THURSDAY, AUGUST 27, 1903.

ALCOHOLIC FERMENTATION.

Die Zymasegärung Untersuchungen über den Inhalt der Hefezellen und die biologische Seite des Gärungsproblems. By Eduard Buchner, Hans Buchner, and Martin Hahn. Pp. viii + 416. (München: Oldenbourg.) Price 12 marks.

IN the preface to this book, written by Profs. Eduard Buchner and Martin Hahn, credit is given to the late Prof. Hans Buchner for the general scheme of arrangement which has been carried out after his death by the other authors.

There are four parts to the treatise; the first, by Prof. Eduard Buchner, entitled "Über die Zymasegärung," occupies nearly three-quarters of the entire book, and deals with the important researches of this author and others on the soluble ferment first separated by him from yeast-cells and called *zymase*, the ferment which induces alcoholic fermentation of sugar.

His original papers on the subject have appeared in contributions to scientific journals since the end of 1896, and are now presented in book form.

After a brief historical review of the development of ideas on the subject of alcoholic fermentation, and a comparison of Liebig's and Pasteur's theories with regard to this process, he discusses the nature of "zymase," which he brings into the category of the enzymes, or soluble ferments. A very full and complete account is given of the method of preparing "active" yeast-juice, the main steps of which are now familiar to all students of the subject. Especial stress is laid on the powdering of the yeast-cells with quartz sand in order to break up the cell-membranes. Without this, no amount of pressure avails for getting active juice from the cells, while, after breaking the cells, comparatively little pressure will give some active juice, increase of pressure increasing both the activity and the yield. The activity of yeast-juice, *i.e.* its capacity for inducing the alcoholic fermentation of sugar, varies with different species of yeasts; no conclusion as to richness in zymase can be drawn directly from observed variations in activity, as yeast-juice contains, besides several previously discovered ferments, one, endotryptase, which digests and destroys zymase, and this is present in very variable amounts in the different yeasts. Juices also of very different activity are obtained from different batches of the same variety of yeast. These differences are partly explained by the action of endotryptase on zymase.

The method of determining the "activity," dependent as it is on these conflicting factors, is fully described, and consists in the estimation of the quantity of carbon dioxide formed in a given time under standard conditions.

When the juice is collected in fractions, the first fraction that is pressed out shows least activity, and the activity increases with successive fractions to the last, so that methods which give a small yield may also give juice of relatively small activity. The most active juice is much less active than fresh yeast, and the explanation is that in fermentation with the latter there is always a fresh production of zymase. The so-called self-fermentation of yeast-juice is fully discussed, and shown to be a function of the glycogen content. Some interesting results are recorded in the fermenting of sugars other than glucose. For instance, glucose and fructose are fermented equally fast by the yeast-juice, whereas fresh yeast ferments glucose the more quickly. The author explains this as due to the fructose having a lower rate of diffusion into the yeast-cell. Similarly, glycogen was fermented by yeast-juice obtained from yeast which, in the fresh state, did not ferment this carbohydrate, the explanation being that the glycogen cannot diffuse through the cell-membrane. The experimental proof that the juice can ferment glycogen is an interesting confirmation of what has been induced theoretically, viz. that any cell which can synthesise glycogen must be capable also of hydrolysing it, at least intracellularly. It explains the phenomenon of "self-fermentation," and accords with the new theory of the reversible action of ferments.

The discussion on the mode of action of antiseptics is interesting, but not always convincing. As regards chloroform, the hypothesis is adopted that living cells are subdivided into separate workshops by partitions of cholesterin (Overton), which the author thinks may be injured by the drug and thus allow of a mingling of substances which ought to be kept apart. He gives the impression that chloroform is a substance almost inert towards ferments, for which, therefore, some mechanical action on living cells is to be sought. Chloroform is, however, certainly not without action on ferments, and affects some much more than others; the maltase of yeast, for instance, is distinctly affected by it, and it may be that some ferment essential to cell-growth and multiplication is extremely sensitive to it. It is difficult to estimate at all quantitatively from his experiments the sensitiveness of zymase to such antiseptics, on account of the unknown factor of their action on endotryptase. This also applies to the experiments on the action of added alcohol; expt. 425*b* especially suggests that the alcohol has no negligible effect on endotryptase. The experiments with arsenites are interesting, and give food for reflection to physiologists and physicians alike.

The quantitative fermentation of cane sugar in concentrated solution by zymase was attempted, but the yield of CO_2 and alcohol was always less than the calculated amount, and the author considers and discusses several possible explanations of the phenomenon. In this connection he touches on cases of zymo-hydrolysis where incompleteness has been traced to the action of the hydrolytic products, but does not clearly distinguish between a direct paralysing action of one of the products on the enzyme, such as was found by Taumann in the hydrolysis of amygdalin by emulsin, and a slowing down due to mass-action of the products, a consequence of the reversible nature of enzyme-action, and occurring only on the approach of chemical equilibrium in the system on which the enzyme acts. The fermentation residue was examined for cane sugar with a negative result, but not for a reversion sugar. The author, however, hopes to investigate this question further. In an experiment given later, done with a lower sugar concentration than in the above, the yield of alcohol approaches the calculated amount.

Glycerol is probably not found in the cell-free fermentation, and is considered a product of cell-metabolism, a similar view to that held by Pasteur about ethyl alcohol. May not the production of glycerol and other higher alcohols be equally due to the action of soluble ferments not yet discovered?

The experiments on regeneration of yeast, which conclude part i., serve to show how much work remains to be done in this direction. The whole account of the general research is given in a lucid and interesting manner, and deals with many lesser matters arising out of the main thesis, each point being illustrated by tables of the actual experiments performed, and the results of the experiments are fully discussed. The author establishes himself especially firmly where other investigators have questioned some of his work.

Part ii., by Profs. Hahn and Geret, gives an account of the discovery of endotryptase by the former author, the description of the experimental work being followed by a good summary.

Part iii. is by Prof. Hahn alone, and describes the reducing properties of yeast-juice as shown by experiments performed by himself and Dr. Cathcart. Some reasons are given for the author's thinking that the reducing power is due to the same ferment, zymase, which induces alcoholic fermentation.

Part iv., by Profs. Hans Buchner and Rudolph Rapp, is on the relation of oxygen-supply to the fermenting power of living yeast-cells.

The contradictory results of previous workers are first reviewed, Pasteur's theories being considered and Chudiakow's work repeated and examined critically in detail. The latter had found that air had no effect on the fermenting power, but that it killed yeast-cells more rapidly than hydrogen, when each was drawn through a sugar solution containing a small quantity of the yeast. The authors find that his results were partly due to defects in his aspiration methods, more air than hydrogen being drawn through in a given time, with consequent injury from shaking. They state also that he used a yeast of too little vitality for general conclusions. They find that neither air nor hydrogen, as such, affects the fermenting power, and that the mechanical shaking of the fluid is detrimental if it exceed a certain limit. The effects of air and hydrogen differ only in that the former induces a slight multiplication of the yeast cells, and thus leads to a rather larger production of CO_2.

The authors then pass on to investigate the effect of air on cultures of yeast grown on beer-wort-gelatin with 10 per cent. of glucose. Here, with a free supply of air, they find one part of sugar oxidised to every five parts fermented. The yeast multiplies more rapidly under such conditions than when very little air is supplied, but in the latter case a given weight of yeast ferments more sugar.

The whole volume is full of interest and instruction, and cannot fail to give the greatest pleasure to a student of alcoholic fermentation.

ARTHUR CROFT HILL.

AN INDIAN FLORA.

The Flora of the Presidency of Bombay. Vol. i. Ranunculaceæ to Rubiaceæ. By Theodore Cooke, C.I.E., M.A., M.A.I., LL.D., F.G.S., M.Inst.C.E.I. Pp. 645. (London: Taylor and Francis, 1901–3.) Price 27*s*.

THE labours of botanists and of a small band of foresters, in India and at Kew, have supplied us with rich stores of information as to the Indo-Malayan flora. These rendered possible the issue of Sir Joseph Hooker's monumental "Flora of British India."

But British India and Malaya, including as they do countries far apart, with climates ranging in temperature from low alpine to high torrid extremes, in humidity from the perpetual aridity of the desert to the permanent moistness of the equatorial tropics, exhibit subfloras and kinds of vegetation of corresponding variety. In order to map out these separate floras of British India, including Burma, the Government of India has decided to issue a series of "regional floras." Such a series will be of great service, because the information at present available as to the floras of certain large tracts of India is lamentably deficient. This deficiency Sir George King's inauguration of a botanical survey of India is calculated to remove.

For the preparation of the first of the "regional floras"—that of Bombay Presidency—the Government of India was fortunate enough to secure the services of Dr. T. Cooke.

To write an ideal "flora" of Bombay is at present impossible. For such a work should not only enable persons to identify plants found in the Presidency, but should also give information as to the geographical distribution of the indigenous species, including their general and local distribution, their habitats, and their frequency of occurrence; it should also impart information, often unavailable to the worker in Europe, as to the habits, colours, dates of flowering, of sprouting, and of defoliation. Finally, it should give a general account of the whole flora and vegetation of the region, and map out their subdivisions within that region. The present "flora" does not contain all these desiderata, for it is not yet concluded, and much remains to be discovered in regard to the local distribution and periodicity of the Bombay plants. This, the first volume, includes the whole of the Polypetalæ, following Hooker's sequence of orders, and the natural order Rubiaceæ.

The characters exhibited by the natural orders are given very fully, so much so that an inexperienced person would find it difficult to decide upon the really salient features. This difficulty might be reduced by printing important diagnostic characters in different type. But when the work is finally complete, the author may aid the tyro by giving abbreviated diagnoses, or possibly an analytical key of the natural orders.

In describing genera and species of exotic plants the botanist working in a herbarium is often at a disadvantage. The specimens reaching him are frequently comparatively small, their colours are changed, and the information supplied by the collector regarding them may be meagre. But Dr. Cooke, with his ripe experience in India, is in a position of vantage. His descriptions of genera and species are clear and vivid, and at times include information on vegetative characters that can be observed only on the spot. It may be suggested, however, that an even more free record of vegetative characters would greatly facilitate the identification of a plant by a person happening to meet with it in blossom but not in fruit, and would supply botanists at a distance with valuable information otherwise inaccessible. To take specific examples. The two indigenous lythraceous genera with indefinite stamens, Lagerstrœmia and Sonneratia, are distinguished from one another in the analytical key by their fruits; yet their habits and habitats are sufficiently dissimilar to be of immediate use in an analytical key, but we are not told in the present work whether or no *Sonneratia apetala* possesses the erect respiratory roots so characteristic of *S. acida*. Again, in the Rhizophoraceæ, the four genera of the saline swamps and littoral situations are at once separable from the inland Carallia by their habitats, apart from the seeds, which are used as the basis of distinction in the analytical key. Furthermore, species of Rhizophora emit aërial roots from their epigeous branches, and thus stand apart from other rhizophoraceous plants, and, indeed, so far as I know, from all mangrove plants except *Acanthus ilicifolius*. Surely the mention of these roots would greatly facilitate recognition of species of Rhizophora, yet no mention is made of them; and if, as is quite conceivable, these species are apt not to possess them in Bombay Presidency, information to this effect would be of extreme interest to botanists. Whilst discussing vegetative characters, it may be remarked that the "white spongy bodies" in the shoots of *Jussiaea repens* are adventitious roots, not stipules. And the generally accepted view in regard to the leaves of Rubia is that they are stipulate, but that the stipules are often leaf-like in form.

Dr. Cooke's analytical keys of genera and species are, it need hardly be stated, admirable examples of the approved form, and he may be wise in adhering to the system that experience has shown to be most useful, even though it frequently assumes that a person using the "flora" possesses shoots, flowers and fruits of the specimen he desires to identify.

The attractive and clear detailed descriptions of the species are succeeded in most cases by mention of the times of flowering. In many instances there is no record as to whether a plant described is deciduous or evergreen. Records on this point, coupled with additional information as to the times of opening of floral and vegetative buds, and of the shedding of the leaves, would throw much light upon the scarcely touched subject of the periodicity of plant-life in the tropics. As this subject has, in addition, considerable practical economic significance, it is to be hoped that authors of the Indian "regional floras" will record such of these data as are known, and will thereby stimulate further observation.

On the question of geographical distribution, facts are given as to the occurrence of the indigenous species in places outside the Presidency, and many details are added concerning their frequency of occurrence, localities and habitats, within the Presidency. But the author specially directs attention to the need for information on the local distribution of species. Despite of this lack of complete information, the hope may be expressed that Dr. Cooke will include in his work some account of the floristic subdivisions of the Presidency dealt with, and that the authors of other Indian "regional floras" will do likewise. Of equal scientific interest, and probably of greater practical importance, would be an account of the distribution of types of vegetation, or plant-formations, within the area. Such an account of the distribution of types of vegetation within Bombay Presidency would be of especial botanical interest, for

"the rainfall varies . . . from 3 or 4 inches, or even less in the almost rainless districts of Sind, to upwards of 300 inches on the Western Ghâts."

The vegetation shows corresponding diversity, varying from arid or rocky desert-tracts to moisture-laden evergreen forests. As to the practical aspect, we now recognise that vegetation reflects in its form the environment, and that plants, when their actions are interpreted aright, are more cunning analysts of external conditions, including soil and climate, than are the most accomplished chemists and meteorologists.

Brief references to the economic uses of many of the species described, and vernacular names, add value to the book before us.

In conclusion, Dr. Cooke is to be congratulated on producing a most excellent work.

PERCY GROOM.

THE STUDY OF FERMENTATION.

Fermentation Organisms, a Laboratory Handbook. By Alb. Klocker. Translated from the German by G. E. Allan, B.Sc., and J. H. Millar, F.I.C. Pp. xx+392. (London: Longmans and Co., 1903.) Price 12s. net.

THE importance of a systematic study of the micro-organisms which play a part in the various processes of fermentation is making itself felt more and more as time goes on and new facts and phenomena are brought to light. The old empirical methods of twenty years ago have passed away before the marvellous changes first introduced by Hansen, and the culture of yeast is recognised as one of the secrets of success in the manufacture of the various kinds of beer. The study has long been carried on under the personal supervision of Hansen and his assistants, but until recently has been almost entirely conducted under some form of personal supervision. As in other cases, however, the study has outgrown so limited a method of teaching, and we have in this volume a laboratory handbook which will enable practical work in the culture of fermentation organisms to be more widely spread, and probably more successfully conducted, than has hitherto been the case. The volume is welcome on this account especially, but it has other claims also on the student, coming as it does from the

Carlsberg laboratory, and embodying the ideas and teaching of Hansen himself. It is welcome also to English readers from the fact that it has been translated in great part by one of the disciples of the Burton-on-Trent school, from which have come so many valuable contributions to our knowledge of the chemistry of the carbohydrates concerned in brewing.

The author has described at great length what we may consider to be an ideal laboratory for the practical study of the lower fungi, including, indeed, the pathological bacteria, though these are not necessarily included in the range of study he sets forth. His description is greatly to be commended, for he is not satisfied with saying what apparatus should be provided and what precautions observed in arranging tne laboratory, but he gives a careful explanation of the reasons underlying his plans, so that mere empirical work has no place in this course. The descriptions of apparatus are good, showing what are the best forms of the modern appliances now at the disposal of workers at the subject. Perhaps a little less detail would have sufficed in the section upon the microscope, as the instrument has now so widespread an application in so many branches of science. Workers will welcome especially the instructions given in the methods of culture of micro-organisms, from the original methods of water culture of Hansen to the modern plate cultures, in which gelatin and similar media take so large a part.

A very important section of the work is devoted to the biological analysis of yeasts, and the methods of ensuring pure cultures. Also to the biological analysis of water, air, and soil.

In the later portion of the volume the author treats in some detail of the fermentation organisms themselves. In this section the Saccharomycetes occupy the largest place, as is natural when we consider the fermentations in which they play a part. Mucor and its allies, however, are not neglected, and fair attention is given to the ascomycetous moulds. Their diagnostic features are described, and the part they play in various fermentations is discussed, the idea being kept prominently in view that the author is writing as a teacher for students, and that the work is a laboratory handbook. Finally, the bacteria come in for recognition.

The book will be welcomed further for the very admirable historical sketch of the gradual development of our knowledge of fermentation from the earliest times. It is very satisfactory to find that this section contains an admirable summary of the work of Hansen himself.

The volume concludes with a very complete bibliography.

OUR BOOK SHELF.

Five Figure Logarithmic and other Tables. By Alex. M'Aulay, M.A. Pp. xl + 161. (London: Macmillan and Co., Ltd., 1903.) Price 2*s.* 6*d.*

Siebenstellige Logarithmen und Antilogarithmen. By O. Dietrichkeit. Pp. 64. (Berlin: Julius Springer, 1903.) Price 3 marks.

THE book by Mr. M'Aulay is of a very handy size, specially adapted for the pocket. The author, in the preliminary pages, explains the general properties of logarithms and the use of the tables which follow. The tables themselves comprise, first, an ordinary four-figure table of logarithms of numbers, occupying two pages, and without the usual antilogarithms. Next, a five-figure table of logarithms of numbers from 0 to 100,000, with a complete set of proportional parts or differences; these take up thirty-six pages. Then comes the second principal table of the book, giving the logarithmic sines, cosines, tangents, and cotangents of angles for each minute, with differences for intervals of ten seconds. Some subsidiary tables and useful numbers follow, very much condensed, so as not materially to add to the size of the book.

The tables would be improved if they could be provided with a marginal or thumb index to facilitate reference. The two main tables are printed in clear bold type, and the little volume will prove extremely useful to all who require greater accuracy than is given by four-figure mathematical tables.

The tables of Herr O. Dietrichkeit are most ingeniously arranged. The numbers in the columns are given to seven figures, the last two of which are written as suffixes in smaller type. The logarithm or anti-logarithm of any four-figure number can be read directly from the tables to any desired accuracy up to seven figures without requiring differences to be used. The two tables of logs and anti-logs are printed on paper of different tints, a very good feature, and they occupy only eighteen and twenty pages respectively. They are provided with a complete thumb index, reading both backwards and forwards, and it will be found that readings may be taken from the tables almost, if not quite, as quickly as from the well-known four-figure tables.

If five-figure accuracy were required for five-figure numbers, the difference for the fifth figure would have to be calculated. And it is possible from these tables, although occupying only a few pages, to obtain seven-figure accuracy for seven-figure numbers, by means of an interpolation constant and a most ingenious method of calculation, which, however, would be too long except for occasional use. The tables will prove most valuable in cases where, though four-figure accuracy is usually sufficient, it is desired to have at command a means of greater accuracy for special purposes. The volume is beautifully got up and printed, and it is quite a pleasure to use the tables.

Économie rurale. By E. Jouzier (Encyclopedie agricole). Pp. xv+476. (Paris: Baillière et Fils, 1903.) Price 5 francs.

THIS book belongs to a type of which we have few representatives in this country; it consists of a discussion of such general principles of political economy as may be illustrated in the conduct of a farm.

Beginning with an account of the relations of agriculture to the State, questions of taxation, transport and markets, it proceeds to discuss the capital required in the business of agriculture, the live and dead stock, insurance, depreciation, and the valuation of such contingencies as cultivations and manurial residues. Such general principles as the minimum of production necessary to profit and the law of diminishing returns are explained and illustrated. Questions of labour, methods of finding the cost and profit or loss of the different operations are considered; finally, tenure, compensation for improvements, systems of land holding, cooperation, and similar matters touching on the economics of agricultural production are dealt with. The whole is treated in a somewhat abstract and generalised fashion, and would find little favour with the practical farmer or landowner here; we can, however, commend the book to teachers of agriculture as suggestive and likely to lead to a wider outlook than generally prevails in the treatment of similar questions in this country.

A Naturalist's Calendar, kept at Swaffham Bulbeck, Cambridgeshire, by Leonard Blomefield (formerly Jenyns). Edited by F. Darwin. Pp. xix + 85. (Cambridge: University Press, 1903.)

IN his introduction the editor has given several reasons (all of them excellent in their way) for the reissue of this excellent memorial of an exceedingly accurate and gifted naturalist. He has apparently omitted, however, that which, in our opinion, is the most important argument of all, namely, the relatively early date (previous to 1846) at which the record was kept. This renders it extremely valuable for comparison with observations of a similar nature made at the present day, for the purpose of ascertaining whether any secular changes in the date of the arrival of migratory birds or in the flowering of plants has taken place in this country since the compilation of this calendar. Whether any such differences do occur would require very careful comparison, but we should not be surprised to learn that the average date of the cuckoo's arrival has altered somewhat since Blomefield's time. Be this as it may, the well-known scrupulous accuracy of its compiler renders his calendar of nature a record of exceptional value and interest, belonging to a period when such compilations were rare. There is, therefore, every justification for its republication in the present convenient form, and its appearance at a morphological centre like Cambridge may certainly be regarded as a good augury for the future of natural history studies.

Mr. Darwin gives several anecdotes of the author, to which the present writer can add another. Mr. Jenyns (as he was then called), who was by no means a handsome man, was in early life accustomed to preach occasionally in a church attended by the Henslow family. After one of these periodical visits, the younger members of the family were asked why they were always so unusually quiet in church when Uncle Leonard preached. To which query came the reply that "he kept on making such ugly faces."

R. L.

Elements of Physics, Experimental and Descriptive. By Amos T. Fisher, B.Sc., assisted by Melvin J. Patterson, B.Sc. Pp. 184. (London: D. C. Heath and Co., 1903.) Price 2*s*. 6*d*.

THOSE of us who are engaged in university teaching are personally interested also in the kind of science teaching which is given in schools. Lads come to college fresh from school crammed with what is called physics; but, owing to its unsatisfactory character, our first effort is usually to knock out of them the loose and erroneous knowledge with which they have been crammed. We are afraid that the book under review is not likely to improve matters. A long list of errors which we have noted down lies before us—far too long to reproduce here—and we must be content with a few as a sample.

The diagrams of lines of magnetic force of currents (p. 131), of the dispersion in a prism (p. 96), of the formation of a rainbow (p. 98), are all wrong. It is incorrect to state that the image of (*sic*) a concave lens is always smaller than the object, and that a concave meniscus is a converging lens. The field of a magnet does not vary as the inverse square of the distance. An induced charge is not usually equal to the inducing charge.

A paint-brush illustration of the production of induced currents (p. 137) gives the wrong direction to the current. The conservation of energy is stated to be a consequence of the conservation of mass!

In spite of numerous errors and fallacies, and weaknesses of description, the book is not wholly bad; but what a burden is thrown upon the teacher who has to put all these wrong things right! For the private student the book cannot be recommended.

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.]*

An Earthquake Shock at Kimberley.

LOCAL earthquakes are rare phenomena here. There was, however, a small shock at 8h. 43m. p.m. (G.M.T.) on Friday last, July 31. It was accompanied by the loud rumbling noise resembling the passing of a heavy waggon, and caused some shaking of furniture. It appears to have been felt and heard over a considerable area. The record by my large horizontal pendulum showed a single nearly sudden dip to the west of 3·6mm. (*i.e.* from 30·4mm. to 34·0mm., measured from the reference base-line), roughly corresponding to a tilt of about 3″, and a rather more gradual recovery, with very little (if any) return swing to the east. No certain signs of preliminary tremors could be detected upon the record. It seems important (*cf.* Milne, "Earthquakes," p. 309, 4th ed., 1898) that for some days previously there had been a gradual, general dip of the level to the east, the mean distances of the hourly readings from the reference base-line, measured from east to west, being:—

July 27	34·3 mm.
,, 28	34·0 ,,
,, 29	31·1 ,,
,, 30	27·0 ,,
,, 31	28·1 ,,
Aug. 1	29·0 ,,

The weather during the week had been moderately warm and cloudy, but, so far as I know, there was not any rain anywhere on the table-land. There was no disturbance of the barometer accompanying the shock.

I enclose a cutting from the *Diamond Fields Advertiser* of August 3. It gives the duration at Koffyfontein as three minutes, which probably really means that some loose articles of furniture might have remained swinging for some time after the shock had passed. Koffyfontein, however, like Kimberley, is a diamond mining centre, and from various reports it seems to be demonstrated that the earth-movement was much more pronounced in the vicinity of the open workings than elsewhere. J. R. SUTTON.

Kenilworth, Kimberley, S. Africa, August 3.

Sun-spots and Phenology.

IT can be shown in several ways, I think, that we have, on the whole, in these parts (London), more warmth when the sun-spots are numerous than when they are few, a state of things rather opposite to that in the tropics, where (according to M. Nordmann, who has lately confirmed the work of Dr. Köppen some thirty years ago) sun-spots mean coolness, and there is most warmth about minima.

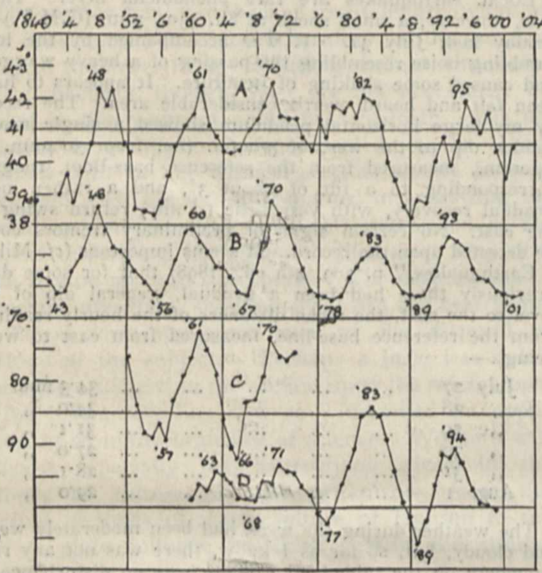
The recurring contrast, in the case of Greenwich, appears to be most distinct in the early part of the year. Thus we may show it by taking the mean temperature of February and March, and smoothing the curve with averages of five (curve A in diagram). B is the sun-spot curve. Thus about sun-spot maxima, the milder weather of spring seems to set in, on an average, *earlier* than at other times. It might be expected that this would have an influence on the data of phenology (time of flowering of plants, &c.), and in many cases we find it is so, that is, curves which represent the dates of flowering of plants will be found to show a certain agreement with the temperature curve of February-March, and with the sun-spot curve.

In the diagram are given two of these phenological curves (C and D). C is that for flowering of *Ribes sanguineum* in Edinburgh (1850–87), and D that for flowering of *Azalea pontica* at Parc de Baleine, Allier, in the heart of France (1858–1901). (The scales are separate.)

The date of flowering is given as the day-number in the year, and these numbers are smoothed with averages of five. The curves are inverted, so that high points represent early dates and low points late dates.

Other examples might be given. This line of inquiry has been followed to some extent by M. Flammarion in France, and it seems desirable that attention should be given to it in this country by those interested in phenology.

The contrast above referred to between the relations of sun-spots and temperature in western Europe and those



in the tropics also calls for elucidation. Probably no meteorologist would now regard it (or other such contrasts) as fatal to the idea of sun-spot influence.

ALEX. B. MACDOWALL.

Retarded Motion of the Great Red Spot on Jupiter.

PERHAPS the most notable fact brought to light by observations of Jupiter during the present season is that the velocity of the great red spot has been again retarded. The rotation period of this well-known object has been as follows in recent years:—

	h.	m.	s.
1898	9	55	41·8
1899	9	55	41·9
1900	9	55	41·7
1901	9	55	40·9
1902 and to May 1903	9	55	39·0
May 26 to August 21, 1903	9	55	41·5

At the end of May last the longitude of the spot was about 30°, whereas at the present time it is 32°, indicating an easterly drift of 2°, whereas during the preceding twelve months the marking had shown a westerly drift of about 1° per month. The spot now follows the zero meridian (system ii. of Mr. Crommelin's ephemeris, *Monthly Notices* R.A.S., lxiii. p. 110, December, 1902) by about 53 minutes. A remarkable disturbance has recently occurred in the southern equatorial belt of Jupiter. In about longitude 140° to 175° (system i.) several nearly black spots have appeared, and the belt in this region is much torn and full of irregularities, changing from night to night, and evidently subject to extensive commotions.

W. F. DENNING.

The Spots on Saturn.

DURING the past two months about 75 transit times of these objects have been taken here. Several of the more conspicuous markings are moving slower than expected, and their positions appear to be well represented by a rotation period of about 10h. 39¼m.

W. F. DENNING.

Bishopston, Bristol, August 25.

THE SOUTHPORT MEETING OF THE BRITISH ASSOCIATION.

SINCE the prospective programmes of the various sections of the British Association were obtained for last week's NATURE, the following additional particulars referring to the subsection of Section A, devoted to astronomy and meteorology, and the International Meteorological Committee have been received from Dr. W. N. Shaw, chairman of the subsection.

It is intended that the subsection shall meet on Friday, September 11, and on the following Monday and Wednesday. The proceedings may be expected to be especially interesting on account of the presence of a number of distinguished meteorologists from foreign countries who will be in Southport in connection with the meeting of the International Committee. It is hoped that arrangements can be made to enable the members of the committee to take part in the meetings of the subsection, although separate meetings of the committee must be held for the transaction of business.

The questions already proposed for discussion by the Committee include the initiation of international cooperation in connection with atmospheric electricity and solar physics, and its extension as regards terrestrial magnetism; the revision of the arrangements for the exchange of daily telegraphic reports, and the modification of some of the existing international conventions with regard to the observations made at stations of various orders and the method of recording them.

In the subsection on September 11, after an address by the chairman on methods of meteorological investigation, the president of the Association, Sir N. Lockyer, will read a paper on the correlation of solar and terrestrial phenomena, which will be followed by a discussion, as a preliminary to a proposal for putting the organisation of work in connection with that subject upon an international basis. Dr. Buchan will contribute a communication illustrating the distribution of rainfall in Scotland according to the succession of years of the sun-spot cycle. At the same session it is hoped that some of the members of the International Meteorological Committee who have taken a prominent part in the prosecution of researches in connection with that committee may be able to contribute papers. In particular the work of the committee on cloud observations has recently been brought to a conclusion, and a summary of the final results achieved would be very acceptable.

For any further available time on that or the other days there is already a substantial programme. Various astronomical papers have been referred to in the previous notice. The committees which have to present reports are those on kite observations, on the Ben Nevis Observatory, and on seismological observations, and any one of them, either of themselves or in connection with papers on special points associated with them, may give rise to valuable discussion. Prof. Hergesell, the chairman of the aëronautical committee, will be able to give the latest information as to the international investigation of the upper air, and Dr. Varley will exhibit the record obtained by him for Mr. P. Y. Alexander with an unmanned balloon that reached the extraordinary height of 70,000 feet on a journey from Bath in July. The kite equipment and method of investigation employed by Mr. Dines will be exhibited, if possible, in action.

Prof. Callendar will speak upon self-recording instruments, and thus open the way for the discussion of a subject which is of pressing importance in cooperative meteorological work.

The exhibition of objects of interest in connection with meteorology, terrestrial magnetism, and allied sciences has already been referred to in the columns of NATURE. Arrangements have been made with the view of exhibiting the formation and physical properties of the remarkable vortex ring of smoke produced by the discharge of a mortar of the same type as those which are extensively used in southern Europe with the object of mitigating hailstorms.

By way of illustration of the method adopted by the Meteorological Council for dealing with telegraphic weather reports, a weather chart for north-western Europe, with remarks and forecasts for the British Isles, will be prepared each morning during the meeting on the receipt of telegraphic information at Southport, and a limited number of lithographed copies will be available in the reception room.

THE OLDER CIVILISATION OF GREECE.[1]

STUDENTS of the older civilisation of Greece, which we usually know as "Mycenæan," will welcome the appearance of the eighth volume of the British School at Athens Annual, which, we are glad to say, this year is printed on much better paper than formerly, and shows a great improvement both in editing and arrangement. The volume contains the chief results of the excavations which were undertaken in Crete in 1902, both by the officers of the British School itself and by the Cretan Exploration Fund, of which Mr. A. J. Evans is the prime mover. More than a third of the book is occupied by an elaborate paper by Mr. Evans, who continues his annual description of the results of his excavations at Knossos; this is profusely illustrated by no less than seventy-four reproductions from photographs and line drawings, a map showing the state of the excavations at the present time, and two plates. Mr. Evans's paper is exceedingly interesting reading, and his discoveries appear to have been, as is usually the case, of first-class importance; we earnestly hope that good fortune may attend his labours in the future at Knossos as it has done in the past! It is, however, obvious that, for extensive excavations of this kind, which involve heavy and prolonged expenditure, increased funds are necessary. It is well known that Mr. Evans has contributed to the expenses of the work from his own private means far more than was right, but it is clear that no archæologist, however enthusiastic he may be, can continue to spend his own money indefinitely on researches which would, in any other country but England, be undertaken either by the Government or by some wealthy academy.

The most important objects described by Mr. Evans are:—(1) A series of tablets of porcelain mosaic representing houses and towers, which are curiously like children's dolls' houses, with a door in the middle and the windows divided by mullions. (2) A series of similar porcelain tablets with representations of warriors and animals. (3) A set of terra-cotta models of pillar-altars, with figures of doves perched upon the top of them. (4) Fragments of ivory figures of leaping youths, with the hair represented by bronze spirals let into the ivory. (5) A small shrine discovered *in situ* in the southern part of the palace. The shrine and its contents have been carefully kept in their original position, and a small house has been built over them to protect them from the weather. The contents consist of rude iconic figures of deities, and a horned altar, which is somewhat Canaanitish in type. These horned altars are familiar objects in Cretan diggings, and they are usually described by Mr. Evans as "horns of consecration." (6) Objects inscribed in ink with Cretan hieroglyphics. These are of great importance, for they show that the Cretans employed the Egyptian means of writing as well as the Mesopotamian; they used both pen and ink as well as clay tablet and stylus. (7) The sanitary arrangements of the palace, which appear to have been extraordinarily modern in character. The latrines were water-closets, which were provided with carefully constructed drains made of terra-cotta pipes, the sections of which remind one (see Fig. 7, p. 13) of a sanitary engineer's catalogue of the present day. The exigencies of space will not allow us to enumerate the minor discoveries, and we refer the reader to the Annual itself for a full account of them.

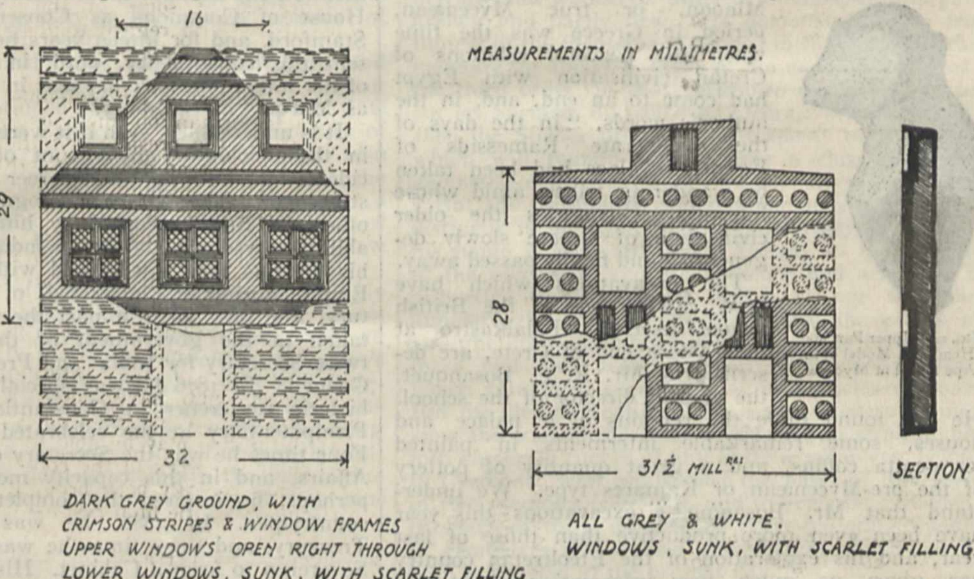


FIG. 1.—Porcelain Tablets in Form of Houses (slightly enlarged).

Mr. Evans ends his paper with some speculations as to the possible connection of Crete with Egypt as early as the time of the fourth and fifth dynasties, *i.e.* about B.C. 3700–B.C. 3200, and it is of interest to note that Mr. H. R. Hall, of the British Museum, publishes in this volume of the Annual a paper dealing more or less with this very subject. Mr. Hall traces the history of the connection between Egypt and the peoples of the Ægean, and the southern coast

[1] "The Annual of the British School at Athens" No. viii. Session 1901–1902. Pp. 348, 20 plates, and many illustrations. (London: Macmillan and Co., Ltd.)

of Asia Minor, from the periods of the sixth and twelfth dynasties down to the reign of Rameses III., *i.e.* for a space of more than 2000 years. The great value of his paper to Greek archæologists consists in the fact that he derives his materials from the Egyptian monuments alone, and he has shown pretty conclusively from the Egyptian records that the Mycenæans, or "Minoans," of Crete were in close communication with Egypt as early as the time of the eighteenth dynasty, about B.C. 1650 to B.C. 1400, and probably much earlier. We may note in passing a point of interest, namely, his identification of the true name of the Island of Cyprus in the time of Thothmes III., viz. Yantanay, which is undoubtedly the same as the Assyrian name for the island, "Yatnana." Mr. Hall also gives new material to the student of Mycenæan art in his identifications of Cretan vases among the tribute depicted on the walls of the tombs at Thebes, about B.C. 1550. The rest of his paper is occupied with an account of the relations of the Egyptians with the Mediterranean tribes who successively invaded Egypt under the nineteenth and twentieth dynasties. He proves that the period of peaceful relations between Crete and Egypt under the eighteenth dynasty was the period of the Minoan civilisation of Knossos and Phæstus, and that the post-Minoan, or true Mycenæan, period in Greece was the time when the peaceful relations of Cretan civilisation with Egypt had come to an end, and, in the author's words, "in the days of the degenerate Ramessids of Egypt, its place had been taken by wandering tribes, amid whose internecine struggles the older civilisation of Greece slowly degenerated and finally passed away.

Fig. 2.—Upper Part and Head of a Model of an Ape found at Mycenæ.

The excavations which have been carried on by the British School itself at Palaikastro, at the eastern end of Crete, are described by Mr. R. C. Bosanquet, the present director of the school. He has found there the remains of a palace and houses, some remarkable interments in painted terra-cotta coffins, and a great quantity of pottery of the pre-Mycenæan or Kamares type. We understand that Mr. Bosanquet's excavations this year have been even more productive than those of last year, and his exploration of the Eteokretan country has given us much new information about this remote but interesting portion of the island. Two or three years ago Mr. Bosanquet discovered on the site of Præsus, the ancient capital of the Eteokretans, another example of an inscription in the non-Greek language of eastern Crete. This is critically examined by Mr. R. S. Conway in this number of the Annual, but we think that his attempt to prove that the language is Indo-European is unsuccessful. Kretschmer has shown that the languages of southern Asia Minor, of which Lycian is the best known example, were not Indo-European, and legend connects the Eteokretans with Lycia. Of the Lycian language Mr. Conway naïvely admits (p. 156, note 2) that he has no knowledge, but yet criticises Kretschmer! The remaining article in the volume, which is by Mr. Marcus N. Tod, is of interest to classical scholars only. The above remarks are sufficient to indicate the interest and importance of the new volume of the British School at Athens.

THE MARQUIS OF SALISBURY.

THE death of Lord Salisbury has robbed us of a great statesman. He had been ill for some weeks and the peaceful end came during the evening of Saturday last. At the beginning of June of this year an attack of nephritis, complicated with a weakness of the heart, set in, and from this illness Lord Salisbury never recovered. Since the preceding Wednesday, when his heart began to fail, it was generally known that there was no hope, and the quiet, painless passing came as a fitting conclusion to a distinguished career, marked always as it was by a dignified reserve and an unusual love for seclusion.

Born in Hatfield on February 3, 1830, Lord Salisbury died in his seventy-fourth year. He was the direct lineal descendant of the great Lord Burleigh, and was educated at Eton and Christ Church, Oxford, where he graduated in 1850. The few years following his stay at Oxford were spent in travel, and included a somewhat prolonged visit to Australia and New Zealand. During this period he learnt from personal experience the dangers and charms of life at cattle stations and at the gold diggings. Returning in 1853, he was elected to an All Souls Fellowship, but as subsequent events showed he preferred the activity of politics to the quietude of university life. In the autumn of the same year he entered the House of Commons as Conservative member for Stamford, and for fifteen years he continued to represent this constituency, until, in 1868, on the death of his father, he took his seat in the House of Lords as Marquis of Salisbury.

It is unnecessary, even if it were appropriate, to give in these columns an account of the numerous incidents in the political career of this renowned statesman. The barest catalogue of the important offices of State occupied by him with consummate ability serves adequately to indicate how intimately his life has been intertwined with the history of the Empire during the latter half of the nineteenth century, and how large a part the dead statesman has taken in the government of the nation. He was twice Secretary for India and President of the Indian Council. In 1876 he was special Ambassador to the historic conference at Constantinople; and in 1878 Plenipotentiary at the celebrated Berlin Conference. Four times he was the Secretary of State for Foreign Affairs, and in this capacity more than any other, perhaps, he inspired the complete confidence of his countrymen. In 1886 he was First Lord of the Treasury, and three times he was called upon by his Sovereign to form a Cabinet. His premierships lasted respectively from 1885–6, 1886–1892, and 1895–1902.

But an account of Lord Salisbury's political career gives no proper idea of the versatility of his genius. When a member of the House of Commons he was actively engaged in journalistic work, and his contributions to the *Saturday Review*, the *Quarterly Review*, and other papers would have secured for a less gifted person a sufficiently high reputation. To men of science, however, the most interesting recollection in connection with Lord Salisbury is the fact that in 1894 he was President of the British Association, and that throughout his political triumphs his great pleasure was, in his leisure hours at Hatfield, to pursue scientific researches in physics and chemistry.

In commenting on the Presidential Address delivered by Lord Salisbury at Oxford in our issue for August 9, 1894, we remarked:—"Many of those who know Lord Salisbury only as a politician and as Minister for Foreign Affairs will be surprised at the wide range of thought and reading displayed in his handling of the diverse topics which he passes under review." And though Lord Salisbury himself said in that address, "In presence of the high priests of science I am only a layman, and all the skill of all the chemists the Association contains will not transmute a layman into any more precious kind of metal," yet on that occasion he proceeded to give in a masterly fashion "a survey not of our science but of our ignorance." The references to the want of knowledge of the nature of the capricious differences which separate the atoms from each other; the description of the ether as "a half-discovered entity"; the explanation of the deep obscurity which at the time of the address still enveloped the origin of the infinite variety of life, and the impossibility of demonstrating the process of natural selection in detail, combined to make the Oxford British Association address comparable in importance with the great controversy at the same city when the Association met there thirty-four years previously.

The study of science was for many years the solace which Lord Salisbury sought from the cares of State, and it is far from fanciful to suppose that these investigations influenced his political outlook and contributed to his success in meeting the difficulties of government. But whether this is so or not, there can be no doubt that Lord Salisbury's acquaintance with physical and chemical science was of an intimate nature, and added greatly to the joy and comfort of the short years of his retirement.

Lord Salisbury held many other appointments and received numerous academic distinctions. Among these may be mentioned that from 1869 to the time of his death he was Chancellor of the University of Oxford, and his interest in higher education was also shown by the fact of his being a member of the Council of King's College, London. He was a Doctor of Civil Law of Oxford, and a Doctor of Laws of Cambridge University, as well as a Fellow of the Royal Society.

This brief notice of a great career may be fittingly closed with a paragraph from Dr. Traill's monograph. "Lord Salisbury's record is that of an English statesman who, while directing the affairs of his country abroad with singular skill and judgment, has also guided its domestic policy in the paths of wisdom and equity, and, though loyally submitting to the 'will of the majority' in all things lawful, has held it his first duty to maintain the just rights of every class, however small a minority it may constitute, in the State."

PROF. LUIGI CREMONA.

AN interesting account of the life and work of the late Prof. Cremona, by Prof. Blaserna, appears in the *Proceedings* of the Royal Society of Edinburgh (vol. xxiv.), an advance copy of which has been received. By permission of the general secretary of the Society, we print a free translation of Prof. Blaserna's contribution and extracts from a note appended to it.

Prof. Luigi Cremona was born at Pavia on December 7, 1830, and studied there until the year 1848, when he suspended his academic work to join the ranks of the Italian volunteers, and to take part in the heroic defence of Venice until the capitulation of that famous town. He then graduated in mathematics at Pavia, where he had among his teachers Francesco Brioschi, and among his fellow-students Eugenio Beltrami and Felice Casarati. Thereafter he taught in the Gymnasium at Cremona and in the Beccarian Lyceum at Milan.

In 1860 he was appointed to the new chair of higher geometry in the University of Bologna, then reorganised by the Italian Government, and thence he passed, in 1866, to the Polytechnic at Milan. When, after the year 1870, the Italian Government undertook the organisation of the great University of Rome, with its annexed engineering school, Cremona was called, in 1873, to be professor of higher geometry in the university and director of the engineering school, which he reconstructed and established in the old Convent of St. Pietro in Vincoli. The duties of this double post he discharged with fidelity and distinction to the last years of his life.

Although Cremona had been a pupil of Brioschi, an eminent analyst, his predilection was always for geometry, in which he may be said to have created a classical school. His numerous publications refer chiefly to the theory of algebraic curves and surfaces. All the problems that arose in this department of mathematics between 1860 and 1880 attracted his attention, and everywhere he left an indelible trace of the depth and the clearness which characterised his genius.

To general theory are dedicated the "Introduction to a Geometrical Theory of Plane Curves" (1862) and "Preliminaries to a Theory of Surfaces" (1866), two monographs in which he expounds, with originality of view and wonderful unity of method, results partly known and partly new. He demonstrated the fruitfulness of the theorems contained in the second of these memoirs by applying them to the study of surfaces of the third order, in the "Mémoire de Géometrie pure sur les Surfaces du troisième Ordre," which gained in 1886 the Steiner prize of the Academy of Berlin, and which will remain for all time a classic model of geometric research.

But the originality of Cremona appears still more distinctly in his study of the transformations to which his name is now attached. Already in the first half of the nineteenth century a theory had arisen of the projective transformations which change the points and straight lines of one plane into the points and straight lines of another plane, and side by side with these had also been examined the correspondences which transform straight lines into circles or conics. But the idea of treating from a more general point of view the transformations which change straight lines into algebraic curves of any order *n* whatever belongs to Cremona, who established the basis of this theory in two memoirs (1863–65), and afterwards extended it to space of three dimensions (1871–72), thus opening to geometers a vast field of research, which has not been exhausted at the present day.

While, by these works, of which I have mentioned only the most extensive, and by his splendid lectures, Cremona was firing the rising generation with the love of pure science, and thus exercising a great influence on original geometric research in Italy during the last thirty years, on the other hand he was never weary of showing his interest in the technical applications of mathematics. His little work on "Reciprocal Figures in Graphical Statics" is a beautiful example of this interpenetration of pure and applied science, an interpenetration which characterises another side of his broad genius. Always pursuing this order of ideas, he took assiduous care with his engineering students in Rome to keep science and practice side by side, inciting them to attain that just balance of different faculties of which he gave himself so fine an example.

Besides all this, Luigi Cremona was a statesman. Nominated a Senator of the kingdom in 1879, he took an active part in all the work of the Senate. He was, indeed, one of the most respected and influential of the

Senators, and his reports and speeches reveal a man of frankly liberal views and of firm and stable character He was, for a short time, Minister of Public Instruction in one of the ministries of the Marchese di Rudini.

The fame of Luigi Cremona is world-wide. Almost all the foreign academies elected him a fellow. His death (which happened on June 10 last) has been a loss not only for Italy, but for science universal, in which his discoveries will long secure him a place of honour.

In the course of a note appended to Prof. Blaserna's valuable statement of facts as to Cremona's career, Prof. Chrystal remarks :—

In the year 1884, Cremona, along with Hermite and his son-in-law Émile Picard, was my guest during the tercentenary festival of the University of Edinburgh. Besides these three distinguished mathematicians, the following were present at the festival :—Helmholtz, Bierens de Haan, Cayley, Sylvester, Lord Kelvin, Stokes, Salmon, Lord Rayleigh, and Tait. The majority of these dined one evening with Lord M'Laren, and it is scarcely probable that there ever was such a feast of mathematicians before or since. Of this brilliant band of nineteenth century men of science, there remain with us now only Kelvin, Rayleigh, and Picard.

NOTES.

THE ninth International Geological Congress was opened at Vienna on Thursday last, when Dr. Tietze, director of the Imperial Institute of Geology, was elected president.

A REUTER telegram from Cape Town states that the Cape Legislative Council has agreed to a motion in favour of addressing a communication to the Imperial Government on the subject of the adoption of the metric system.

ACCORDING to the *Athenaeum*, a resolution was passed at the conclusion of the recent geodetic congress at Amsterdam requesting the various nations to carry out extensive measurements of gravity from the Atlantic towards the east through the lowlands of Europe and Asia, as well as in the plateau around Thibet. A clear conception of the variations of weight and of the distribution of bulk in the crust of the earth would be gained thereby in connection with astronomical determinations of longitude and latitude.

Science states that the commission sent by the U.S. Marine Hospital Service to Vera Cruz reports three propositions as having been demonstrated beyond doubt, namely, (1) that the cause of yellow fever is an animal parasite, and not a vegetable germ or bacterium; (2) that the disease is communicated only by the bite of mosquitoes; (3) that only one genus of mosquitoes, *Stegomyia Fasciata*, is the host of the yellow fever parasite.

THE *British Medical Journal* states that Dr. S. R. Christophers, who was associated with Dr. Stephens in the investigation as to malaria conducted on the west coast of Africa and in the Indian cantonments, has been notified by the Indian Government that the medical authorities desire him to proceed at once to India, with the view of his again taking up special work relating to malarial infection. Dr. Christophers is, it is stated, leaving almost immediately to enter upon his duties.

ACCORDING to a Stockholm correspondent of the *Times*, the Swedish steamer *Frithjof*, which on August 17 started from Stockholm for the relief of Dr. Otto Nordenskjöld's South Polar Expedition, will take on board at Bremerhaven provisions for three years and wireless telegraphy apparatus. Such apparatus is also, it is stated, to be fitted on board the Argentine gunboat *Uruguay*, and it is thought that this vessel, which is iron built, will remain outside the ice while the *Frithjof* will push on as far south as possible. From Bremerhaven the *Frithjof* will go to Plymouth to coal, and then *viâ* Madeira to Buenos Ayres, where possibly an Argentine naval officer will join her. She will then go to Punta Arenas, whence her commander proposes to reach Snowhill, the supposed winter station of the Antarctic.

ON Saturday last the Canadian Government steamer *Neptune* sailed from Halifax, Nova Scotia, for Hudson Bay and Arctic waters on an expedition to last a year and a half. The object of the expedition is to conduct, on behalf of the Government, a botanical, geological, and natural history investigation. The party will take formal possession of the Arctic Islands and the shore of Baffin's Bay. The commander of the expedition will report on the alleged extensive American poaching in the Hudson Bay fisheries. The importance of the cod and halibut fisheries will be reported on.

A MESSAGE from Naples, dated August 22, states that the explosions of Mount Vesuvius are increasing in violence, and quantities of volcanic matter have been thrown to a height of about 200 yards. At half past 6 o'clock of the morning referred to, a slight earthquake shock was felt.

THE arrangements for the eighth International Geographical Congress, to be held next year at Washington, are, says the *Times*, taking shape under the care of a committee representing the ten geographical societies and mountaineering clubs of the United States, which have united to welcome the geographers of all nations to American soil. The congress will meet in Washington on September 8, 1904, and will hold daily sessions on September 9, 10, 12, 13, and 14. The subjects for treatment and discussion during the meeting at Washington are classified under the following heads:—(1) Physical geography, including geomorphology, meteorology, hydrology, &c.; (2) mathematical geography, including geodesy and geophysics; (3) biogeography, including botany and zoology in their geographical aspects; (4) anthropogeography, including ethnology; (5) descriptive geography, including explorations and surveys; (6) geographical technology, including cartography, bibliography, orthography of place-names, &c.; (7) commercial and industrial geography; (8) history of geography; (9) geographical education. The committee urges that early notice be given by those desirous of presenting communications or proposing subjects for discussion, July 1, 1904, being fixed as the latest date for submitting communications designed for printing in connection with the congress, and August 1 in the case of abstracts (not exceeding 1000 words in length) designed for insertion in the daily bulletin.

AN International Electrical Congress will be held at St. Louis, Mo., from September 12 to 17 of next year. The sections which have been proposed for the main body of the congress are:—*General Theory*.—Section A, mathematical and experimental. *Applications*.—Section B, general applications; Section C, electrochemistry; Section D, electric power transmission; Section E, electric light and distribution; Section F, electric transportation; Section G, electric communication; Section H, electrotherapeutics. Prof. Elihu Thomson has been elected president of the committee of organisation, and the general secretary is Dr. A. E. Kennelly, Harvard University, Cambridge, Mass.

The *Times* Brussels correspondent states that the eleventh International Health Conference will be held in Brussels from September 2 to 8. One of the leading questions for discussion is whether the tuberculosis bacillus in the domestic animal is identical with that of the human species.

In connection with an exhibition which is to take place at Milan in 1905, a national sanitary congress is to be held. The work of the congress will be dealt with in the following sections:—sanitary assistance, public hygiene, clinico-scientific and therapeutic, medical jurisprudence and accidents to workmen, professional interests.

A general exhibition arranged by the Central Association of Inventors, of Bayreuth, for the purpose of facilitating the sale of patents and copyrighted patterns is to be held during September and October next at Nuremberg. There are, it is stated, more than 200,000 copyrighted patterns in Germany and more than 140,000 patents, but one-half of these are not in public use, the reason being that the inventors are not able to exploit their inventions. It was because of this that the Central Association came into being some years ago. Its purpose is to assist the members to make their inventions profitable to themselves, the majority of inventors not having the means to do so. The Association furnishes space to inventors without means free of cost, and charges no fees for effecting a sale.

According to a Reuter telegram from Berlin, a number of mining officials will, at the instance of the Minister of Commerce, shortly be sent to this country to make a thorough study of the hygienic and sanitary arrangements in mining districts.

The *Electrician*, quoting from the *Western Electrician* of Chicago, states that preliminary reports have been given concerning wireless telegraph experiments which have been conducted on board the training ships *Prairie* and *Topeka*, in conjunction with shore stations, by the Navy Department of the United States during the last year. The reports state that the Slaby-Arco system is well suited for naval purposes, and has been adopted by the United States Navy. It was tested in competition with French, German, and English devices, not, however, including the Marconi system. Satisfactory terms, it is stated, could not be made with Mr. Marconi for the installation of his instruments on the war ships, and further negotiations were discontinued. Twenty sets of Slaby-Arco instruments have been installed on eight war vessels, which used them in the fleet manœuvres.

A telegram from New York, through Laffan's agency, states that the advisory board of the American scientific expedition to Babylon has been compelled to abandon its plan of extensive excavations at that place, preparations for which have been made during the last three years. The abandonment is due to the persistent refusal of the Porte to permit the American society to carry on such work, although it has readily authorised excavations by other nations.

The collections made by Mr. M. J. Nicoll, who accompanied Lord Crawford, as naturalist, in the R.S.Y. *Walhalla* during his recent tour round the world, have arrived at the Natural History Museum, South Kensington, and contain about 1500 specimens. The *Walhalla* remained so short a time at most of the places where she stopped that it was not possible to procure a large number of examples of terrestrial animals, but about 250 bird-skins were brought home. The principal collections were made in the Magellan Straits, at Valparaiso, in the Samoan and Fiji groups of the Pacific, and in Torres Straits. Mr. Nicoll is now engaged in arranging and naming the specimens.

Several living specimens (three of which have arrived safely) of the wild guinea-pig of Brazil have, according to *Science*, recently been sent to the zoological laboratory of Harvard University by Mr. Adolph Hempel for the purpose of experimental studies in heredity.

Dr. Carroll gives an interesting *résumé* of our knowledge of the mode of transmission of yellow fever (*Journ. Amer. Med. Assoc.*, May 23). He points out that the mosquito theory has been proved to be true, and that the non-communicability of the disease from person to person, and by means of fomites, has been demonstrated. Yellow fever has been eradicated from Havana, one of its endemic homes, by the institution of measures directed against the mosquito, after extreme cleanliness and energetic disinfection had proved dismal failures.

The specificity of anti-venene, the anti-serum for snake venom, has been a matter of controversy for some years. Calmette originally asserted that anti-venene was not specific, that is, cobra anti-venene, prepared by injecting an animal with increasing doses of cobra venom, though most active against cobra venom, would also antagonise other venoms. Martin, and more recently Tidswell, in Australia, questioned the correctness of this view, and Captain Lamb, I.M.S., has now proved beyond doubt that anti-venomous sera are just as specific as any other anti-sera, *e.g.* diphtheria or tetanus (*Sc. Mem.* of the Gov. of India, New Series, No. 5). He has tested the neutralising properties of several anti-venomous sera towards the venoms of many species of venomous snakes, and in no case was any neutralising power exhibited by a serum except towards the venom with which it had been prepared.

The annual report issued by the superintendent of the Botanical Department in Trinidad bears testimony to the useful work which is carried on at the St. Clair experiment station. The Lagos "silk rubber" plant *Funtumia elastica* continues to be in demand, as the points in its favour are suitability to the climate, easy coagulation, and good rubber yield at an early age. The experiments with seedling sugar-canes are unfortunately limited by the small amount of space available for growing plots, but the demand for canes to the full extent of the available supply is a sufficient guarantee of the success of the undertaking. The cultivation of cotton in the West Indies would be the revival of an old industry. Through the cooperation of the Cotton Growers' Association, a quantity of seed has been provided for distribution, and prizes are offered for the best results.

The botanical features of that district comprised in the Delta of the Ganges known as the Sundribuns are so unique that even after the surveys by Prof. Heinig and Mr. C. B. Clarke there still remains scope for the account which is presented by Dr. Prain in the *Records* of the Botanical Survey of India. This includes the first complete list of plants gathered in the district, with a guide to the genera and species, as well as a summary of the principal ecological associations, and observations on the manner in which they may have originated. First in point of interest comes the mangrove vegetation, which includes a heterogeneous collection of plants, many of which are characterised by the development of root suckers having a respiratory function; further, the collections of plants found at the sea face and in the clearings present problems in connection with the dispersal of species.

THE causes of acceleration and retardation in the metamorphosis of *Amblystoma tigrinum*, the adult form of the Mexican axolotl, form the subject of an article by Mr. J. H. Powers in the June number of the *American Naturalist*. According to the author, previous observers have been in error in attributing the retention of the larval form to inability to leave an aquatic life, and, conversely, the early acquisition of the adult condition to removal from water. The real factor in the case, he believes, is nutrition. A paper by Mr. J. H. Lovell, in the same journal, on the colours of northern gamopetalous flowers and their relations to bees and other insects, contains much matter of interest alike to the botanist and to the entomologist. The sequel will be published in a later number.

To vol. ii. No. 5 of *Marine Investigations in South Africa*, Dr. J. D. F. Gilchrist contributes some important notes on the development of South African fishes. The publication of these notes, which are confessedly crude and imperfect, would have been deferred until fuller investigations had been undertaken were it not for the circumstance that they have an important bearing on certain disputed points connected with the Cape fisheries. Many of the fishermen urge, for instance, that the spawn of several of the commoner food-fishes is developed on or near the sea-bottom, and is, in consequence, seriously damaged by trawling. To this the author replies that, since in northern waters it has been demonstrated that only one valuable food-fish, the herring, has deep-lying spawn, and since the Cape seas are the home of only a small species of herring of little or no commercial value, it is probable that the damage done by trawling in South African waters has been largely overestimated.

A PRELIMINARY report upon "Trypanosomiasis of Horses ('Surra') in the Philippine Islands," by Messrs. Musgrave and Williamson, has been issued by the Government Laboratory, Manila. The disease seems to have been recently introduced into the Philippines, for careful investigation has failed to show any evidence that it existed there before May or June, 1901. It is transmitted through the bites of insects, and until the exact species are discriminated, for preventive measures all insects should be considered as carriers of the infection. In Manila a certain number of the rats have been found to be infected with the horse trypanosoma. An account is given of the symptoms of the disease and of the preventive measures to be adopted, the most important of which is the prevention of the access of all flies and insects.

A SHORT time ago M. Blondlot announced the discovery of a new form of radiation found with Röntgen rays, and possessing the power of penetrating black paper and many metals. The rays could be reflected and refracted by quartz lenses, and were without photographic action; they could, however, be detected by their power of increasing the luminosity of small electric sparks or of a colourless "blue" flame. The rays were subsequently shown by M. Blondlot to be produced by an Auer burner. Following up his researches on these *n* rays, M. Blondlot has been led to discover some remarkable properties which they possess; these are communicated in a recent number of the *Comptes rendus*. It seems that the rays are capable of increasing the illumination given by an incandescent surface on which they fall, and this without any increase of temperature. An experiment which seems conclusive is quoted; a platinum wire which was heated to a dull red was subjected to the action of the rays, and whenever these were allowed to fall on it the incandescence was visibly increased. An auxiliary electrical circuit afforded a means of measuring the resistance, and hence the temperature of the wire, and this showed that the rays produced no increase in temperature; an increase of temperature too small to produce a visible effect in the incandescence of the wire was easily detected by the measuring circuit. This result is particularly interesting, not only in reference to the *n* rays of M. Blondlot, but in reference to theories of incandescence and light emission generally, as it seems possible that these rays may be able to throw some light on the many difficult problems that beset this subject. The remarkable properties that this radiation seems to possess promise to make it of unusual interest, and possibly also of great utility.

IN the *Gazette de Lausanne*, M. F. A. Forel directs attention to what appears to be a recurrence of the coloured circle round the sun (Bishop's Ring), similar to that which was observed after the Krakatoa explosion in 1883. The present phenomenon is paler than that first described by Mr. Bishop, and is supposed to be connected with the eruption of Mont Pelée in May, 1902. M. Forel states that it can only be seen at an altitude of not less than 2000 metres; it was first seen by him on August 1, and he points out that it would be very interesting if alpine climbers, or balloonists, would state when the ring was first observed by them, and whether its appearance is intermittent or continuous.

A CORRESPONDENT of the *Times* directs attention to a supposed cure for the mysterious malady known as mountain sickness. The discoverer of the specific is a Russian topographer named Passtoukhof, who, for some years past, has been making ascents in the Caucasus, where he has climbed the Grand Ararat, Mount Kasbek, and Mount Elbruz. At such high altitudes as these it is easy to understand that the question of mountain sickness becomes a serious one, and on more than one occasion M. Passtoukhof has found not only himself, but all the other members of his expedition, completely prostrated by it. On one of these occasions it occurred to him to try the experiment of lighting his spirit lamp and making some tea, which he administered to himself and his companions in an almost boiling condition, with a result that far exceeded his expectations. Almost immediately the more serious symptoms disappeared, and in a short time all the members of the expedition found themselves well enough to continue the ascent. Later on M. Passtoukhof repeated this experiment of using boiling tea as a remedy for mountain sickness, with results so invariably successful that he now feels justified in considering that it may really be regarded as a specific.

A CORRESPONDENT directs our attention to the fact that one feature of the programme at present in force at the Alhambra is an exhibition of the microbioscope. We are glad, like our correspondent, that science is being introduced—even in the form of amusement—to those who, in ordinary circumstances, take no interest in scientific matters, and think with him that more might be done even with existing resources to bring a knowledge of the advances of science under the notice of the people. "The music halls are," says our correspondent, "being increasingly used for good music; why not for good science? The managers will put money into it if the public respond, and no objection will be made to raising the tone of their programmes if the houses fill. Those interested in science need not spend the evening there; they could go to see just what concerned them."

THE Engineering Standards Committee has just issued "standard sections and specification" for tramway rails. If the series of rails be adopted, it should be easier for the British manufacturer to hold his own against foreign competition, which, in the case of tramway rails, is particularly severe.

WE have received the first parts of the monthly *Bulletin* of the Philippine Weather Bureau for 1903, prepared under the direction of the Rev. José Algué, S.J., director of the service. This bulletin, modelled on the plan of the United States meteorological publications, contains valuable climatological observations and general notes on the weather and crops. The report for 1902 contains an interesting account of the establishment and development of the service under the Spanish Government, and of its reorganisation and improvement under the United States. Meteorological observations were begun in Manila in 1865, and after many years of assiduous study of the behaviour of the typhoons of the eastern seas, Father Faura, the first director of the observatory, commenced his predictions of the approach of typhoons in July, 1879. These storm warnings have been the means of saving much life and property, not only in the Philippine Islands, but on the Chinese coasts. Their value is now fully recognised by the United States Government and by the Colonial Secretary and Chamber of Commerce of Hong Kong. On the recommendation of the chief of the U.S. Weather Bureau, a network of subsidiary stations has been established in the archipelago which will doubtless render invaluable service to our knowledge of the meteorology of the Far East.

A PAMPHLET of sixty-nine pages, extracted from the report of the expedition of the *Stella Polare* in 1899–1900, deals with the magnetic observations undertaken in the Bay of Teplitz by Captain Umberto Cagni. These observations were reduced by Prof. Luigi Palazzo, who gives the following results for July, 1899, and June, 1900:—Declination, 21° 10′ and 21° 18′ east; inclination, 83° 25′ and 83° 1·2′ north; horizontal intensity, 0·06846 and 0·06855; vertical intensity, 0·59319, 0·55990; total force, 0·59713, 0·56409. The principal instruments used were a unifilar Schneider magnetometer and a Kew inclinometer, but great difficulties were experienced in making the observations; among other inconveniences, snow was carried into the temporary observatory, and succeeded in penetrating through every crack or crevice.

SOME recent researches in the comparatively modern study of experimental phonetics are given by Prof. E. W. Scripture (Yale) in the *Medical Record* (February 28), and *Die neuern Sprachen* (January). In the former paper, Prof. Scripture describes the different methods that have been employed for registering the sound curves of the human voice. The method preferred by the author is to obtain a gramophone or phonograph record of the voice and to trace off an enlargement of the fluctuations either by mechanical or by photographic methods. In the second paper, Prof. Scripture describes a complete record of the melody of the Lord's Prayer as recited in the style characteristic of the eastern part of the United States. A diagram is given showing the main variations of pitch. An investigation in another branch of physiological acoustics, dealing with the audibility of vowel sounds under pathological conditions, is given by M. Marage in the *Comptes rendus* (February).

THE additions to the Zoological Society's Gardens during the past week include two White-crowned Mangabeys (*Cercocebus oethiops*) from West Africa, presented by Mr. C. R. Farquharson; an Ocelot (*Felis pardalis*) from Rio de Janeiro, presented by Mr. John Gordon; a Grand Eclectus (*Eclectus roratus*) from Moluccas, a Black-crested Cardinal (*Gubernatrix cristatella*) from Paraguay, a Red-headed Cardinal (*Paroaria larvata*), a White-throated Finch (*Spermophila lineola*) from Brazil, presented by the Right Hon. Earl of Crawford, K.T.; a Brown-throated Conure (*Conurus oeruginosus*) from South America, presented by Mrs. M. Moir-Byres; a Barred Dove (*Geopelia striata*) from India, a West African Love-bird (*Agapornis pullaria*) from West Africa, presented by Sir Arthur Bigge, K.C.B.; a Common Snake (*Tropidonotus natrix*), British, presented by Mr. Oliver Roberts; a Yellow Baboon (*Papio cynocephalus*) from Africa, a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, a Lion Marmoset (*Midas rosalia*) from South-east Brazil, an Echidna (*Echidna hystrix*) from New South Wales, two Stanley Parrakeets (*Platycercus icterotis*), two Tree Sparrows (*Passer montanus*), three Limbless Lizards (*Pygopus lepidopus*), a Muricated Lizard (*Amphibolurus muricatus*), a Cunningham's Skink (*Egernia cunninghami*) from Australia, a Lesser White-fronted Goose (*Anser erythropus*), two Jackdaws (*Corvus monedula*, var.), European; an American Glass Snake (*Ophiosaurus ventralis*), a Hog-nosed Snake (*Heterodon platyrhinos*), two Couch's Snakes (*Tropidonotus ordinatus couchi*) from North America, deposited; nine Summer Ducks (*Aex sponsa*) from North America, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER:—

Sept. 3. 8h. Saturn in conjunction with moon. Saturn 5° 26′ S.
5. 9h. 26m. Minimum of Algol (β Persei).
7. 5h. Mercury at greatest eastern elongation (27° 0′).
11. 18h. Jupiter in opposition to the sun.
12. Saturn. Polar diameter = 16″·3, outer minor axis of outer ring = 14″·39.
15. Venus. Illuminated portion of disc = 0·002; of Mars = 0·891.
17. 9h. Venus in inferior conjunction with the sun.
,, 13h. 53m. to 14h. 36m. Moon occults α Cancri (mag. 4·3).
20. Sun totally eclipsed, invisible at Greenwich.
21. 7h. 13m. to 10h. 22m. Transit of Jupiter's Sat. III. (Ganymede).
23. 18h. Sun enters Libra. Autumn commences.
25. 11h. 9m. Minimum of Algol (β Persei).
27. 7h. 55m. to 11h. 2m. Transit of Jupiter's Sat. IV. (Callisto).
28. 7h. 58m. Minimum of Algol (β Persei).
,, 10h. 30m. to 13h. 40m. Transit of Jupiter's Sat. III. (Ganymede).
30. 13h. Saturn in conjunction with moon. Saturn 5° 32′ S.

NEW TABLE FOR EX-MERIDIAN OBSERVATIONS OF ALTITUDE.—In existing tables for obtaining the difference between the observed and meridian altitudes, when determining latitude by ex-meridian observations, one has to refer to *two* separate tables, using as arguments declination, hour angle and approximate latitude. To remedy this Mr. H. B. Goodwin, R.N., has just published a pamphlet (Griffin and Co., Portsmouth) showing how the problem may be solved by the use of *one* table only, which is included in his pamphlet, using approximate latitude and azimuth.

The principle on which the method is based is that a body near the meridian may be regarded as changing its altitude with a uniform rate of change, and at any one interval we may take the *mean* rate of change as representative, and obtain the "reduction" to meridian altitude from the formula $dz = \sin A \cos l.dh$, where dz is the change of altitude and dh the contemporaneous change of hour angle; dz for each half degree of latitude and azimuth is given in the table. All that one has to do to obtain the "reduction" is to take the approximate azimuth from any azimuth tables—and this has to be done for another part of the problem—then take out the rate of change, dz, from the Goodwin table and multiply this by the number of minutes in the hour angle.

RETURN OF BROOKS'S COMET.—A telegram from Kiel announces that Brooks's comet was observed by Prof. Aitken at the Lick Observatory on August 18, and that the position of the comet at 12h. 17·4m. (Lick M.T.) on that date was R.A.=21h. 2m. 51·3s., Dec.=−27° 4′ 19″. This position agrees closely with that given by an ephemeris computed by Herr P. Neugebauer, and published in No. 3868 of the *Astronomische Nachrichten*. The following is an extract from this ephemeris:—

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

1903	True α (h. m. s.)	True δ (° ′ ″)	log r	log Δ
Aug. 27	20 56 24·95	−27 0 30·4	0·3284	0·07060
,, 29	20 55 12·95	−26 57 6·4		
,, 31	20 54 6·78	−26 52 54·0	0·3259	0·07321
Sept. 2	20 53 6·98	−26 47 53·8		
,, 4	20 52 13·90	−26 42 6·8	0·3234	0·07693
,, 6	20 51 27·98	−26 35 33·6		
,, 8	20 50 49·45	−26 28 15·2	0·3210	0·08165
,, 10	20 50 18·61	−26 20 12·8		
,, 12	20 49 55·67	−26 11 27·7	0·3187	0·08727
,, 14	20 49 40·87	−26 2 1·0		
,, 16	20 49 34·32	−25 51 53·8	0·3164	0·09369
,, 18	20 49 36·19	−25 41 7·0		
,, 20	20 49 46·55	−25 29 41·9	0·3142	0·10081

According to Aitken's determination of the comet's position, as given above, this ephemeris needs a correction of +22·58s. in R.A. and +1′ 41″·2 in Dec.

Although not a bright object, this comet is of historical interest, because when it was first discovered by Brooks, in 1889, it was held to be a good illustration of the "capture theory" of comets, and was looked upon as identical with Lexell's lost comet of 1770, which had been "captured" by Jupiter. This belief was, however, discountenanced by the subsequent researches of Dr. Poor, of Baltimore. In 1889 Barnard observed the comet as double, and found that the two parts were slowly separating.

This comet has a period of 7·096 years, and was duly observed in 1896, when it performed its perihelion passage on November 4. For the present return the comet takes the designation 1903 *d*.

EPHEMERIS FOR COMET 1903 *c*.—An ephemeris for comet 1903 *c* is given in No. 3890 of the *Astronomische Nachrichten* by Herren M. Knapp and W. Dziewulski.

The comet is now too near the sun to be observed, but it will be observable by astronomers residing in the southern hemisphere after the middle of September.

α CORONÆ A SPECTROSCOPIC BINARY.—Using the 80cm. refractor and the No. 1 spectrograph of the Potsdam Observatory, Prof. Hartmann has determined that the radial velocity of α Coronæ Borealis varies from −20km. (May 28, 1902) to +38km. (June 3, 1902). The observations extended over the period May, 1902–July, 1903, and the respective velocities were determined from measurements of the lines Hβ, Hγ, Hδ, λ 4481 (Mg) and λ 3934 (Ca). The period of the binary is given as about 17 days (*Astronomische Nachrichten*, No. 3890).

THE ALLEGHENY OBSERVATORY.—In his report for 1902 the director, Prof. F. L. O. Wadsworth, laments the fact that the new observatory buildings and their equipments are not yet completed, and especially urges the necessity for mounting and housing the new 30-inch refractor, the discs for which have already been received from Mantois, of Paris; for this purpose a fund of sixty-five thousand dollars is required, none of which is yet subscribed or provided for.

An excellent electrical equipment for lighting and heating, and for all kinds of experimental work, has been donated by Mr. Westinghouse.

An efficient time service was maintained throughout the year 1902 in spite of instrumental difficulties. General observational work has had to be suspended pending the removal to the new observatory. A large number of mathematical researches have already been carried out, and others are suggested for future attention, by the director.

The latter part of the report is devoted to an outline of the work it is proposed to do when the new observatory is in full swing; this work includes exhaustive daily observations of all the solar phenomena and seismographic, gravitational, and magnetic observations.

THE RELATIONS BETWEEN SCIENTIFIC RESEARCH AND CHEMICAL INDUSTRY.[1]

THE particular branch of science with which I have been asked to deal at this meeting of university extension students—viz. chemistry—is perhaps better calculated to illustrate the intimate connection between scientific research and *productive* industry than any other subject. I emphasise the term *productive* industry because it is desirable to distinguish between productiveness and trade, *i.e.* buying and selling. With the latter I have nothing to do beyond pointing out the very obvious principle that, without something to buy or sell, there would be no commerce, and consequently productive industry must be put into the first rank. Now chemical products of various kinds are absolutely indispensable to all civilised nations. You may remember that many years ago Lord Beaconsfield said that the state of trade could be gauged by the price of chemicals. A writer in the *North American Review* in 1899 published an article in which he laid it down that the nation which possessed the best chemists was bound to come to the forefront in the struggle for industrial supremacy. Of course, "there is nothing like leather," and I am bound to agree with him. Had he been an engineer or an electrician he might perhaps have said the same for mechanical or electrical engineering. At any rate, it is perfectly safe to generalise his statement, and to declare that the nation which possesses the most highly trained technologists is bound to take the lead.

In so many ways does chemistry come into contact with nearly every branch of industry that it is difficult to know where to draw the line in giving actual illustrations of the industrial results achieved through chemical research. It is not possible logically, for example, to distinguish between the results obtained through research directed towards the solution of a particular industrial problem and the results obtained as by-products in the course of purely scientific investigation. Industry has been advanced, and always will be advanced, by both methods. Bearing in mind also that chemistry, in its widest sense, is essentially the science of matter—at any rate until the physicist has electrified matter into his own domain—it is evident that we are concerned not only with the production of useful materials for direct consumption, but also with the production of materials required in other industries. Thus chemistry affects engineers through the metals, cements, and other materials used for constructive purposes, and through the fuels used as sources of energy; it affects the agriculturist on account of the relationship between the growing plant and the composition of the soil, as well as through the relationship between the composition of crops and their value as food-stuffs; it supplies materials for the pharmacist, for the manufacture of pottery, glass and soap, for the paper maker, for the dyer and colour-printer, for the bleacher, tanner, brewer and spirit distiller; it furnishes the explosives used in modern warfare, and it supplies photography with all the materials necessary for the practise of that art. Among later developments it may be claimed that the modern science of bacteriology is the outcome of chemical research, and the manufacture of anti-toxins—the industrial result of this science—has until quite recently been in the hands of the chemical manufacturers. I may remind you also that many important products such as sodium, aluminium, phosphorus, calcium carbide, caustic soda, and chlorine are manufactured by electrical processes, so that the demand for these products has given an impetus to the development of applied electricity.

[1] A Lecture delivered at the University Extension Meeting at Oxford on August 3, by Prof. Raphael Meldola, F.R.S.

It is obviously impossible in view of the enormous range of industry in which chemistry is directly or indirectly concerned to do more on the present occasion than take a cursory glance at a few of the more striking cases illustrative of the connection between research and industry. As an example of the creation of an industry through research directed towards a special end, attention may be directed to the manufacture of optical and other glass at Jena. The history of this branch of manufacture, and the results achieved, have been fully described by Dr. Hovestadt in a work published three years ago, and of which a translation, by Prof. and Miss Everett, has been recently published in this country. I must refer you to this work for full particulars. The physical requirements to be complied with in order to produce the most perfect glass for the construction of lenses for optical instruments had long been known, and many attempts had been made to realise these conditions in practice. A visit to the international exhibition of scientific apparatus in London in 1876 led Prof. Abbe to direct attention once again to the fact that the future perfection of the microscope lay with the glassmaker, and in 1881 he, in conjunction with Schott, commenced a set of experiments having for their object the production of a series of glasses of known composition, the optical properties of which were concurrently determined by measurements made by Prof. Abbe. The experimental meltings were enlarged in scale the following year, and an experimental laboratory established for the continuation of the work at Jena. A chemist was added to the staff, and thus there were cooperating in this industrial research a glassmaker, a chemist, and a physicist. Before the end of 1883 the results had been so far successful that the Jena laboratory was in a position to make known to the world the processes for the "rational manufacture of optical glass." At this stage the experimenters were persuaded to put the results of their labour into practice, and the instrument makers, Messrs. Zeiss, having joined in, the Jena glass factory for producing optical glass on the commercial scale was established towards the end of 1884. In the first catalogue published by the Jena Works in 1886, we are told that forty-four optical glasses, nineteen being new in composition, were included. By 1888 the undertaking had been so successful that a supplementary catalogue was issued containing twenty-four additional glasses, of which thirteen were new, and in 1892 a second supplement announced the manufacture of eight more kinds of glass, of which six were new. Consider what this piece of work, prompted by science, fostered by the State, and carried out by a university professor in conjunction with a technologist has done for German industry. In the early stages of the experiments, before commercial results had been obtained, the experimenters were subsidised by the Prussian Education Department and by the Prussian Diet with a wise forethought which subsequent events have amply justified. Need I remind those who have come here to hear about bacteriology from Prof. Sims Woodhead how that science has advanced *pari passu* with the perfecting of the microscopic objective? The Zeiss instruments are now world-renowned, for it is obvious that a command over the processes for making glass with any particular optical properties that might be desired would enable the instrument maker to produce lenses suitable for other purposes, such as telescopes, field-glasses, photographic cameras, &c. I am afraid to dwell too much upon the perfection of the lenses of the Jena instruments because I lay myself open to the charge of holding a brief for a particular firm. If you want to know more fully what this optical glass industry has done for Germany, I refer you to the report on instruments of precision published in connection with the German exhibit at the Paris International Exhibition of 1900. As a further outcome the study of the properties of glasses of known composition in connection with their thermal and electrical behaviour has led to the manufacture of glass especially suitable for making thermometers, as also for electrical insulation, for the construction of the vacuum tubes used for producing Röntgen rays, and for the vessels employed in chemical laboratories. In brief, the manufacture of the finer kinds of glass has been placed upon a strictly scientific footing as the outcome of scientific research.

The next illustration which I propose to make use of refers to the applications of chemistry to agriculture. The growing plant, as you are aware, requires food for its growth just as much as the growing animal. Take an extreme case, and consider the size and weight of an oak tree as compared with the acorn from which it arose. This enormous accumulation of matter represents the assimilation of gaseous food in the form of carbon dioxide from the air through the leaves, and of water and nitrogenous and other mineral matter through the roots. It was the great German chemist Liebig who first established this broad principle of plant growth by systematic experiments upon various crops, and his results were given to the world in a work published in 1840, the English edition, edited by Lyon Playfair (afterwards Lord Playfair), bearing the title "Organic Chemistry in its Applications to Agriculture and Physiology." Perhaps few students consult this work now, but it was, strictly speaking, epoch-making on its appearance, because it brought the chemist into direct relationship with the farmer, and the consequence has been an enormous increase in the food-raising capacity of the soil. It is not necessary to inquire closely here into the motives that prompted Liebig's investigations—whether his work comes under the category of scientific researches directed towards a practical end, or whether he began with a desire of ascertaining abstract truth in the first place, and then found that his results were capable of practical application. It is quite immaterial from the present point of view how this work originated, because we are considering only the bearing of the results upon industry. It is evident that if a growing plant requires certain elements, such as potassium, sodium, phosphorus, nitrogen, calcium, magnesium, sulphur, chlorine, iron, &c., and if the soil by previous crops has been exhausted of some of these elements, it will not be possible to raise subsequent crops on this impoverished soil unless the necessary elements are supplied. In other words, the requisite elements must be added, and added in the form of compounds which the plant can make use of. Thus the great industry of crop-raising, and as connected therewith the feeding of farm stock, was shown to depend ultimately upon the chemical composition of the soil, and the manufacture of artificial manures or fertilisers has been the practical outcome of Liebig's researches.

Let us consider, further, the industrial results so far as these have influenced chemical manufactures. Prof. Warington can tell you all about the agricultural results. The elements which are most likely to fail, and which, in fact, have generally to be supplied, are potassium, phosphorus and nitrogen, excepting, of course, in the case of those particular leguminous plants which have developed a special means of fixing atmospheric nitrogen. Chemistry having thus been called upon to supply the agriculturist with compounds containing potassium, phosphorus and nitrogen, the first development which may be ascribed to Liebig's influence is the Stassfurt salt industry in Prussia, where immense deposits of salts containing potassium were known to exist. Similar deposits are found in Anhalt. The mining of these salts was commenced in 1860, and has proved an immense source of wealth to Germany, the total value of the Stassfurt and Anhalt salts produced down to 1890 being estimated at 11,500,000*l.*, and since that time the output has gone on increasing from year to year. It is not necessary to weary you with statistics, but it is important to note how the demand for potassium salts for agricultural purposes has given rise to a great industry, for the natural salts, consisting chiefly of carnallite, a double chloride of potassium and magnesium and kainite, a double sulphate of potassium and magnesium with magnesium chloride, have to be submitted to various processes in order to separate the constituents, and the Stassfurt salt factories are now supplying Germany, as well as exporting large quantities of potassium chloride and sulphate, magnesium chloride and sulphate, potassium carbonate, caustic potash, &c.

In a similar way the demand for phosphates has given rise to the utilisation of every available source of these compounds. Calcium phosphate is found as the mineral apatite, a double calcium phosphate and chloride or fluoride occurring in vast deposits in America, and also in a less definite form in Canada, the West Indies, France, Belgium and Germany. In this country calcium phosphate occurs in the form of coprolites, supposed to be the excreta of extinct saurians, in Cambridgeshire and elsewhere. All these natural phosphatic mineral deposits are mined, and have become valuable assets to the countries possessing them. The conversion of the minerals into a form suitable for the nutrition of crops is a branch of chemical industry involving the use of sulphuric acid for the conversion of the natural phosphate into the more easily assimilable form known as superphosphate. The greater part of the world's output of natural phosphates finds its way to Germany to undergo this treatment, the annual consumption of artificial manure in that country being estimated at something more than two million tons at a cost of about 5,000,000*l*. The mineral portion of the bones of animals, as you are no doubt aware, also consists largely of calcium phosphate, and before the mining of the mineral phosphates the conversion of bone ash into superphosphate was carried on on a very large scale. Bone ash is supplied now in large quantities from South America, but not much is converted into superphosphate, as the bones, after removal of the fat and the size (for glue), are capable of being finely ground, and are available for manure in this form.

Here is surely a romance of chemistry! The phosphates contained in the vegetation of the South American pampas go to build up the bony framework of the cattle which graze thereon. The skeletons of these beasts ultimately supply, let us say, the growing crop of a beet sugar manufacturer in Germany with phosphates. The phosphates picked out of the soil by South American vegetation concentrate in the bones of cattle, and are then sent into circulation in German beet. Or, even more striking, the phosphates accumulated by the great lizards of a remote geological age are now circulating through growing crops. This circulation of matter through the intervention of the living organism is an every-day story to the chemist. To our greatest poet apparently it was also known :—

> "Imperious Cæsar, dead and turn'd to clay,
> Might stop a hole to keep the wind away:
> O, that that earth which kept the world in awe,
> Should patch a wall to expel the winter's flaw!"

But we must descend from romance to reality. The deposits of sea birds also contain phosphates derived from the fish upon which they feed, and these deposits often accumulate in such large quantities as to make them available for agricultural purposes. Under the name of guano, immense quantities of this material, which contains both phosphates and nitrogenous matter, are exported from Peru. There is subject-matter for philosophising here, also, about the circulation of phosphates from marine organisms through birds into growing crops, and so forth, but time will not admit of many side disquisitions if I am to keep to my text. As another source of phosphate, it is of interest to know that the basic slag obtained in the Thomas-Gilchrist process of making steel is now largely used, so that the work set going by Liebig has, among its latest developments, led to the utilisation of a waste product of the steel industry.

Excepting in the case of leguminous plants, which are capable of utilising atmospheric nitrogen by a process which it does not come within my province to explain, the ordinary source of nitrogen for growing plants is a soluble nitrate, and if the soil is poor in such salts, they must be supplied either directly or indirectly through salts of ammonia, which are converted into nitrates in the soil by bacterial action in a way that nobody is better able to explain to you than Prof. Warington. The great natural deposits of sodium nitrate which occur in Chile and Peru supply practically all the nitrogen applied to the soil in this form for fertilising purposes. With respect to ammonia, the destructive distillation of coal for the manufacture of gas and tar products, or for the production of coke, furnishes practically all the salts of this base required for agricultural and other purposes. The vital importance of assimilable nitrogen to growing crops has led the chemist also to study methods for the fixation of atmospheric nitrogen so as to render this element available for such purposes. It has long been known that nitrogen and oxygen can be made to combine under the influence of the electric spark. This, as you may remember, is one of the methods used by Cavendish in his classical researches on the composition of the air, and it was used also by Lord Rayleigh to separate atmospheric nitrogen from argon. Sir William Crookes has shown that the combustion can be brought about by the electric flame with such facility as to render the production of nitrite and nitrate by this process an industrial possibility, and the manufacture has actually been started in America by utilising the Falls of Niagara for the generation of the necessary electric power. Still more recently it has been found by Caro and Frank that when lime and coal are heated in the electric furnace, the calcium carbide fixes atmospheric nitrogen to form a compound known as calcium cyanamide, and this decomposes in the soil with the liberation of ammonia, so that the nitrogen of the air is thus rendered available for plant nutrition by an electrochemical process. The manufacture of this "Kalkstickstoff" is in the hands of the electrical engineering firm of Siemens and Halske, in Berlin.

There has been no straining of facts on my part in this sketch—necessarily brief—of the industrial results of Liebig's work. The establishment of the fundamental truths was a piece of pure scientific research. Had it not been made known by the irrefragable proofs furnished by scientific method that such and such elements were essential for plant growth, the mineral resources of the earth would have remained unused for this purpose. The minute percentage of nitrogen locked up in the fossilised vegetation of the Carboniferous period would never have been isolated in the form of ammonia and applied to the soil for the nourishment of the crops raised by the present day agriculturist. The successful cultivation of the beet as a source of sugar has been made possible by this knowledge, and it may be of interest to add that the further scientific study of the cultivation of that root in Germany has led to the yield of sugar being increased from $5\frac{3}{4}$ to 13 per cent. during the period commencing about the year 1840 and ending at the present time. The economic result of this industry upon our own sugar-growing colonies is a fiscal question which does not come within the province of this address.

Equally instructive as illustrating the connection between scientific research and industry is the production of alcohol and other valuable products through the agency of living organisms. The spontaneous conversion of saccharine solutions, such as the juice of the grape, into solutions containing alcohol, with the concurrent development of gaseous carbon dioxide, is among the earliest recorded observations in applied organic chemistry. The various theories which were from time to time advanced to explain what is called "fermentation" are now of historical interest only. It is to the researches of Pasteur that we are indebted for the placing of the fermentation industries on a scientific foundation. This illustrious chemist, who as far back as 1860–62 had successfully disproved the so-called "spontaneous generation" by showing that the ordinary air was always charged with living germs, turned his attention to the diseases of wine, with the object of assisting an industry of great national importance in France. His "Études sur le Vin" was published in 1872. A greater work—the great classic of the science of fermentation—appeared in 1876 under the title "Études sur la Bière." In this work it was definitely proved that the transformation of sugar into alcohol is a biochemical change; that the yeast which produces this change, and of which the organised nature had long previously been suspected, is, in fact, a low form of vegetable life allied to the fungi, and that it multiplies and grows at the expense of the sugar and other materials contained in the fermenting liquid, the alcohol and carbon dioxide being the products of its activity. It is now known, through the work of Buchner, that this chemical transformation of sugar into carbon dioxide and alcohol is the result of interaction between the sugar and a certain definite substance—an unorganised ferment—which is formed by the living yeast cell, and which can do its work independently of the cell in which it originated.

The scientific development of the fermentation industries followed from this and other work of Pasteur's. The names of those who have taken part in these later developments are numerous and illustrious, but want of time prohibits a detailed survey of this most fascinating chapter of biochemistry. The leading idea that the formation of alcohol is a biochemical process depending upon certain organisms, or, as we may now say, upon the products of certain organisms, carries with it, as a necessary consequence, the conclusion that the industrial production of alcohol—whether for brewing or spirit distilling, or for the chemical manufacturer—is not an empirical or rule-of-thumb operation depending upon unknown conditions, but a definite chemical change produced in a definite way by a definite organism (yeast), and just as much under control as any other chemical operation. The chemist and the brewer have thus also been brought into association. The recognition that definite chemical transformations can be effected by microscopic forms of life which resulted from Pasteur's studies in wine and beer has had such far-reaching consequences that it is impossible to overestimate the importance of this work for the well-being of humanity. I should be encroaching upon the domain of Prof. Sims Woodhead were I to do more than remind you of the growth of that modern science—the most humanitarian of all the sciences—bacteriology, out of this fundamental conception. Keeping to the main topic of industrial results, one outcome has been, as I have said, to bring the operations of the brewer under scientific control. The organism, the yeast introduced into the vat to induce fermentation, must undergo careful microscopic examination to see that it contains no deleterious organisms, *i.e.* no organisms which would give rise to products other than alcohol. The water used by the brewer must be analysed to ascertain whether it contains the necessary mineral constituents for the nourishment of the yeast, because this plant is subject to the same conditions of growth as any other plant. Instead of obtaining its carbon from carbon dioxide, however, it can utilise sugar for this purpose, and it decomposes the sugar into carbon dioxide and alcohol in the way indicated.

The recognition of yeast as a vital chemical reagent which is apt to contain impurities in the form of wild or stray organisms which may damage the contents of the brewing vat, has led further to the introduction of the process of brewing by what is known as "pure culture yeast." This industry, of which the home is chiefly on the Continent, depends on the use of a yeast cultivated in the first place from a single cell of some particular species or variety or race by methods similar in principle to those adopted by the bacteriologist, the cultivation being carried on from generation to generation in carefully prepared solutions containing the necessary nutrient materials, sugar, nitrogenous matter, mineral salts, &c., and previously sterilised by heat so as to destroy every other form of life. The brewer can now be supplied, as the outcome of a series of brilliant investigations by Hansen, of Copenhagen, to whom he is indebted for this purification of the biological foundation of his industry, with a cultivated yeast as pure in strain as a pedigree horse or a particular breed of dog—a yeast which, by virtue of its purity, can be depended on for giving constant results in the brewing vat. This is another illustration of the relationship between research and industry.

Consider, in the next place, the sugar which the yeast decomposes by virtue of its zymase. In an ordinary brewing operation the liquor which is fermented is not supplied in the first place with sugar as such, but the starch contained in the barley grain is ultimately broken down, as chemists say, into sugar by virtue of certain processes which I cannot stop to explain. But the broad fact is that yeast cannot feed upon starch, but only upon sugar, and, in fact, only upon certain kinds of sugars, and the starch which is stored up in the barley is the raw material which ultimately supplies the necessary kind of sugar. So that starch, which, as you know, is a substance very widely distributed in the vegetable kingdom, can be extracted if necessary from the seeds or tubers which contain it, and converted into sugar by chemical processes, and then used for the production of alcohol. An important industry is flourishing in Germany at the present time for the production of alcohol from potato-starch. In Berlin a few weeks ago we were shown over a large establishment entirely devoted to the fermentation industries, and potato spirit and other products from the potato were the most conspicuous features of the exhibition. Now alcohol is a substance of great importance for chemical industry in many directions, and its inflammability makes it valuable as a fuel, so that the problem of the cheap production of alcohol is worthy of the serious attention of investigators. It is interesting to contemplate the period when our natural sources of fuel, coal and petroleum, are all exhausted, and when we may have to fall back upon the vital activity of a lowly form of vegetable life to supply us with liquid fuel. Scientific research has helped here, also, to call a new industry into existence, because the cost of alcohol, like that of any other chemical product, is obviously dependent upon the yield, *i.e.* upon the quantity obtainable from a given weight of raw material. I must claim your indulgence while I trace in brief outline one of the most beautiful of the modern industrial developments of the principles of fermentation.

It had long been known that in Java an alcoholic beverage, known as arrack, was prepared by fermenting molasses with a peculiar ferment prepared by a special process from rice. From what has been previously said, you will understand that the starch contained in rice is not, as such, available for direct alcoholic fermentation. A detailed scientific investigation of the starch-fermenting materials used in Java and elsewhere in the Far East has revealed the fact that these ferments owe their activity to the joint action of two out of several different organisms which are contained in them. One of these is a mould fungus which has the property of saccharifying starch, *i.e.* breaking it down into sugar, and thus rendering it available for the growth of the other organism, which is a yeast capable of exciting alcoholic fermentation in the usual way. Now the principle revealed by the scientific study of these eastern ferments has been developed into an industrial process for producing alcohol from starch of any origin, such as from maize, rice, potato, &c. The operations, in the briefest possible terms, consist in saccharifying the prepared starch by a pure culture of mould fungus, and then fermenting by means of yeast. The problem of increasing the yield of alcohol has thus been solved; not only is the spirit obtained in more concentrated form, but the actual percentage of alcohol furnished by a given weight of starch is much greater than has ever been obtained by any of the older processes of fermentation.

I have left but little time for dealing with an industry with which I have had long personal connection—the manufacture of colouring matters and other products from coal tar. The relations between scientific research and this industry are so intimate, and are so frequently referred to in public, that it has become a kind of stock example for the use of those who wish to emphasise the interdependence of science and industry. The history of this industry, moreover, is particularly instructive from our present point of view, because it originated in this country in 1858 and flourished here for a period of about twenty years, and then began to decline. The chief centre of activity for the production of coal tar products at the present time is Germany, where there are six large factories and a number of smaller ones. The aggregate capital of the six large factories amounts to some 3,000,000*l.*, and they give employment to about 20,000 people, including chemists, engineers, clerks and travellers, dyers and draughtsmen, workmen, &c. These large firms pay dividends varying between 5 and 25 per cent. upon their capital. The total value of the tar products manufactured in Germany exceeds 10,000,000*l.* annually, and she supplies by far the largest proportion of the dye-stuffs used throughout the world. When, in 1886, I proclaimed our approaching fate with respect to this industry, I found that we were then using about 90 per cent. of German and other foreign colouring matters in this country, and my friend, Prof. Arthur Green, of the Yorkshire College, finds that things are in about the same state at the present time.

The coal tar colour industry arose, in the first place, from an observation made by Dr. W. H. Perkin in 1856 in the course of a research having for its object the synthesis of quinine. He did not succeed in producing the alkaloid, but he noticed that aniline, when oxidised, gave a colouring matter, which he manufactured and introduced under the name of "mauve," and so laid the foundations of an industry which has developed to its present colossal dimensions. The art of the dyer and calico-printer has been absolutely revolutionised by the introduction of the synthetical colouring matters prepared from coal tar. Of these more than 500 are now available—each one a distinct and definite chemical compound with characteristic colour; each one with properties rendering it suitable for application to particular classes of fabrics. Every range of colour, including the deepest black, can be imparted, and every degree of brilliancy or dullness, of fastness to light, to washing and bleaching agents, &c., can be realised as required. The natural dye-stuffs, such as madder, which supplied alizarin for Turkey red; the cochineal insect, which furnished a red dye; the lichens and dyewoods, which were used by the old-time dyers, have been displaced, or are on the way to displacement, by the tar products. The most important of all the natural colouring matters, indigo, is, as you know, among the latest of the achievements of industrial synthetical chemistry, and a great industry worth some 3,000,000*l.* annually to our Indian Empire is threatened with extermination by the German manufacturers. Not a month passes without the introduction of new colouring matters, and so enterprising are the German colour makers that their pattern-books are issued with full directions in various languages, and trained chemists in their service will give personal instructions to our dyers in the application of new and unfamiliar colouring matters.

It is impossible to do more than allude in passing to the enormous influence of this greatest and most refined of all the chemical industries upon every other department of chemical manufacture. It has reacted, and is reacting, with ever multiplying ramifications upon the manufacture of the raw materials such as acids and alkalis, it is revolutionising the methods for producing sulphuric acid, it is pressing into its service electrolytic processes, and it has created new branches of engineering for the construction of special plant and machinery. The utilisation of the infinity of compounds present in the tar is no longer restricted to the production of colouring matters. Valuable medicinal preparations, photographic materials, perfumes, antiseptics, the sweet-tasting saccharin, which is 300 times sweeter than sugar, an artificial musk which exceeds in intensity of odour any natural musk, are among the manufactured products from coal tar. The industry is the direct outcome of scientific research; it has been developed by research, and is being still developed by research. Both methods referred to in this address have been, and are, at work. The by-results of pure scientific investigation are seized upon whenever they show the slightest chance of being industrially useful. Saccharin is such a by-result. The chemical reactions which culminated in the industrial production of indigo were published by their discoverer, the late Dr. Heumann, as an academic discovery in the first place, and were developed industrially by the "Badische Anilin und Soda Fabrik" of Ludwigshafen. By the other method whole armies of highly trained scientific chemists are constantly at work in the splendidly equipped research laboratories of the German factories investigating new products and processes with the direct object of their ultimate industrial application. Nor must it be forgotten that under the term "research" used in this connection is comprised also theoretical research. A close study of the history of this industry will show how throughout it has been vitalised by theoretical conceptions concerning the chemical structure of the molecules of organic compounds, and especially by the so-called benzene ring theory of Kekulé, now so familiar to chemical students. The force of illustration of the connection between science and industry can, perhaps, go no further than in this case, where a purely abstract conception based on a knowledge of the properties of the atom of carbon has reacted upon a branch of manufacture to its lasting benefit.

I have thought it best to limit my treatment to the record of bare facts in order to bring home to you in a concrete way how chemical industry and chemical research are interdependent. Four groups of industries have been dealt with; it would have been easy to subdivide the subject and to deal with four dozen. I must confess that I am getting rather tired of what may be called the platform treatment of education in applied science, which consists in general of the purely clerical or office-boy work of compiling information—doubtless very valuable in its way—concerning the number of schools in foreign countries, the acreage of land which they cover, their cubic contents, cost of erection and maintenance, the number of professors and staff, and the number of students which they turn out annually. The reason why this kind of information is getting stale and wearisome is because it produced at first no effect at all in this country, and then it led to a reckless expenditure in bricks and mortar, and the starting of institutions which are inadequately endowed, insufficiently maintained, and altogether lower in their working capabilities than the continental institutions which prompted their foundation. I thought, therefore, that it might be more acceptable if, instead of dealing with the usual generalities of the statistical order, I sketched the history of a few specific industries. If it appears that Germany has played a very prominent part in these histories, all I can say is that there has been no intentional selection on my part, but it is entirely due to the circumstance that it is to that country more than to any other that industry owes its advancement by scientific method. The preeminence of Germany in chemical industry is sufficiently notorious, as our own manufacturers know to their cost. The most striking feature of the exhibition at Paris in 1900, when, as a member of the International Jury for Chemical Products, I had occasion to examine the exhibits of all countries, was the collective exhibit of chemical products displayed by some ninety German firms. This splendid collection, which revealed more than anything the enormous advances made in chemical industry by Germany, is now deposited in a special building in the grounds of the Technical High School at Charlottenburg.

So much has been said and written about the causes of this wonderful development of German chemical manufactures that I hesitate to add anything more to the discussion. Certainly it is not possible to add anything new. Those who, like Prof. Michael Sadler and Dr. Rose, have made a special study of German educational systems have placed before the public valuable reports in which these causes are fully discussed from the educational point of view.[1] In the official report to the French Government on the products of Class 87, Prof. Haller, the secretary to our jury and author of the report, has devoted a whole section to the "Causes de la Prospérité de l'Industrie chimique Allemande." The general conclusion to which we have all come concerning this remarkable industrial development is that it is mainly due to the higher educational level in Germany with respect more especially to the highest scientific instruction in the universities and technical high schools. It is perhaps permissible to go one stage further back, and to say that this advanced scientific education is in itself the expression of the public faith in such education, and the recognition by the State of the industrial value of such training. It has been well pointed out that the money invested by the German nation in founding and maintaining the chemical chairs at the universities and technical high schools is now worth some 50,000,000*l.* annually to the country in this branch of industry alone. More especially, also, it may be claimed that the recognition of the value—the indispensable value—of scientific research to industry by the manufacturers themselves has been one of the most potent factors in developing German chemical industry, and the lack of such appreciation on the part of our own manufacturers has been one of the chief causes of their decadence.

In so far as the subject under consideration is an educational one, it comes within the province of a gathering of students held under the auspices of the most ancient seats of learning in this country. At any rate, the topic is one of such supreme importance to the welfare of this nation that I could not resist the invitation to take part in your proceedings, because the question is one which has been for years undergoing the most serious consideration by those who have, like myself, been connected on the one

[1] See especially vol. ix. of the special reports issued by the Board of Education, entitled "Education in Germany," by Prof. Sadler. Also Dr. Rose's diplomatic and Consular reports, issued by the Foreign Office, No. 561, "Chemical Instruction and Chemical Industries in Germany"; No. 591, "German Technical High Schools"; No. 594, "Agricultural Instruction in Germany and the Development of German Agriculture and Agricultural Industries."

hand with manufacturing industry and on the other hand with the teaching of science. Whether the old universities are desirous of making a new departure and of enlarging their spheres of activity so as to bring them more into harmony with the practical requirements of the age I have no authority to discuss. Certainly Cambridge, by the establishment of departments of engineering and agriculture, has made a distinct advance in this direction. At any rate, it may be taken as a sign of the times that the relationship between science and industry has been made a special feature of this year's university extension meeting, and the outer world will no doubt take due cognisance of the circumstance that a subject has been chosen for consideration which, in this country, is generally considered quite remote from the higher ideals of university education.

It is evident from what has long been going on in Germany and America, and from what is now taking place with regard to education by our newer universities here, that applied science is, or can be, brought within the province of university education. Of course, if the view be held that science is degraded by being turned to practical account, then we must not look to the universities for the training of our industrial leaders. It is impossible, however, to note the progress of events since the coalescence of science and industry abroad without coming to the conclusion that the position of a nation in the scale of civilisation will be measured in the future by its productive energy —by the capacity of its workers to evolve new ideas and to carry them out practically; by the number, zeal and originality of its scientific workers, and by their mastery over the resources of nature. I do not mean to imply that the old universities have done nothing towards the education of scientific thinkers and workers. What strikes outsiders like myself is the very small part that these universities are taking in the modern equipment of the great industrial army of Britain as compared with the work being done by foreign universities for their respective countries. In view of the industrial struggle between nations which has arisen through the discoveries of modern science—a struggle which is bound to become keener with the progress of science—it cannot be seriously maintained that the material welfare of our country is beneath the dignity of even the most profound academic scholar. The old definition of a university as an educational centre for the cultivation of useless knowledge no longer holds good. If there are universities which still cling to this tradition concerning their functions, it may safely be predicted that their influence in moulding the future life of the nation is destined to shrink to smaller and smaller dimensions.

The part played by the German universities and technical high schools in the training of technologists is now so well known in this country that a detailed restatement of the facts is hardly necessary. I may remind you that their twenty universities, with foundations dating from the fourteenth to the beginning of the nineteenth century, for many years supplied the factories with men thoroughly trained in science, and capable of applying their knowledge to industrial processes. With the development of manufacturing industry along scientific lines it was found necessary to provide more specialised education, and during the first half of the nineteenth century trade schools or polytechnics were called into existence in nine different centres. Of course, you know that our polytechnics here have very little analogy with the German institutions of that name. The polytechnics were in time found inadequate to meet the growing requirements of German industrial training, and their functions were accordingly enlarged and their educational status raised. Out of these nine polytechnics or trade schools have arisen nine technical high schools, and two more such schools are now in course of erection. Thus in Germany both universities and technical high schools are catering for the scientific needs of the national industries. I may add that a few years ago there was a serious discussion in Germany among certain educational bodies and industrial organisations as to whether the State should not be asked further to strengthen the scientific faculties of the universities by creating chairs of technical or applied chemistry, and although there has been no practical outcome of this movement as yet, it is an instructive illustration of the spirit which is abroad in that country.

There is very much misapprehension here concerning the nature and functions of the German technical high schools. They are not glorified polytechnics of our own type for teaching handicrafts to artisans or smatterings of science to ill-prepared students. They are institutions of university rank—their education is of university standard, and their professors stand on a level with the professors of the universities. Their students are not admitted until they have reached a high standard of general secondary education. Their courses of instruction are as purely scientific as the university courses, and the only difference between the two kinds of education is that the technical high school is all scientific, and the various sciences are taught both theoretically and practically with a view to their ultimate industrial applications. It is a "technical education" in the highest and best sense, and not in the narrow—I may even say degraded—sense in which the term is so frequently used in this country.

The question of the hour which the old universities have now to face is whether they are willing to take part in the newer education required by our industrial leaders, whether they are prepared to strengthen and develop the teaching of those physical sciences which underlie productive industry, and to recognise the claims of the applied sciences as subjects worthy of inclusion in their curricula. There will, of course, be a divergence of opinion with regard to this question. There will be the old, old conflict between the advocates of the "humanising" influence of the ancient classical studies and the supporters of modern scientific education. So far as my opinions are worth anything, I cannot see, and I never could see, why a study of nature at first hand should be less "humanising" than the study of those classical subjects which have so long held the field. I admit that the teaching of the physical sciences as they should be taught at the present time in any institution of university rank is more costly—that the equipment consists of something more than a library, and that their teachers, to be effective, should be themselves active investigators, inspiring originality and a desire for creating new knowledge in their students. I can understand that a subject which to the classical don wears the aspect of a financial ogre should be kept down as long as he has a preponderating influence in regulating the affairs of his university. But this is a matter of expediency, and not a real conflict between fundamental principles. I cannot find that the classical teaching of the American or German universities has been impaired by the splendid development of their scientific faculties; neither does it appear that the human products of their scientific activities are in the least degree inferior as men to their classical scholars. Of course, I am a special pleader, and I am making the best use of my opportunities, and I repeat that I never could see where any antagonism existed between the older and the newer studies excepting in the struggle for financial means. There are many educational authorities here and abroad who will tell you that the scientific development of the German universities has reacted upon and improved the classical teaching by an infusion of scientific method into the latter. Moreover, it must be remembered that we who are advocates for the new education are not clamouring, as many people think, for the abolition of the old studies, I for one should deplore any falling off in the prestige of the old universities as seats of classical learning. Neither is it suggested that our future leaders of industry would never at any period of their studies derive benefit from that particular kind of culture which the ancient literature is capable of imparting. I firmly believe they would; but the question as to when and how would open up the whole field of education, elementary, secondary, and university, both pre- and post-graduate, and I should find myself floundering among shoals and quicksands in no time. The ideal university is one that offers facilities for both the older and the newer education; they are not mutually exclusive—they can, and do, thrive side by side elsewhere, and there is no reason, at any rate no theoretical reason, why they should not do so here.

The form in which the question may be put is therefore whether, given the means, the older universities should develop their work in the direction of applied science. A large body—I cannot say how many—of outsiders who are well-wishers of these universities is of opinion that they should, and there is an idea abroad that they are suffering financially now from having neglected this side of education in the past. There was, for example, a leading article in the *Times* of May 25 in the course of which the writer suggests that they may have suffered through having a false reputation for being very wealthy bodies, and he adds:—"Or is it perchance, because the modern millionaire, being a man of his age and an Englishman to boot, has no great belief in the economic value of knowledge as such, and no great confidence in the capacity of our ancient universities to adapt themselves to the needs of the coming time?" Now, so far as the chemical manufacturers of this country are concerned, I can say with some personal experiences of my own that they certainly have shown no great belief hitherto in the economic value of scientific knowledge, as they now know to their own cost. But if, to make a purely hypothetical conjecture, some beneficent millionaire were to test the capacity of our old universities for undertaking this kind of work, and were to offer adequate means for the purpose, I feel pretty confident, from what I know of the spirit which dominates their governing bodies, that such an offer would be accepted both at Cambridge and here at Oxford with few dissentients. If such a departure were placed within their power, I think that that great public which glories in the past achievements of these universities would rejoice in their new development. And I will further add that the creation of chairs of applied science would react upon and strengthen the teaching of all those sciences which are in any way connected with industrial productiveness.

Of course, this is all hypothesis—the most nebulous of hypotheses. We all know, unfortunately, that the financial resources of the universities have been, and are, inadequate for the purpose of enabling them to meet the requirements of modern scientific education, either in the way of staff, accommodation, or equipment. It can be said, and justly said, that so long as these universities are without the means of developing their schools of pure physical science to an extent worthy of their reputation, it is useless to talk about developing the teaching of applied science. So it may be. But I remind you that we are still in the region of hypothesis, and the captious critic might retort by saying that they have not done even as much as they might, and could, have done for the proper development of scientific teaching with the means already at their disposal—that they are still overweighted by ancient tradition, and that their internal scientific forces are still feeble as compared with the preponderating forces of the advocates of the older culture. There is no time, even if I knew enough about the inner mechanism of university administration, to discuss this aspect of the question, but if you want to know an American view of the case—a strong view!—I would invite attention to an address by Prof. Victor Alderson, Dean of the Armour Institute of Technology, delivered before the Chicago Literary Club in October last year, an abstract of which was published in NATURE of February 12.

The question of the recognition of applied science by our old universities must, as I said, be faced—the time is at hand for them to consider seriously whether it is desirable that they should cater for the training of those who are destined to be the founders and upholders of our national prosperity. The longer this question is shelved the smaller will grow the chances of their being able to participate in the work. At present we in this country are not up to the German level so far as concerns the higher technical training of industrial leaders. Our universities, in other words, have not yet had to encounter the full force of competition with newer institutions of the rank of the technical high schools. We have but very few, if any, schools of this status here now, but if I read the signs of the times correctly, the differentiation between the old and the new education—which has already become well marked—is bound with the progress of science to become more and more strongly pronounced. Our newer universities—especially those in large manufacturing centres—will be driven more and more into the teaching of applied science, and our polytechnics and technical colleges will perforce have to raise their educational standard. The effect cannot but be to cause the older universities to become of smaller importance in the general scheme of national education as time goes on. That is why I have taken advantage of the opportunity which has been placed in my hands for raising this note of alarm, because even if nothing practical results from this meeting, it may at any rate be useful to let it be known that many of us desire to see the most ancient and the most renowned of our educational foundations doing more for the education of a nation the prosperity of which is so largely dependent on productive industry.

Whether as the outcome of the lectures delivered and the conferences held during this meeting the attitude of the universities towards applied science undergoes modification or not, the ventilation of opinions cannot but be of advantage in many ways. If, for example, it is made manifest that the current of national thought is moving slowly—alas! very slowly—towards the recognition of science as the main factor of industrial progress, it may help to emphasise the necessity for strengthening and developing the teaching of pure science. If the beneficent millionaires are not forthcoming for the purpose of endowing applied science, there is, at any rate, ample scope for their beneficence in the endowment of pure science in our old universities. A school of active science workers would—to use a quasi-scientific expression found in the pages of many writers of fiction—"galvanise into life" the science teaching of the schools. If you can only help to mould the public mind into the belief that science is a living reality veiling truths of inestimable value to humanity from every point of view, moral, social and material—truths that are to be wrested only by conscientious, laborious and persistent *research*—you will be assisting a great cause. If you will proclaim this doctrine from the house-tops and assist in sweeping away that dust heap of formal text-book knowledge which passes for science in our examination rooms you will be doing something towards raising the general level of opinion in this country. We need it badly! Think of all the creative intellectual power running to waste—the unrealised assets in the way of originality of thought which Great Britain might have at her disposal if the brain power of her teachers and students were only diverted into the right channels. The old universities, by virtue of their prestige, their traditions, and their past achievements, have still a powerful hold upon the public mind. They must open their doors still more widely to science if they wish to retain their hold. If their means are at present insufficient to enable them to meet the requirements of the age, they can still forward the national cause by upholding the dignity of science, by insisting upon originality of thought as an essential qualification for its successful teaching, and by helping to dispel the notion that it undergoes degradation by being applied to human welfare. It must be realised, and it cannot be realised too soon, that the peaceful campaign of industrial competition requires leaders well trained in scientific method, and not crammed with mere formal book learning—men as alert in mind and resourceful in meeting difficulties, as upright in principle, as keen in enthusiasm, as far-seeing in imagination, and with as intimate a knowledge of human nature as the statesmen, warriors, divines, lawyers, and schoolmasters which these old universities have given to their country. The victory of the future is with that nation which enables her children to approximate more closely towards Tennyson's ideal:—

"... the crowning race
Of those that eye to eye shall look
On knowledge; under whose command
Is Earth and Earth's; and in their hand
Is Nature like an open book."

IRRIGATION WORKS.

INDIA.

IN a recent number of the *Revue générale des Sciences* is an article on irrigation in India which is interesting as showing the impression made on the mind of a foreigner after an inspection of the great works that have been carried out under the British administration for mitigating the effects of famines and improving the condition of agriculture. In a report published a few years ago by Mr. Deakin, the Minister of Water Supply in Victoria, under the title of "Irrigated India," Mr. Deakin stated that, in his opinion, after an inspection of the irrigation works in Italy, Egypt and America, he was satisfied that there was no canal system in the world that could hold comparison with that of India, and expressed his surprise that so little was known of it. The area of land irrigated in India by canals amounts to about 30 millions of acres, six times that of Egypt, and nearly double that of the whole of the rest of the world. M. Chailley Bert, the writer of the article under notice, after spending considerable time in inspecting the various irrigation works, seems to have come to very much the same conclusion. He expresses his opinion that, after the principles of the general administration of the country, and the conduct of the English in India, there is nothing of more interest and more worthy of observation than the system of irrigation, the methods pursued in carrying out the works, and the results that are obtained.

From all time there has existed a close relation in India between famine and irrigation. The ancient rulers of India have left everywhere traces of the great works which they had carried out for overcoming the want of rain and providing against the constant recurrence of famines; and since the English administration irrigation has been forced to the front by the terrible famines which periodically visit a portion of this vast territory, in every instance caused by deficient rainfall, which sometimes lasts for two or three consecutive years. The great famine of 1837 in Bengal led to the project of the Ganges Canal, which has now 5500 miles of main canals and branches; that of 1853 to the works at Madras; that of 1859 to the works in the north-west. The famine which desolated Orissa and the north of India in 1864, when a million of the inhabitants lost their lives by starvation notwithstanding the expenditure of 1½ millions of pounds in combating the famine, and also more than 3 millions in works of irrigation, resulted in the policy of systematically carrying out extraordinary public works by which it was contemplated to spend half a million a year in developing irrigation for the purpose of preventing the recurrence of these terrible disasters. During the terrible famine of 1876, for which a large relief fund was raised, 5¼ millions of lives were lost, although the Indian Government expended 11 millions in relief.

The rainfall of India is very various, amounting to 200 inches in a year in some districts, while in others the fall does not amount to more than from 2 to 10 inches; and over a vast area the land is dry and sterile, except where the rivers have been canalised, or the rain coming from the mountains has been caught and stored in reservoirs.

The peasants inhabiting these districts are described as being utterly improvident, and population goes on increasing at an enormous rate. The dry and unfertile years find them without any resources, and when famine comes untold misery ensues, and the population is decimated by starvation and death.

A vivid description is given by M. Chailley Bert of the irrigation works undertaken for the relief of the inhabitants in the great famine of 1901 in the Presidency of Bombay. Here five camps were established where provision was made for 10,000 people who were engaged in the construction of a reservoir. To this camp came a mass of people of all ages and conditions, old men, women, and children, besides the actual work people, driven from their homes by misery and starvation. To deal with this multitude a complete system of feeding and hospital requirements, sanitation and the care of children had to be provided, while all the able-bodied were organised into an army of workers. The writer says that no description can correctly give an idea of the complete system of organisation and order of this installation, and he seemed to be greatly impressed with the fact that the whole management was carried out by native functionaries under the direction of a single English engineer, with the occasional visits of the collector of the district and his assistants.

It is pointed out in the article that irrigation, besides providing a means of meeting the sterility due to the absence of rain, adds very greatly to the fertility of the land, in some cases doubling, and in others increasing the yield fourfold, and increasing the value of the land from 2*l*. or 3*l*. an acre to ten or twelve times that amount. Irrigation also permits the cultivation of the more valuable crops, such as rice, wheat, sugar cane, and indigo, and it also leads to other works which assist in the mitigation of famines, such as roads and railways for the conveyance of the produce of the irrigated lands.

The Indian Government has already expended upwards of 23 millions sterling on irrigation works, providing water for 13 millions of acres at an average cost of 35*s*. an acre.

SOUTH AFRICA.

At the meeting of the South African Science Association held in May last, amongst other subjects discussed, the most important in the interests of the country was that relating to irrigation, which Sir Charles Metcalfe described as the most prominent question of the day. In a paper read by Mr. Westhofen, the author stated that, owing to the insufficiency and uncertainty in the distribution of the rainfall, it was absolutely necessary that irrigation should be resorted to if the country is ever to be made a self-supporting one. Thousands of square miles of the most fertile land are lying waste owing to the want of this most essential adjunct to agriculture. The institution of a proper system of irrigation has hitherto been hindered by want of capital, want of experience, and ignorance of the best methods of storing water and applying it to the greatest advantage. Irrigation is no new thing in Africa. In Rhodesia there exist the remains of ancient works, and for miles and miles may be seen the traces of skilfully engineered irrigation canals. No information exists as to who carried out these works. In a rude way the natives of the Zambesi at the present day obtain from two to three crops off their land by employing a simple system of irrigation. As an example of what might be done, and as a public object lesson, a large reservoir containing 1000 million gallons of water was constructed by Mr. Rhodes at Matapos, the water in which is held up by an earthwork dam 100 feet high.

While thousands of acres of fertile land are lying waste in Africa for want of irrigation, food to the value of 2½ millions of pounds is imported through Cape Town.

Before an efficient system of irrigation can be organised, legislation is required to define the water rights. Sir W. Willcocks, in his report on the subject, suggested that all rivers and streams should be proclaimed as public domain and become the property of the nation.

The forestry of the country was also dealt with in a paper by Mr. D. E. Hutchins, who showed that while at one time there is evidence that Africa was a well-wooded country, the forests of to-day consist generally of nothing but stunted evergreen trees confined to sheltered kloofs. There are now, however, Government forests worked systematically by the Forest Department, but so scarce is the supply that the imports of commercial timber amount to half a million pounds. It was stated that the special sleeper plantations established by the Cape Government Railways cost 60,000*l*., and that in twenty-five years they were estimated to bring in a revenue of 100,000*l*. a year. There is no doubt that the encouragement of the growth of forests will have a material effect in conserving the rainfall of the country.

NEW MEXICO.

In the report issued by the New Mexico College of Agriculture for April, an account is given of the experiments carried out for pumping water for irrigation from wells. New Mexico has a genial climate and fertile soil, but the amount of rainfall is light, averaging not more than from 8 to 16 inches a year. Irrigation, therefore, becomes a necessity. It was with a view to demonstrate the practicability of providing such a supply of water from the underflow that the experimental work was undertaken. The strata consist of sand and gravel, with occasional layers of clay. The Rio Grande Valley is underlaid with gravel beds sufficiently thick to procure from them an ample supply of water at a depth of from 20 to 80 feet. There are two methods of obtaining water from the underground supply. One by sinking a well down to the water-level, and then forcing perforated pipes to some depth below this. The experimental station well was sunk 48 feet deep, with sixinch pipes driven 21½ feet below this. The other method is by driving tubes varying from 3 to 6 inches diameter down from the surface some distance into the water-bearing surface. With tube wells as small as 3 inches in diameter, the perforated portion at the lower end is driven with the pipe, but with larger tubes the open pipe is first sunk, and the strainer or perforated part lowered inside; the tube is then jacked up until the perforated tube is exposed. The pipes are sunk by means of a sand bucket, which consists of a cylinder 3 to 5 feet long, the diameter being a little smaller than that of the tube, provided with a plunger and valve at the bottom. The cylinder is forced into the ground, and then the plunger is driven down to the bottom, and when drawn up sucks the sand and small stones into it. It is then raised to the surface and emptied. In some cases pressure has to be exerted by means of weights or levers to force the bucket down, and it is continually turned round by means of clamps. In favourable ground it will sink at the rate of 1 foot a minute. Owing to the quantity of fine sand in suspension in the water, centrifugal pumps for lifting the water were found to answer best. Where wells are used the suction pipe draws from the water at the bottom, but with tube wells the suction pipe is attached to the top of the tube.

FORESTRY IN THE UNITED STATES.

THE bulletins, professional and hydrographical papers, which form part of the serial publications of the United States Geological Survey, treat of a variety of subjects, among which forestry figures conspicuously. Five beautifully illustrated volumes, accompanied by carefully prepared and coloured maps, have recently been received. The statistics and information collected from various sources by well-trained experts and specialists are put forth in a very plain and comprehensive manner.

The first paper is by Mr. Henry Gannett, and treats of the forests of Oregon. It deals very concisely with the composition and character of the different forests and woodlands in the State. At the outset a land classification table is given, which shows total area, merchantable timber area, open country, burned, cut, and barren areas.

As the author remarks, "the most startling feature shown by the land classification map of this State, is the extent of the burned areas." A point worthy of note, to which the author directs attention, is that "the burns are greatest and most frequent in the most moist and heavily timbered parts of the State, and are smaller and fewer where the rainfall is less and where the timber is lighter," the reason being that the density and abundance of the undergrowth forms excellent fuel for the fire, and vastly increases its heat and destructiveness. Of the total timbered areas, not less than 18 per cent. has been thus destroyed. This represents a total of 54,000 million feet in the State, with an estimated value of 54 million dollars, which the author very truly remarks is too much to lose through carelessness. However, as the region of the fire area is well watered, reafforestation appears to be progressing favourably, especially where the burns have not been extensive; but, where many square miles have been involved, the lack of seed has retarded the process considerably. The dangerous fire season is autumn, when most things are dry. However, the magnitude of such devastations appears to have been worse prior to and during the days of early settlement—from 1843 to 1870. The rest of the paper consists of extremely valuable notes accompanied by tables which give a classification of the lands together with the amount and classification of timber for each county in the State. There is no extraneous matter brought in—each sentence is pithy and to the point. The text, accompanied as it is by illustrations and maps, gives as perfect an idea of the character and stand of the timber of Oregon as can well be conceived.

The next professional paper (No. 2) of the series is by the same author. It deals with a revision of the estimates of the standing timber and its distribution in the State of Washington. These forests consist mainly of red fir (*Pseudotsuga taxifolia*), mingled with spruce, hemlock, and cedar. They are the densest, heaviest, and most continuous in the States, with the exception of the red wood forests of California. The author's general description is followed by a summary of the standing timber in Washington, after which each county is taken up separately and in detail.

The revised estimate shows an increase over that given in a former report; this is due to the inclusion of species which have now come into use, and also such species as are of known value though at present not utilised.

The next report (No. 3) of the series is by Mr. Fred G. Plummer. It deals with the forest conditions in that part of the Cascade Range lying between the Mount Rainier and Washington Forest Reserve. The land classification map which accompanies this report covers 2,800,000 acres, but after deducting the naturally timberless areas, such as arid lands, lakes, and glaciers, also the area destroyed by fire (8 per cent.) and logging (1·64 per cent.), there remains an area of 2,292,820 acres which can be called timber lands. After dealing with general matters, the author gives a list of trees and shrubs of central Washington, which is followed by a very useful and instructive table showing the distribution of species by zones of altitude. Then comes a detailed record of the amount of vegetable growth supported by an acre of average soil of the Cascade Mountains. The defects and diseases of timber trees, also the market prices of lumber, receive due attention. The bulk of the report is taken up with detailed descriptions of the various watershed areas. At the end of the paper irrigation, grazing, and mineral springs are reported upon. The author's remarks on irrigation are interesting, as they show what can be done in the way of reclaiming and utilising arid tracts for agricultural purposes.

Report No. 4 of the series deals with the conditions of the Olympic Forest Reserve, Washington, and has been prepared from field notes taken by Messrs. Arthur Dodwell and Theodore F. Rixon. It deals first with topographical matters, agricultural lands, stand of timber, timber trees, forest fires, mining, roads, &c. The principal part of the report gives a detailed description of the various townships contained in the forest reserve. There is much useful information regarding the accessibility of the forests and the facilities of timber transport, which are matters of considerable importance.

The forest conditions in the northern part of Sierra Nevada, by John B. Leiberg, form the fifth paper of the series. This report deals with the topographical features of the region examined, along with the extent and composition of the forest and woodland. The distribution of the various coniferous trees and forest type presented by each receive adequate attention from a sylvicultural point of view. The topographical, agricultural, and sylvicultural aspects of the various river basins are then taken up and described in detail.

In addition to the above, three volumes on forestry, each consisting of several papers, have already been published in former annual reports of the United States Geological Survey.

We have only been able to sketch in the briefest outline the scope and significance of the above works, which represent several years of painstaking and accurate investigation. The undertaking shows that the great importance of the forest is now duly recognised in America, although not so many years have elapsed since forestry was a comparatively unknown science in that country.

In the days of early settlement axe and fire were indiscriminately employed to the great destruction of the forest, and in later days, when timber was required for structural purposes, lumbering operations were so diligently and recklessly pursued in the most accessible forests that in a short time they were depleted of all but the most worthless material. He who wants a vivid description of this state of affairs need only refer to Prof. Heinrich Mayr's work, "Die Waldungen von Nord America," which contains a great amount of information and good advice as regards the conservation of the North American forests. We are glad to see such advice has now been accepted. The good work already done by the Geological Survey will form a basis upon which future schemes of management for the conservation of the forests of North America may be built.

THE VIENNA ACADEMY OF SCIENCES.

WE have lately received the *Proceedings* (vol. cxi.) of the Imperial Academy of Sciences at Vienna (*Sitzungsberichte der kaiserlichen Akademie der Wissenschaften*) for part of 1902. The volume is an important publication now, and is divided into four sections, dealing with different branches of the natural and physical sciences.

Section i. (April to July) includes mineralogy, crystallography, botany, physiology of plants, zoology, palæontology, geology, physical geography, and travels. We notice several important papers on systematic zoology and botany; by F. Siebenrock, on Podocnemis, Wagl., a genus of tortoises; by A. Zahlbruckner, on Brazilian Lichens; by E. Lampa, on liverworts; and by A. Attems, on the Myriopoda of Crete. There are also papers by O. Richter, on magnesium in its relation to plants; by F. Pischinger, on the structure and regeneration of the assimilative apparatus of Streptocarpus and Monophyllæa; by A. Abel, on asymmetry in the skulls of the toothed whales; by H. Hofer, on petroleum; and by F. Berwerth, on the structure of a meteorite from Mukerop, German West Africa; and several other papers, chiefly dealing with geology and palæontology.

In section ii*a*. (May to July), devoted to mathematics, astronomy, physics, meteorology, and mechanics, we have a large number of important papers, of which those relating to meteorology are perhaps of most general interest, such as those by J. Haan, on the meteorology of the equator, from observations taken at the Museum Goeldi at Para; by F. M. Exner, on the variations of the pressure of the air from day to day; and by J. Valentin, on the fall of dust between March 9–12, 1901. There are also several interesting papers on electricity, magnetism, photography, &c., as well as on mechanics and applied mathematics.

Section ii*b*. (April to July) includes chemistry, and comprises a large number of papers by various writers, among which we notice one, by R. von Hasslinger, on the formation of artificial diamonds by the fusion of silicates.

Section iii. (January to December) deals with the anatomy and physiology of men and animals, and also with theoretical medicine. There are only a few papers of importance in this section; by C. Storel, on caseine in asses' milk; by F. Winkler, on the infiltration of the vessels of the skin, when stimulated by heat; by F. Ballner, on the disinfective effect of saturated vapour of water at different boiling points; by O. Löw, on the chemiotaxis of spermatozoa in the female genital tract; by S. von Schuhmacher, on the cardiac nerves of men and Mammalia; by K. Toldt, jun., on the development and structure of the zygoma in man; and by J. Seegen, on the influence of alcohol on the diastatic energy of the ferments of saliva and of the secretion of the pancreas; and also on the formation of sugar in liver preserved in alcohol.

This imperfect sketch may serve to illustrate the activity of Austrians in various branches of science, and it will also be seen that, while the separation of the journal into sections is convenient, it can only be rough and imperfect, for the various sciences trench upon each other to such an extent that many papers might almost as well be referred to a different section to those in which they have been with equal propriety placed; thus a paper on organic chemistry would not be out of place in the section on physiology, or perhaps even zoology or botany, and so in other instances.

We may also direct attention to another point. All the papers in this volume (apart from their publication in it) are separately priced, and can be bought separately. In Britain, except where a paper fills the whole of a part, this is not the case, and separate papers are only furnished to authors to give away, on the tacit understanding that they are not to be sold. Perhaps this is sufficient for British needs, owing to the much smaller number of students who are engaged in special scientific work in Britain, as compared with German-speaking countries.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ON more than one occasion it has been pointed out in these columns that the study of economic botany is neglected by our universities and colleges. But though educational authorities have failed to make provision for students and research in economic botany, Kew has long been a training school from which men have been sent to all parts of the world, and a centre of expert advice on vegetable products. For thirty years or more a course of lectures on economic botany, intended to prepare men for service in India and the colonies, has been given in the museums of the Royal Botanic Gardens, Kew; and the course just finished, by Mr. J. M. Hillier, the keeper was attended by twenty gardeners in training. It is desirable that the study of vegetable economics should be encouraged in great commercial centres such as Glasgow, Liverpool and Belfast, as suggested by Prof. Bower in an address referred to in NATURE of December 18, 1902 (vol. lxvii. p. 165); but it must not be forgotten that, while universities and educational authorities have practically ignored the subject, Kew has been steadily training practical botanists and investigators for botanic gardens and other establishments at home and abroad. As a result there is now scarcely a botanic garden in India and the colonies which has not on its staff one or more men trained at Kew or recommended by the director of the Royal Gardens. Kew affords facilities for scientific and technical training in botany unequalled by any other institution, and it is satisfactory to know that so many members of the staffs of our botanic gardens have been trained there.

WE have received two publications from the United States concerning the education of deaf children. One pamphlet is the sixth report of the home in Philadelphia for the training in speech of deaf children before they are of school age, and the other is a special report, by the superintendent of schools, of the school for the deaf and the normal training department for teachers of the deaf in connection with the Board of Education of the City of Detroit. These booklets show clearly enough that it is quite possible so to educate deaf children that they can understand ordinary speech, and so work satisfactorily with normal persons.

WE have received a copy of the report of Prof. Starling, the Dean of the Faculty of Science of University College, London. The report was read at the assembly of the Faculties of Arts and Laws and of Science which took place in July last, and reference was made to it in our issue for July 9. Referring to the amount of scientific research done at University College, Prof. Starling says:—"I believe I may safely assert that in no university does the quality and the quantity of the original work turned out exceed that which we have to record at University College. Our success in this direction is attested by the continued increase in the number of research students, that is of men of the highest ability who are seeking the best form of training for their subsequent careers. Whereas last year we had seventy-two research students, this year we have eighty-seven on our books. These men are drawn from all parts of the world, the British Isles, colonies of Canada, Australia and South Africa, and our Indian dependencies, Japan, Germany, Switzerland, and so on. Much of the work which they have turned out represents important advances in our knowledge, and will be of lasting value. It is satisfactory to know that, whereas a few years back all our best students and we ourselves regarded a visit to Germany as a necessary part of a science curriculum, the conditions are now beginning to be reversed." The list of original papers and other publications from the scientific departments of University College during the past year, with which the report concludes, contains more than a hundred entries.

A BLUE-BOOK showing the amount spent on technical education by local authorities in England and Wales, with the exception of five which have made no return, during the year 1901–2 has been issued by the Board of Education. The return shows that the total amount thus expended on technical education in England and Wales during the year 1901–2 was 1,057,399*l*. This amount is exclusive of the sums allocated to intermediate and technical education under the Welsh Intermediate Education Act, 1889. The amount raised by loan on the security of the local rate under the Technical Instruction Acts was 206,426*l*., the amount of loans, so raised, outstanding was 1,030,952*l*., and the balance in hand of moneys received and allocated to technical instruction was 658,319*l*. 16*s*.

SOCIETIES AND ACADEMIES.

EDINBURGH.

Royal Society, July 20.—The Rev. Prof. Flint in the chair.—An obituary notice of Prof. Cremona, by Prof. **Blaserna**, was communicated by Prof. Chrystal.—Mr. James **Russell** read a paper on the molecular condition of iron, demagnetised by various methods, in which a large number of experiments on the mutual effects of superposed magnetisations were described and discussed in the light of the molecular theory which had suggested them. According to the author's view, when iron has been demagnetised by a series of reversals diminishing by very small steps, the molecules in any small region, instead of being left in a condition in which as many point one way as another, are left with a preponderance pointing uniformly round the equatorial belt at right angles to the direction in which the magnetising forces had been applied. It is obvious that if a new magnetic force be applied codirectional with, or perpendicular to, the direction of the original set of forces, there will be no induction at right angles to the new force. But if the new force be applied in any other direction, there will be a component of induction perpendicular to this direction. The consideration of the theory in various combinations led to results which were tested by experiment. In all cases the theory stood the test of experiment satisfactorily.—Dr. D. Fraser **Harris** read a paper on affectability and functional inertia as the two fundamental properties of protoplasm. These were regarded as the two physiologically opposite functional capabilities, the degree of the relative intensities of which determined the particular manifestation at the moment. As examples of manifestation of functional inertia were mentioned insusceptibility, automatism, heredity, rhythmicality of action, the manner in which functional exhaustion was warded off and the state of fatigue substituted, &c. Functional inertia not only accounted for vestigial organs, but also for vestigial metabolism, as, *e.g.* the formation of uric acid in the mammal, an avian or reptilian metabolic relic.—Dr. Noel **Paton** communicated a paper on October salmon in the sea, in which some new points in the life-history of these fish were brought to light. In late runs of salmon male fish markedly preponderated. In the series studied, ovaries in all stages of development were found, so that ripeness of ovary was not the determining factor of migration from sea to river. One fish which had been obtained was of peculiar interest. In its strong mandible and large teeth it resembled a male, but when the viscera were exposed ovaries were found. The ovaries were flabby and soft, and had a yellowish opaque appearance, with pale opaque patches on many of the eggs.—In a note on resistance change accompanying transverse magnetisation in nickel wire, Prof. C. G. **Knott** and Mr. P. **Ross** described an experiment which seemed to show that in nickel wire in strong fields (in moderate fields in which the effect of longitudinal magnetisation is easily observed there is no measurable effect) there is very slight effect until a field of nearly 2000 units is reached, when the resistance begins rapidly to decrease, and goes on decreasing linearly with increase of current to fields of 5000. When the coil is wound with a pitch of 1 in 20, the component of the field along the wire gives rise to an increase of resistance which in the lower fields may counterbalance the slight decrease due to the transverse field. In the higher fields, however, this longitudinal effect is of comparatively small account.—Mr. J. H. Maclagan **Wedderburn** communicated a paper on the application of quaternions in the theory of differential equations.—In a note on a method of bringing together the two spectra produced by the ordinary spectrophotometer, Mr. J. R. **Milne** described a neat application of the well-known heliometric device of the divided lens. By using a divided lens in the eye-piece, he was able not only to bring the two spectra edge to edge without intervening dark space, but was able to shift the spectra sideways relatively to one another so as to compare directly the luminosities of strips belonging to different parts of the spectrum.—A paper by Dr. Thomas **Muir** on the theory of axisymmetric determinants in the historical order of development up to 1841 was also communicated.

PARIS.

Academy of Sciences, August 17.—M. Albert Gaudry in the chair.—Spectroscopic observations of the Borrelly comet (1903 *c*), by M. H. **Deslandres**. The spectrum obtained with an exposure of two hours is nearly identical with that of the comet 1893 *b* (Rordame). The bands due to hydrocarbons and cyanogen are clearly made out, and from the nature of the cyanogen bands it is concluded that the illumination of this gas on the comet is due to electrical phenomena.—On the aërodynamical phenomena produced by the cannon used in dispersing hailstorms, by M. J. **Violle**.—Examples of the mechanical analysis of soils, by M. Th. **Schlœsing**, sen. Examples are given of the mechanical analysis of soils by the method described in a previous paper. It is shown that the amount of clay does not interfere, and that analyses of the same earth, repeated under different conditions, give concordant results.—On the relation of the work of S. Lie to that of Liouville, by M. N. **Saltykow**.—On entire functions of zero order, by M. Edm. **Maillet**.—On the integrals of Fourier-Cauchy, by M. Carl **Störmer**.—A diagram giving the properties of nickel-steels, by M. Léon **Guillet**. The diagram is constructed with percentages of carbon as abscissæ, and percentages of nickel as ordinates. The diagram is divided into four areas, and allows of the deduction of the structure and mechanical properties of the steel from its composition.—On unsymmetrical tetramethyl-di-amino-diphenylene-phenyl-methane and related dye-stuffs, by MM. A. **Guyot** and M. **Granderye**.—A fixing liquid isotonic with sea-water, by M. M. C. **Dekhuyzen**. The solution is made up of a 2·5 per cent. solution of potassium bichromate in sea-water, 25c.c. of normal nitric acid, and 54c.c. of a 2 per cent. solution of osmic acid.—On the presence of lactic acid in the muscles of the invertebrates and the lower vertebrates, by M. Jean **Gautrelet**.—On the presence of microsporidia of the genus Thelohania in insects, by M. Edmond **Hesse**.—On the post-embryonic development of Ixodes, by M. A. **Bonnet**.

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