed by materials, machinery, and generally of the conditions of work and organisation necessarily enforced in a commercial business. This is, of course, no new view. It has been expressed to me all over the three kingdoms, and I fear there is much truth in it. Part of the ignorance is due to the exclusiveness of the manufacturer, who dreads the theft of his secrets. But the impression left on the employers is partly the fault of the schools. It was one of the defects of the technical education movement that it was hasty and tumultuous. Schools were not graded. Teachers and institutes set up claims impossible of fulfilment, and the British public misunderstood. Hence the doing, unfortunately not yet ended, of much mischief, which has had to be repaired.

This is, perhaps, the best place to direct attention to one of the commonest features of the employers' views. They think that evening schools, technical institutes, and schools of art may help the individual pupil; it does not enter their minds that such schools may aid their industries.

I have devoted more attention to the elementary side of technical education than might, at first sight, appear necessary. My object has been to show what the employer thinks of what he comes most in contact with. His views in that respect may serve as a guide to the kind of appreciation he is likely to give to that of which he knows less.

Higher Education.

I am much disappointed to find that a works of a technical character and with a world-wide reputation, says, "The men technically trained up to 20–22 years of age employed by us are comparatively few in number, and are generally such as have had special introduction to us," and I am also much surprised to find a large and well-known firm of engine-makers saying, "We have never had any application from the universities." Another firm, the name of which is a household word, says, "There are no proper ——— schools" (naming an important and common article of commerce which forms the subject of large industrial works), "in this country such as are found on the Continent, so it would be difficult for us to get properly

trained men of 20 to 23 years of age straight from the university to fill the highest posts in our business." On the other hand, a professor of chemistry at a university, in which great stress is laid on the value of chemical research, says, "It is, perhaps, an index of the slender relationship between commercial chemistry and scientific work to state that although all the research done in my laboratory is in ——" (using exactly the same term as the firm), "I have never had a single inquiry for a chemist from a manufacturer producing or using these compounds." I hope to serve as a labour exchange between this laboratory and that factory.

There is, again, a common impression that the training in the universities and higher institutions is not sufficiently practical, and much fear is expressed that the university man would not care for the continuous and laborious routine of commercial life. A gigantic association in the north of England, with extensive business ramifications all over the world, and at the works of which considerable chemical knowledge and a general scientific training is necessary, says: "For our works, the youths who come to us have had a public school or grammar school education of modern type. They are taken from school and sent to the works for twelve months, after which, if they show ability, it is arranged that they should take a three-years' day course at a technical school and obtain the degree of B.Sc. They then go to our own laboratory, and a training specially suitable to our requirements is given to them." They add, "Provided a youth appears to be energetic and not to have suffered materially from the defects often induced by such a course, we should upon the whole prefer a man who had been to a university. . . . For our best positions in the commercial departments we prefer boys of 18 or 19 from good public schools" (I think it is the Manchester Grammar School type which is in mind), "to those who are younger, and we are equally glad to have university men, provided they are energetic and fond of work. Our opinion of the usual result of a course at the university is that it is not calculated to induce this spirit. The length of the vacations, and the great freedom enjoyed by undergraduates, do not form a good preparation for the absolute tie, the long hours, and the very short holidays of a business life."

This particular view was written in the north of England. Whether true as a criticism of some phases of our university life and work, it represents too common a view to be omitted. It is not true of some of our largest technical institutions, and I cannot think that it is true of the younger universities. But it may serve to show these institutions what spade work they must undertake. Let me return to criticisms. A general manager of one of our great railway companies says, "We have in the past appointed a few university men, but it is not an experiment which we are repeating." On the other hand, the general manager of another large railway company says, "In my opinion, no man is fitted for the higher posts in the engineering world unless he has received a full university education, and it is a great advantage to a man in the industrial and commercial world if he has had, and has made proper use of, a university training." And again by another, "The university or other technical institute curriculum does not enter into our estimate of the fitness of the individual. It is certainly in favour of the lad who has enjoyed it, but it is, after all, only a means to an end, and unless it has been intelligently employed by the favoured student, the less fortunate lad with definite aim is not irremediably out of the running."

The head of a chemical manufacturing company, which employs university trained men, puts his views thus: "We invariably find that men who come to us with the highest technical qualifications, either from a technical institute or from the universities, require a considerable time before they are able to utilise their knowledge practically. An analyst, for example, will take some time before he recognises the fact that analyses must be done quickly and accurately, and that no mistake in analyses is permissible; with regard to experimental work, it is also some time before a university man can be got to distinguish between results which are likely to be of practical value and those of only theoretical interest. Some men acquire their experience very quickly, others very slowly or not at all."

One more quotation under this head. A consulting engineer with a large practice, who employs twelve university or technical college trained men, in addition to a large technical staff of a lower grade, says, "I am a thorough believer in university and scientific training, but there is, no doubt, considerable difficulty in combining the university and practical training."

The general absence of replies of any importance from salesmen and merchants not manufacturers, may be taken as indication that the minds of business men of that type are not interested in the problems presented to them by my letters of inquiry. The opportunities for the propagandist commercial traveller and for the economist have still to be developed. But when the War Office and great railway companies make use of the School of Economics, other State and municipal departments and great corporations will, sooner or later, follow.

Finally, the industrial and commercial firms point out, as the colleges do, that other qualities than those which generally show in an academic career are necessary in the fields of commerce and industry. Those are the business or economic sense, alertness, capacity for work, loyalty to the firm's interests, push, perseverance, social qualities, including good manners towards clients, tact towards subordinates, and capacity to get the best out of them, and generally the power to control men and things. These qualities do not, as a rule, show early, and consequently firms should in their own interests make the basis of selection large and broad.

In concluding this section, let me say that many British manufacturers, especially those under younger management, are displaying their economic sense in a new and interesting direction. Firms manufacturing common commodities and employing thousands of hands have invited me to visit their works, and have shown me that not only do they employ scientifically trained engineers and chemists, but they employ public-school men as managers, they employ on their permanent staff doctors and dentists for the sake of their hands, they provide much for the social and economic welfare of their workers, and generally they show that they take as much interest in the human as in the other material which comes into their works; and they do this, not as philanthropists, but as business men. They find that in the interests of their business the human material, as much as the coal and the steel and the sugar and the flour, can respond with more efficiency to scientific and generally enlightened management.

What the Consuls-General Say.

It is impossible to ignore the unanimity of the story told by H.M. Consuls and the experience and earnestness and sense of responsibility of the men who tell it. The main question submitted to them was this:

It has been said from time to time that British firms (merchants, manufacturers, and so on) do not sufficiently apply scientific methods to the canvassing of the various markets of the world, and in particular that, as a rule, their travellers and agents do not know the language of those with whom they are dealing; that advertisements, prospectuses, and so on are published in English, with English weights, measures, and money terms; that British firms do not sufficiently study the needs of the markets; and that in general there is a want of activity and enterprise of the right kind. The answer is, "To a large extent, true." And this answer is so emphatic, so unanimous, and withal so moderately stated and so clearly expressed, that it is not possible to regard it as incredulous. The story is as follows.

Commercial Education.

British merchants and manufacturers (and British shipowners) until about thirty years ago may be said to have had rather more than their share of the world's trade, and, comparatively speaking, made money so easily that they grew over-confident, relaxed their energies, and took little pains to improve their business methods as time went on and to learn from their competitors. It is only from about that time that they have begun gradually and slowly to realise—through the falling off of profits and through losing a share of the markets which they used to monopolise—that the traders and manufacturers of other countries, in particular those of Germany and of the

United States, have made up their minds to have, and have already succeeded in obtaining, a larger proportion of the world's trade than was previously left to them by Great Britain.

Our leading manufacturers are so strong, and their work of such excellence, that they can push themselves in any market; but it is not the same with other firms, and if these were to amalgamate they would acquire great strength. Cooperation is adopted in our shipping business with marked success, and should serve as an example for other industries.

The Britisher believes in competition and the survival of the fittest. The results, it is alleged, are a limited number of robust units and a mass of mediocrity which cannot resist foreign cooperation either in the home or foreign markets.

The great trouble is the lack of enterprise on the part of British firms in sending out travellers. Lamentation on this head is loud and frequent. Figures for two European countries are given to me. The first country is eminently suited for trade with England, more especially just now when the two countries have so much in common, and when "things English" are so much in vogue. The total number of commercial travellers' licences issued at "A" (the capital) during 1909 was 1203. During the same year 357 licences taken out at other towns were presented to the "A" police for visa. The 1203 licences were issued as follows:—to German commercial travellers, 605; to British, 142; to other nationalities, the remainder. Of the 357 the Germans had 146, the British 37; the remainder were distributed among various nationalities. The other country is also one which would also appear to be eminently suited for British trade. In the year 1908 (the figures for 1909 were not available) 7000 commercial travellers visited this country; 4700 were of German nationality, 1500 French, 61 represented Great Britain, the rest various.

In general, there is no complaint against the natural qualities of the British traveller; "a smart British business man accustomed to travel and deal with foreigners has no equal the wide world over, but, alas! there are too few of them." Another says:—"As regards the other qualities—push, activity, enterprise, and so on—they all seem to exist in such satisfying degrees in the British commercial man that if he direct his attention to rectifying the faults arising through this insular attitude, and the lack of commercial education which so narrows his outlook, the future would then look at least as hopeful as it does in any other country." A third maintains:—"There is no inherent quality in the Britisher which prevents his being able to compete successfully, not only in capturing new markets, but also in ousting his rivals who have been there before him. On the contrary, he possesses in as great as, if not in a greater, degree than any other nation just those qualities which eminently fit him for such work—endurance, perseverance, reliability (a very great adjunct), and concentration." And so on.

Until by scientific education the British realise that commerce means an intricate and complex organisation of intimately interconnected parts, they will lose many an opportunity, and their Consulates and Chambers of Commerce will be unable to do for them the work which could easily be done. Engineering, it is pointed out to me, is looked upon as a science, but commerce is not.

Metric Measures.

Failure to adopt the metric system places British manufacturers at a decided disadvantage. A French merchant, accustomed to one system of weights and measures, uniform and exact, resents receiving quotations from England in quantities which are absolutely mysterious to him. Circulars and price-lists, printed only in English with English weights, measures, and prices, are often sent to the Continent of Europe beautifully, even artistically, printed and illustrated; but they are of no practical use, as they are not understood by the persons for whose inspection they are intended. Only in cases where it is known that some member of the foreign firm is well acquainted with English, or has already dealt with English firms, can any practical result be looked for by sending out English catalogues. Further, a good deal of delay and inconvenience is sometimes caused at the Custom House through the use of the English system of weights and measures, owing to the fact that all weights and measures have to be reduced to the metric system before the goods are cleared.

Foreigners will not buy goods simply because they are British. The man who wishes to sell and to increase the number of his clients must seek the goodwill and favour of the buyer, and not look to the buyer so much to accommodate himself to the ideas and business rules of the manufacturer. Enough stress cannot be laid on the vital importance of personal acquaintance with the country, the people, their customs, needs, weaknesses, likings, and prejudices; and also with the local methods of doing business—in short, with everything and anything that can and does affect the market.

In this connection I would like to recall what Lord Cromer said to Lord Reay's Committee on the Organisation of Oriental Studies in London: "It is quite possible for an Englishman to pass half his life in the East and never understand anything about Easterns."

Foreign Languages.

If the requirements, industrial and commercial, of any country are to be understood thoroughly, a knowledge of the language of that country is essential. One Consul says:—"I have seldom met a foreign traveller who does not speak one or two languages besides his own." Another says:—"I have very seldom, I might say almost never, met an English commercial traveller who knew a word of ——" (the language of the European country from which he writes). If I were at liberty to identify the individual, by naming the country, it would be seen that his statement, while appearing incredulous, would really appear to be highly credible. Another Consul says—and others write to the same effect:—"Lastly, but perhaps first in importance, is the fact, which cannot be brought home too strongly to every young commercial man, viz. the absolute necessity of learning foreign languages. English, it is true, is spoken everywhere abroad, and although fresh business may possibly be secured in foreign countries by men who speak nothing but English, the circumstances are exceptional, and point to the fact that the goods are absolutely wanted and none others, and not to any special acumen on the part of the salesman. The majority of travellers, however, have goods to offer which are by no means unique, and in the sale of which they will have to compete very severely with rivals. The case of the man in this country (an extensive country, with large trade possibilities) who speaks nothing but English is too obvious to need any elaboration."

I will add but one further quotation:—"Until it is realised in the English system of education that modern languages are useful as means of communication between persons, and are not merely theoretical subjects in which a knowledge of grammatical rules results in the pupil being awarded a prize, they will probably continue to be handicapped." He adds, "I speak feelingly on this subject, as my own children have been able to converse comfortably in four or five languages, and after two or three years at a first-class school have since entirely forgotten how to use them, although two of the said languages are in their regular school course. I understand, for instance, that although when conversing they use the subjunctive mood naturally and correctly after certain conjunctions, they are unable to write out a list of all the conjunctions which govern the subjunctive, and consequently they are made to spend their time learning this and such-like rules instead of adding to their vocabulary as an infant does by daily practice."

The languages which these officers call upon the British traveller to learn are French, German, and Spanish. A knowledge of French will carry any commercial traveller through France, Belgium, Russia, Italy, and Switzerland, as well as through many parts of Germany. For Germany and Austria, German is necessary. Spanish is wanted for the Peninsula and the South American trade.

Let me repeat that the views set out above are not mine. They are those of His Majesty's Consuls at stations distributed over four continents.

The Present Position and Needs.

I have now come to the last section of this paper. For fear of being misunderstood, let me say at once that I have no lack of respect for our ancient universities, and that any appearance of such in this paper is quite unintentional. It would, indeed, be difficult to exaggerate the share which our oldest universities have had in the formative life of this country, and the work of the past is still necessary. Universities must continue their detached work; they must pursue knowledge for its own sake or for the purely mental training it gives; they must continue to produce statesmen and churchmen and lawyers and doctors and schoolmasters, and they must educate the leisured classes. I would even go so far as to say that it is a national asset to have institutions setting the standard of efficiency and honour in national games. But the modern world needs something more, especially from the departments of applied science. The sympathy and support which these departments have received from the public have, to a large extent, been based on the belief that they would contribute to the success of national industry and commerce. The same holds true of the large technical institutions with day departments for young manhood. There is a public need, and in some cases a public demand. It is our object to increase the demand.

I have no magician's wand to offer as a means of revolutionising public opinion, and I should like to make clear that I have no thought of advocating mere imitation of German methods, which would be extremely foolish, if not disastrous. The industrial and commercial conditions and the character and traditions of the people of Britain and Germany are dissimilar. Again, the German universities endeavour to send out men ready to take their place immediately, not in the ranks, but as officers in the industrial and commercial armies. Further, the British system of education is so different that not to give heed to what exists would certainly court failure. Many useful lessons may, however, be gathered from a study of German methods; but possibly our most useful lessons are to be gathered from America, where the character of the people is more like our own, and where it is clearly realised that whatever training of the highest kind a man may have, he must still begin in the ranks and climb his way to the top. It has been said that British character and methods produce a few brilliant units and a mass of mediocrities. The surest road to success would probably be for the mass of mediocrities to adopt the methods of the brilliant units.

The normal attitude of the employers, if not of the public, may be expressed in three sentences:—(1) Only those value higher education who have felt the need for it. (2) The purely practical man can do much, the purely theoretical man can do little; a combination is therefore necessary. Should one quality only be obtainable, which would be regrettable, that quality should be the purely practical. (3) Teaching institutions may assist individuals to get on; they form no essential part of our industrial or commercial system.

For these three sentiments I suggest that we are all anxious to substitute three others:—(1) Setting aside exceptions, every man who achieves success must give so much time to fit himself for his work, whether the time is given in college under guidance and discipline or is expended in self-education. (2) In the end, and again setting aside exceptions, the man who has received the highest training in college under guidance and discipline will, other things being equal, achieve by far the greatest success. (3) The work of research and training carried on in technical school and university college is an integral part of any nation's successful industrial and commercial organisation.

Organisation and Management.

How is the substitution to be accomplished? The demand of the shareholders of an industrial or commercial concern for dividends forms a great stimulus to intelligence and activity on the part of the staff. Without such stimulus in a technical school or faculty of applied science there is a tendency for things to become comfortable. I suggest the following:—

(1) The management of all technical institutions and departments of applied science should be put on a business footing. The ordinary governing bodies, as a rule, serve for ordinary governing purposes. The chief need is that of consultative committees attached to all specialised faculties or departments, such committees to be advisory and to be composed of industrial or commercial leaders or experts of the highest reputation. This is probably the best and surest means of enlisting the full sympathy of industrial and commercial leaders. The faculty or department, the curriculum and the examinations, would benefit by having its work and methods criticised sympathetically by experts of the first rank. Such a committee would form the surest medium of communication between the college and the workshop; and its formation would certainly be followed by a wide extension of the appreciation of the advantages of technical education, because the captains of industry would learn exactly the character of the work done in college and how in practice to utilise it.

The head of the teaching department and his staff would by this means gain easy access to factory and workshop, and bring back some of their atmosphere to the laboratory. On the examining committee of the engineering department of the Glasgow and West of Scotland Technical college are the engineering director of the Fairfield Shipbuilding and Engineering Co. and the engineering director of John Brown and Co., Clydebank Shipbuilding and Engineering Works. Such men would probably be generally recognised as the leaders in their particular profession on the Clyde. I understand that it is their practice to look in great detail through worked papers and designs, and to give the engineering department of the college the benefit of their criticisms. Employers, parents, and students cannot but have faith in the instruction given in an institution so aided. Let me make it quite clear that I am not advocating a mixed governing body, but an advisory committee of experts attached to each technical department. Governing bodies should consult such advisory committees before appointing the head of a department or even the principal of a college or technical institution. In the qualifications of principals and heads of departments it is customary to give too much consideration to academic status and too little to industrial experience and business capacity. Such a consultative body as I have referred to would act as a corrective in this respect.

(2) A connection should be maintained with old students and a record kept of their after-careers. One of the means of success of the American colleges is the list of after-careers of their students. It is almost incredible how little has been done in Britain in this respect. I hope parents and the public generally will develop a habit of asking for such a list.

(3) At each technical institution and university there should be an organisation to assist students in getting placed. The Blue-book recently issued by the Board of Education shows how much English universities have in the past neglected this aspect of their work, and how much there is still to be done to establish appointments committees or bureaus. I am not overlooking the fact that much excellent work has been done by individual professors and occasionally by the secretary or the principal. But this was unorganised. I am asking for an organisation. The manufacturer and the merchant have been denounced in no measured terms by representatives of learning for their short-sightedness in not applying scientific methods to manufacturing and business processes; could not the manufacturer and the business man retaliate that not only have university and technical college goods been of such various qualities that it was impossible to discriminate, but also that scientific principles—even common business empirical methods—have not been applied to the marketing of school and college products? It is a discredit to the universities and technical colleges that they have so long neglected this obvious means of assisting students, this obvious means of promoting the cause they proclaimed.

(4) A change in curriculum and in degree requirements. Let me read some remarks on American colleges which I wrote in 1904. "Again, there is, in each American institution, a considerable 'mortality' or shedding of students. Some students find their general preparation insufficient; some find the pace too great; others find their funds give out; and some are advised that they have made a bad selection. In such cases the American student accepts advice, and acts promptly. At every step a student's work is known, and the faculty—staff of professors in each department—every four months discuss fully a student's work. The middle of the third year is the critical point in a student's career. At this stage the requirements of the Institute of Technology demand a final decision as to choice of work. Fifteen men in one department were, at this point, recently advised to change their courses or to withdraw from the institute. I was informed that, as a rule, 25 per cent. of the civil engineering students drop off at the same stage. These numbers have to be added to those who have previously 'fallen by the way.' The greatest patience is extended to the students, and the best advice is offered to them; but in the interest of the individual, as of the standing of the institute and of its influence on industrial work, such shedding of students is regarded as inevitable, and is acquiesced in. It does not follow that the men are 'wasted.' As a rule they find employment of a lower character than they were aiming at; they change the directions of their careers, to their own great advantage, or they pursue a course of studies on the same lines at a secondary institution—a two-year course school."

It appears to me that such kind of advice and action is necessary in British teaching institutions, but it is hardly possible under existing conditions.

(5) Another means of bringing the college class-room and laboratory into closer connection with factory, workshop, and office would be more liberal provision of short, specialised courses suitable to the heads of firms or their successors. I am not referring to that provision of evening courses which is made in technical schools and schools of art, but to provision, whether day or evening, of advanced courses for industrial and commercial leaders or their successors in institutions which there could be no presumed loss of self-respect in attending. Such courses are provided at several colleges; they need multiplication. I know that a large number of able men obtain, at much expense, instruction through private agencies, because the best institutions do not appear to cater directly for their needs under suitable conditions.

(6) As to modern languages, three things are necessary for the majority of students:—(i) less the scholar's and more the utilitarian point of view; (ii) more concentration during the later school and college years; and (iii) speaking generally, a better class of teachers.

In conclusion, let me say that this preliminary study of a very large question has disclosed much hopefulness of the future. The obstacles which university and other highly trained men encounter in getting a footing in the industrial world are still formidable, and the breaking down of the barriers between our highest teaching institutions and commercial life forms a specially difficult task. But there is plenty of need for first-class men, and there is not much difficulty in getting the exceptionally good man placed. It is gratifying, too, to find that His Majesty's Consuls speak in the highest terms of the personal qualities of our foreign commercial travellers.

On the side of education, too, there is much hopefulness. A distinguished university writer not long ago stated that the object of university education "was not how to keep our trade, but how to keep our souls alive." Between such a representative of university education and the business man who inquires what is the money value of a degree there is little room for accommodation. But the writer did an injustice to the universities, and the facts as to the objects of university education are against him. It may be true that in the long view the keeping of our souls alive is the object of university education, but even the oldest of our universities are becoming conscious that the immediate condition of saving our souls alive is that of saving our trade.

ROYAL SANITARY INSTITUTE.

THE twenty-fifth annual congress of the Royal Sanitary Institute, held at Brighton from September 5–10, was attended by upwards of 1200 members. To the address of the president, Sir John Cockburn, K.C.M.G., we have already referred (NATURE, September 8). Seeing that no fewer than sixty-three papers were printed *in extenso*, and many of them "taken as read" before discussion, it will be understood that it is impossible, within the limits of our space, to do more than glance at the general aspects of the work of the congress, endeavouring to indicate the drift of opinion on some of the more important questions which were raised. All problems relating to the health and physical well-being of the community are regarded as coming within the province of the Institute. In the Lecture to the Congress Dr. Arthur Newsholme set forth the now well-known statistics of diminishing birth-rate, and considered the arguments in favour of, and against, the present crusade against infant mortality. "Is it worth while to dilute our increase of population by 10 per cent. more of the most inferior kind?" The diminishing fertility-rate is as noticeable in the ranks of skilled artisans as it is in the ranks of the well-to-do. He concluded that it has not been proved that the inferiority of the offspring of the most fertile class, the unskilled, is due to inferiority of stock so much as to the unsatisfactory conditions into which they are born, and he strongly deprecated the attitude of that section of eugenists whose pass-word is "Thou shalt not kill, but need'st not strive Officiously to keep alive." The services of health visitors and the adoption of the Notification of Births Act are, the lecturer considered, the most hopeful agents and means whereby the death-rate of early life may be reduced.

The numerous papers and discussions we can but summarise under separate headings. *The Municipal Control of Tuberculosis.*—Compulsory notification of all cases was strongly advocated, and the removal of cases which cannot be nursed at home, without risk of spreading infection, to the empty wards of fever hospitals and small-pox hospitals; the risk of cross-infection being *nil* if suitable administrative measures be adopted. This system had its initiation in Brighton, so far as the use of hospitals is concerned, and its value has been thoroughly proved. Patients receive the educational treatment which gives them a practical understanding of the lives which, for the sake of other people, as well as for their own, they must henceforth lead. *Preventive Medicine in School Life.*—Much consideration was devoted to the work of the school medical officer, the administration of the Education Act of 1908 being, as everyone acknowledged, in a tentative and, in many respects, a very unsatisfactory phase. More financial support is needed. Inspection without school clinics is in many districts in which there is difficulty in obtaining treatment of very little use. The question of the periodical disinfection of school premises led to warnings regarding the danger of "sprinking a little carbolic acid, and leaving the rest to Providence." There are, indeed, few subjects in which sanitary authorities themselves are more in need of education than in the use of disinfectants. Faulty drains are not reconstructed, nor are their dangers lessened by an antiseptic odour which allays the anxiety of the public. Several papers were read upon school planning, and opinion appeared to be universally in favour of the Derbyshire and Staffordshire type, which provides efficient cross-ventilation of every class-room. Cross-lighting must, however, be avoided as far as possible. Open-air schools on the lines of the Thackley (Bradford) school, in which each class-room has a verandah for fine weather, were commended. Rectangular class-rooms with more direct lighting and warming by the sun's rays are to be preferred to square rooms. Appliances for drying cloaks and shoes should be provided. The treatment of tuberculous children and of the pre-tubercular was brought forward by Dr. Broadbent, who strongly advocated teaching such children in the open air, and a modified curriculum. The X-ray treatment of ring-worm was approved; but the utmost caution is necessary at the present time, lest its unskilful application should throw it into disrepute. *Disease Carriers.*—Prob-

ably about 3 per cent. of the cases of typhoid fever which have recovered from the disease continue to breed and distribute the germs (Brückner). To scarlet fever, diphtheria, cerebro-spinal meningitis, and measles some risk of the same kind is attached. The importance of this matter can hardly be exaggerated. Instruction in cleanliness, periodical examination of the excreta of typhoid carriers, disinfection of the alimentary canal by drugs, are obviously necessary; with restriction to such occupations as afford the least opportunity for the dissemination of disease. *Control of Foods.*—There can be no hope of freeing the milk supply from the bacillus of tubercle without more effective control of milk growers and milk sellers. At present the milk supply can be stopped only for one particular district, and the farmer is at liberty to send the condemned milk to any other district without incurring any penalty. *Housing and Town Planning.*—Dr. Fremantle argued that the expense and opposition which an attempt to proceed under the Regulations of 1910 will entail will deter municipalities from taking advantage of the Act. *Sewage Disposal.*—C. Chambers Smith maintained that economy in the disposal of sewage may be carried much further than at present. Sedimentation tanks and percolating filters are less expensive than contact beds. Shenton advocated the sterilisation of sewage effluents by hypochlorite of lime, proving with well-ordered figures the need for this final destruction of bacterial life, and showing the efficiency and inexpensiveness of the agent recommended. An interesting paper on the influence of underground waters on health was read by Baldwin Latham, who associates the epidemic appearance of fever with a fluctuating level of subsoil water, and especially with an unusually low water level.

A conference of women on hygiene was held under the presidency of the Countess of Chichester, at which questions of great practical importance in relation to the artificial feeding of infants and the influence of the employment of married women upon infant mortality were discussed; but the subject which aroused most interest was "Home-making Centres"—centres for the teaching of what in Canada is defined as household science. Whatever other items may be introduced into the curriculum to meet the needs of particular localities, the chief subjects taught at such centres must always be cooking, housewifery, dressmaking, the care of infants and children, personal and domestic hygiene.

In the popular lecture, which brought the proceedings of the congress to a close, Dr. Alex. Hill took the opportunity of directing attention to some of the recent triumphs of sanitary science, quoting especially from the report of Sir Rubert Boyce on the condition of the West Indies:—"Look to your laurels, Brighton! 'The West Indies are rapidly becoming the sanatoria which nature surely intended them to be.'" He next proceeded to expound the principles of Mendelism, answering, incidentally, Dr. Archdall Reid's objection that they have only been shown to hold good for human abnormalities and for the characters of cultivated plants and domestic animals by pointing out that, unless characters are either so unusual as to be "abnormal" or so much exaggerated by breeding as to be outstanding, it is impossible for the biologist to isolate them as allelomorphs. He then submitted a scientific basis for Dr. Newsholme's contention that all infant lives must be cherished by the community by showing photographs of a white albino guinea-pig from which the ovaries were removed soon after birth and replaced by those of a black guinea-pig; one of several litters of young, all black; and their white albino sire. The doctrine of the continuity of germ-plasm, the lecturer said, by throwing the origin of the individual so far back, has profoundly modified our ideas of the heritability of the moral and pathological characteristics of the immediate parents.

The congress was fruitful in discussion, and those who attended it will carry away many new conceptions and discard some misconceptions; but amongst the many congresses which meet at this season that of the Sanitary Institute stands somewhat apart in that it supplies the stimulus for the publication of a large number of papers of permanent value. Medical officers of health and others stationed in distant parts of Britain find in it an opportunity of putting their observations and reflections in print, and submitting them in this form rather than only, to a considerable body of their fellow-workers. An admirable and extensive Health Exhibition was organised in connection with the congress.

INTERNATIONAL CONGRESS OF PHARMACY.

THE tenth International Congress of Pharmacy was held in Brussels on September 1 to 6, and was attended by over five hundred pharmacists. The Governments which sent official representatives were those of France, Italy, Spain, Russia, the United States, Norway, Denmark, Sweden, Holland, Greece, Hungary, China, Japan, the Ottoman Empire, Venezuela, the Argentine Republic, the Republic of San Salvadore, Guatemala, Haiti, and Chili. The delegates from the Pharmaceutical Society of Great Britain were Mr. Edmund White, a member of the society's council, and Mr. E. S. Peck, one of the permanent hon. secretaries of the British Pharmaceutical Conference. The most important subject which came up for consideration related to analytical methods. The international conference for the unification of the formulæ of potent drugs, held at Brussels in 1902, defined standards for a number of drugs and galenical preparations, but different methods of standardisation give different results, and it was one of the objects of the pharmaceutical congress to consider what steps could be taken to bring about the approximation of analytical methods. After a long discussion it was unanimously resolved, on the motion of Prof. Bourquelot, representing the French Government, to ask the Belgian Government to convene an interational conference, composed largely of practising pharmacists, for the purpose of unifying the methods of estimating potent drugs, with the recommendation that, for the estimation of alkaloidal preparations, preference should be given to gravimetric methods. The congress also agreed that it was desirable that pharmacopœias should indicate the precise methods of determining physical constants, and that in the case of chemical tests the reactions should not be capable of giving rise to any difference of interpretation. The related topic of the international unification of analytical reagents also received consideration, and the congress resolved to request pharmacopœiæ commissions to adopt as far as possible normal reagents or some multiple of the normal. The decisions on these two questions constitute the most useful part of the work of the congress.

Next in importance was the discussion on the sale of proprietary disinfectants, and the congress unanimously resolved to recommend that the sale of proprietary antiseptic products and disinfectants should be officially regulated. No such products should be sold unless the manufacturers of them shall have obtained a licence from the Government, only to be granted after the products shall have been officially examined both chemically and bacteriologically with the view of ascertaining if they possess the properties claimed for them. It was also resolved to recommend that all such products should be labelled with the name and address of the seller as well as the manufacturer, and that the bactericidal strength and the date of manufacture should be stated on the label.

Among other subjects discussed were:—(1) The desirability of a large representation of pharmacists on the commission charged with the preparation of an international pharmacopœia; the congress expressed approval of the principle. (2) The advisability of pharmacists making their own galenical preparations; the congress agreed that this was desirable where possible. (3) The limitation in each country by the State of the number of pharmacies; the congress approved of the principle of limitation and agreed on a method of limitation. (4) The desirability of instituting in schools of pharmacy courses on the macroscopy, microscopy, and chemistry of natural and pathological secretions; the congress agreed that such a course of study might with advantage be instituted.

In addition to the discussion on topics of general and pharmaceutical interest, several communications of purely scientific interest were presented. Prof. Bourquelot made a further contribution to the biochemical method of examination of vegetable glucosides hydrolysed by emulsin. He pointed out the relation between the optical properties

and reducing power of the products of hydrolysis by emul and suggested as an index of enzymolytic reduction weight of reducing substances, calculated as gluc formed in 100 c.c. by the action of emulsin corresponding to a rotation of 1° observed in a 2 dcm. tube. After showing the different uses of this method, he gave a list of medicinal plants in which the presence of glucoside had been shown by this means, but which had fallen into disuse, as no active principle had been separated formerly.

Prof. Herissey explained a chemical method of obtaining the true glucoside arbutin, which gives glucose and hydroquinone on hydrolysis with emulsin. Commercial arbutin, extracted from *uva ursi*, is a mixture of true arbutin and methyl arbutin, and this, on being treated with alcoholic potash, gives a precipitate of the potassium salt of true arbutin, from which the glucoside can easily be obtained in a pure state. This glucoside is apparently identical with that isolated recently from the leaves of the pear tree by Prof. Bourquelot and Mlle. Fiehlenhots.

Mr. Leger described his experiments which had led to the establishment of the constitution of the aloins. These experiments show that barbaloin and isobarbaloin are glucosides which can with difficulty be split into alœmodin and α arabinose. These two aloins are stereo-isomers. Nataloin, treated with sodium peroxide, furnishes methylnanatœmodine, decomposable by hydrochloric acid into natalœmodin and methyl chloride. Nataloin appears to contain in its molecule a pentose sugar.

Prof. Perrot described the method which he, in collaboration with Mr. Goris, has devised for obtaining dried plants in which the properties of the fresh plants are preserved; the principle upon which the method is based is the destruction of the diastase.

Mr. Hercod read a paper by himself and Mr. Maben on the assay of pepsin, and the congress decided to refer the question to an international committee with a view to establishing an international standard and method of assay.

Mr. Moller read a paper dealing with the determination of colours, and the congress agreed to recommend the adoption, as an international code of colours, of the code of Klinksieck and Valette.

The above is a brief summary of the work accomplished at one of the most interesting international meetings of pharmacists which has ever been held. It should also be mentioned that a decision was arrived at to form a permanent international pharmaceutical association, the headquarters of which will probably be at the Hague.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. PHILIP WARD, who has just been appointed a Commissioner of National Education in Ireland, is the first national teacher to fill the position. He is a former president of the National Teachers' Organisation.

THE following courses of Gresham science lectures are announced for delivery at the City of London School, Victoria Embankment:—Geometry, by Mr. W. H. Wagstaff, on October 4, 5, 6, and 7; physic, by Dr. F. M. Sandwith, on October 25, 26, 27, and 28; astronomy, by Mr. S. A. Saunder, on November 7, 8, 10, and 11.

PROF. GOLDWIN SMITH, according to the Toronto correspondent of the *Times*, has bequeathed the sum of 140,000*l.* to Cornell University "to show my attachment as an Englishman to the union of the two branches of our race on this continent with each other and with our common mother"; the greater part of Prof. Goldwin Smith's library, and 1800*l.*, are left to the University of Toronto.

THE new calendar of the Battersea Polytechnic shows an increase of work in all departments. In connection with the engineering and building department, new evening classes are being commenced in pattern-making and architectural measurements, and in connection with the gun-making section a course of study extending over three years has been arranged in gun and ammunition manufacture. A course has also been arranged by request of the Institute of Certificated Grocers on subjects which appeal to the grocery and provision trade. The chemistry department is extending its work by providing more advanced instruction in paper-making and bacteriology, and new classes in soap manufacture. In the women's department, a third-year day course of science as applied to housecraft has been arranged. The new library presented by Mr. Edwin Tate, at a cost of 8000*l.*, is to be opened by the Archbishop of Canterbury on Friday, October 21.

THE Belfast University Commissioners have decided to establish a faculty of commerce within the University, to consist of the professors and lecturers in the subjects of the faculty, and in addition there will be an advisory committee. In framing the curriculum the needs of three classes of students have been borne in mind:—those who are, or expect to be, engaged in business; those who are preparing for the administrative work of the State or the municipality; and those who contemplate social or philanthropic work. It is proposed to grant a degree in the faculty to matriculated students who have pursued prescribed courses of study for at least three years and who have satisfied the examiners in certain subjects. To meet the case of students unable to devote to these subjects the time necessary for the acquisition of a degree, a diploma in commerce or a diploma in social science will be granted after a two years' course and the passing of the prescribed examinations.

THE issue of the Bulletin of Armour Institute of Technology, Chicago, for May last, which has reached us, is a general information number, which differs little in character from the calendars and prospectuses published at this time of the year by colleges and technical institutions in this country. The work of the institute in Chicago was begun in 1893. Four-year courses in mechanical and electrical engineering were first organised. A union was effected with the Art Institute of Chicago for the purpose of developing the course in architecture which that institution had maintained since 1889. The result was the establishment of the Chicago School of Architecture. In 1899 the course in civil engineering was added, in 1901 the course in chemical engineering, and in 1903 the course in fire-protection engineering. The courses in these subjects all lead now to the degree of Bachelor of Science. Each of these four-year courses represents a balanced group system of studies, combining a thorough and broad scientific training with the elements of liberal culture.

THE Department of Agriculture and Technical Instruction for Ireland has issued its programme for technical schools and science and art schools and classes for next session. The regulations which were in operation during the session 1909–10 will continue in force, with one alteration only. Small schools are to be permitted to adopt specialised courses of instruction covering a period of two years only. A prefatory note points out that the schools and classes working under this programme are mainly, though not exclusively, evening schools, and adds that instruction in evening classes cannot form a substitute for the more general and systematic education given in day schools, whether primary, secondary, or technical. The work of such evening schools and classes constitutes a specialised form of education intended to fit those receiving it for industrial or commercial pursuits, or to render those already engaged in such pursuits more efficient in their work. Attendance is purely voluntary. Those attending are for the most part engaged, or about to be engaged, in some form of industry, and are meeting problems and difficulties which the evening technical school can help them to solve. They perceive that the higher branches of their calling may be reached only by increased technical skill and knowledge; but progress is hindered by several circumstances: hitherto the previous preparation of students joining evening technical schools has in many cases not been such as to fit them for the specialised form of instruction which it is the special function of such schools to impart. An attempt is made in these regulations to remedy this defect.

THE recently issued syllabus of classes at the Sir John Cass Technical Institute, Aldgate, for the coming session shows that graded curricula of study extending over

several years are provided for those engaged in chemical, electrical, and metallurgical industries. In addition, several special courses of instruction are to be given; in the chemistry department there is to be a course of work for those engaged in the fermentation industries, which includes lectures and laboratory instruction in brewing and malting and on the micro-biology of the fermentation industries, as well as a series of courses on liquid, gaseous, and solid fuels. In the metallurgical department special courses of an advanced character are provided on gold, silver, and allied metals, on iron and steel, and on metallography. The winter session at the Merchant Venturers' Technical College, which has just commenced, is the fifty-first held in connection with this institution. It will be remembered that the faculty of engineering of the University of Bristol is provided and maintained in the college. The new calendar, in addition to necessary general information, supplies full particulars of the day classes of the Bristol School of Commerce, the faculty of engineering of the University of Bristol, the extensive evening classes, and the school of art. The calendar also contains a list of gifts and loans to various departments of the college made by numerous manufacturing firms and learned societies, which shows that the college authorities are successful in securing the cooperation of employers of labour and others in the useful work they are doing in providing suitable technical instruction for the workers of the district.

THE first congress of the newly established Textile Institute, the objects of which are to promote the interests of the textile trades, was opened on Thursday last at Bradford by Lord Rotherham, who, in his inaugural address, said he looked for the institute to do its part in establishing cordial relations between men of science and practical spinners and manufacturers. The delivery of the address was followed by the reading of a paper by Mr. F. Warner on technical education in relation to the textile industries, in the course of which the author said that the existing system of education is overcrowding the office and starving the factory and workshop. Great Britain cannot afford to scrap from 5 to 7 per cent. of the working population, and the remedy for the present evil is more technical instruction and the practical training of the rising generation in industry and trade. The old apprenticeship system had manifest advantages, and its revival was suggested; but modern technical instruction, properly applied, offers advantages to the student for advancement which were impossible to the apprentice. Day classes should, by the cooperation of employers, be arranged to a far greater extent than was now the case, and in this respect England is far behind modern practice in the textile trades abroad. An essential requirement is proficient art teaching, for though in the perfection of cloth structure British goods are unsurpassed, in the class of fabric in which design and colour are required the reputation of our manufacturers is on a lower plane. Mr. Warner advocated the formation of a national department which, controlled by a council composed of captains of industry in all branches of manufacture and commerce, and of artists, designers, and educationists, could deal directly with art and technical schools. A similar system should also be put in operation in local centres. The financial difficulty should be met both by local and Government aid.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 5.—M. Bouchard in the chair.—Madame P. **Curie** and A. **Debierne**: Metallic radium. Starting with 0·106 gram of the purest radium chloride (atomic weight 226·5), the method of Guntz for the preparation of metallic barium was followed. The radium chloride in aqueous solution was electrolysed with a mercury kathode and a platino-iridium anode. After the electrolysis the solution contained 0·0085 gram of the salt. The amalgam decomposed water and was readily attacked by the air. The dry amalgam was rapidly transferred to a clean iron boat, the latter placed in a quartz tube, and was rapidly evacuated. The distillation of the mercury from the amalgam offered some difficulties; to prevent visible ebullition, which resulted in loss by projection, the tube was filled with carefully purified hydrogen, the pressure of which was kept slightly above the pressure of the mercury vapour at the temperature of the boat. At the close of the operation the metal was left in the boat, brilliantly white, and melting sharply at 700° C. The authors regard this as sensibly pure radium. The metal alters very rapidly in air, blackening immediately, probably owing to the formation of a nitride. Some particles detached from the boat, falling on white paper, produced a blackening similar to a burn. Radium energetically decomposes water going into solution, indicating that the hydroxide is soluble. Radio-active measurements showed that the increase of activity followed the usual law for the production of the emanation, the limiting activity of the metal becoming normal. Since it was found that the metallic radium was much more volatile than metallic barium, it is proposed to purify the metal by sublimation in a vacuum.—Léon **Kolowrat**: The β rays of radium at its minimum activity. The author has repeated the experiments of O. Hahn and Mlle. Meitner, and has arrived at conclusions confirming the existence of a very absorbable β radiation.—Georges **Baume** and F. Louis **Perrot**: The fusibility curves of gaseous mixtures: compounds of methyl oxide and methyl alcohol with ammonia gas. The results of these cryoscopic researches are given in graphical form.—J. B. **Senderens**: The preparation of acrolein. It has been found that potassium bisulphate reacts catalytically with glycerol, so that, instead of adding the bisulphate in the proportion of twice the weight of glycerol, as is customary, one-fiftieth of this amount of the bisulphide is sufficient.—Paul **Gaubert**: Soft crystals and the measurement of their indices of refraction. Figures are given for the refractive indices of crystals of beeswax, ammonium oleate, ozokerite, paraffin, and lecithine.—R. **Robinson**: The vessels of the fork of the median nerve. A contribution to the study of the manual dexterity of man.

CONTENTS.