THURSDAY, OCTOBER 11, 1906.

ELEMENTS OF ELECTRICAL ENGINEERING.

Electrical Engineering in Theory and Practice. By G. D. Aspinall Parr. Pp. viii+447; illustrated. (London: Macmillan and Co., Ltd., 1906.) Price 12*s.* net.

THIS book is the first of two or more volumes dealing with the subject named in the title. It is introductory, and treats of the elementary theory and testing methods while describing the simpler apparatus used in electrical engineering. Direct and alternating current machinery are to be dealt with in a later volume.

Magnetism is first considered, then electrostatics. Electric currents and electromagnetic effects follow, and in this way the more practical portions of the work are approached. Each chapter ends with a set of examples, chosen, for the most part, from papers set by recognised authorities. The student who works through these examples after reading each chapter will obtain a good grasp of its contents, even though one or two of the examples are perhaps unfortunate, as, for instance, that specially worked out on p. 85, which relates to a rather impossible generator the voltage of which drops noticeably when a high-resistance voltmeter is connected across its brushes. The author has taken considerable trouble to bring the book up to date, both in the descriptions of apparatus and by frequent reference to the more important of recent papers.

There is much, however, in the book, and chiefly in its earlier chapters, which to the present writer seems open to criticism. It professes to be a text-book introductory to the subject of electrical engineering. As such, its functions are surely to show clearly how the various elementary formulæ used by the electrical engineer are derived, and to describe the appliances by which electrical and magnetic quantities are measured, and also the simpler commercial applications. Many books have been written which have had this aim, but few have attained it. Either a theorist writes a text-book which, however perfect theoretically, is so far removed from actual practice as to be almost useless to the engineer, or a book is written like the present, which is full of useful information, but is not sound theoretically; or perhaps one should say rather that it is incomplete on that side. Rigid proof of fundamental formulæ is shirked, and the student loses that confidence in them which always goes with a precise knowledge of the way in which they have been derived. Text-books on electrical engineering, at any rate, should not now be written to which either of the foregoing reproaches can be urged, for the day is gone in which it was questioned whether a sound theoretical training was necessarily the basis of a practical engineer's knowledge.

The present work is quite large enough to deal thoroughly with the theory without even increasing the space devoted to this part of the subject; and yet, when reading it, just where one would expect an exact statement of the way in which a given formula has been derived, one reads that "it can be shown," or that "space will not permit a proof here." Such passages occur frequently; for instance, when deriving the magnetic force near a long wire (p. 129) or that in a long solenoid (p. 131); or, again, when obtaining the relation between hysteresis loss and the area of curves of cyclic magnetisation (p. 147), the pull along magnetic lines of force (p. 157), the capacity of a condenser (p. 173) or of condensers in series (p. 180), and the energy stored in an inductive circuit (p. 197). It is true that in one or two of these cases some very elementary application of the calculus would have been required; but even this may surely now be expected of any reader to whom the theoretical portion of the book shall be of any use at all. An equivalent graphical proof may frequently be given with advantage instead of the symbolical one, so that even this difficulty may be met. These comments do not apply to the derivation of the more complicated expressions, but only to the derivation of those which form the basis of other formulæ which the engineer may frequently have to use.

The section entitled "Electrical Resistance" includes, not only an account of the various standard and testing resistances employed, but also much useful information on insulating materials and the forms they take in practice. A matter of importance to electrical engineers is the subject of contact resistance, and particularly that occurring with carbon brushes on commutators. Exact information on this point is now available which should find a place in such text-books as the present. A few pages might also have been devoted to resistances for the absorption of power, and more than a casual reference to the use of micanite as an insulator. Considerable space is devoted to the magnetic qualities of iron stampings. One of the best chapters is that on electrical and magnetic instruments, in which the various types now used in testing and switchboard work are well described. It may be remarked, however, that under hot-wire instruments, that of Hartmann and Braun, which is the only such instrument widely used, is not described.

Although the book is generally quite readable, the English is by no means perfect throughout. The reasoning is here and there unsatisfactory, loose language creeps in, or the style becomes diffuse. These are, however, small matters, which will no doubt be remedied in a later edition.

The book includes a large number of excellent tables of physical constants and data useful to the engineer, from which much redundant matter has been excluded and modern information put in its place. Such data should always, in the present writer's opinion, be so stated as to give an idea of the percentage accuracy attainable in their measurement. To quote the hysteresis loss in tungsten steel as 216,864 ergs per cycle (p. 150), or the specific resistance of paraffin wax as $13{,}385 \times 10^6$ megohms per inch cube (p. 107), is to give a false impression of the useful accuracy attainable. Three significant figures in the former and two in the latter would be ample. Indeed, those familiar with insulation resistance measurement will agree that to get results concordant even in the exponent of 10, let alone the significant figures, is not always easy with such material as paraffin wax, and a much greater accuracy in stating the measurement has, therefore, no meaning.

The illustrations, of which there are nearly 300, are on the whole good, especially those of apparatus. Among the illustrations, however, there are some diagrams, such as Fig. 88, which are singularly poor, chiefly through faulty perspective drawing.

The section on glow-lamps is good and up to date, and includes a very full account of the construction and use of vacuum pumps. The subject of arc-lamps and of illumination is also well treated. The concluding section, on the "production of electromotive force" (induced voltage being, presumably, excluded), contains an account of thermoelectric effects and of primary and secondary cells, the latter being given due prominence, as becomes their importance to the engineer.

The descriptive portion of the work is throughout very carefully written and illustrated. It is full of representative information as to recent types of apparatus. It will thus be seen that Mr. Parr has placed before us a book on the elements of electrical engineering which, if not satisfying from every point of view, is nevertheless a good example of the type of text-book which will introduce the student at once to the theory and to the elementary practice of his subject. D. K. M.

COLLECTED WORKS OF ERNST ABBE.

Gesammelte Abhandlungen. Zweiter Band. By E. Abbe. Pp. ii+346. (Jena: G. Fischer, 1906.) Price 7.50 marks.

THE first volume of Prof. Abbe's works has already been noticed in the pages of NATURE (vol. lxix., p. 497). The contents of the second volume, while extremely interesting, are more miscellaneous in their character. The editors did well in collecting together in one volume their author's epoch-making papers on the theory of the microscope and his original papers on optical problems.

Abbe's friends, however, will value the possession of his complete writings, and the volume now under review shows the width of his interests and the extent of his knowledge. It opens with his inaugural dissertation at Göttingen in 1861 on the experimental foundation of the law of the equivalence of heat and mechanical energy, a paper which deals chiefly with the thermodynamics of a perfect gas so far as they can be deduced from the first law. This is followed by two astronomical papers of somewhat local interest communicated to the Frankfort Physical Association.

The fourth paper is Abbe's dissertation on receiving authority to teach in the philosophical faculty at Jena in 1863, and is on the law of the distribution of errors in a series of observations.

Abbe's interest in optics was, as is well known, first aroused by the request to help Carl Zeiss in his construction of the microscope, and it is clear that as a young man other branches of science attracted him.

A paper reprinted from the Jena *Zeitschrift für Naturwissenschaft* for 1874 follows, occupying some eighty pages of the volume, and gives his own account of two of his best-known instruments. It is entitled "New Apparatus for the Determination of Refractive Indices and Dispersion Constants," and in it are described the Abbe refractometer and the method of determining refractive indices by total reflection.

The Abbe refractometer is well known, and in the skilful hands of the Jena firm has developed into a most useful and valuable instrument. Abbe's own account of its development and of the reasons which led him to its adoption are full of interest; it was one of his earliest instruments in which the principle of autocollimation was employed; the light from the collimator is made to fall normally on the second face of the prism the index of which is required and to retrace its path; when this is the case the angle of refraction is equal to the angle of the prism, and can be easily measured; the angle of incidence can also be measured, and from a knowledge of the two the refractive index is obtained. The principle which forms the basis of the method described in the second part of the paper has been further developed by Pulfrich in his well-known total refractometer.

Another interesting article is the first list of the productions of the glass technical laboratory of Schott and Company at Jena, dated July, 1886. The story of this work has often been told; the growth of the Jena firm in the twenty years which have elapsed since the first list was published affords conclusive proof of the fertility of the union of the mathematician who had the skill to apply his knowledge in aid of the needs of industry and the manufacturer who realised that Abbe's science had a commercial value, and could be made a factor of real importance in the struggle for progress.

The introduction to this first catalogue of optical glasses opens thus:—

> "The industrial undertaking which is here first brought before the notice of the public arose out of a scientific investigation into the dependence of the optical properties of solid amorphous fluxes on their chemical composition which was undertaken by the undersigned with a view to bring to light the chemico-physical foundations of the production of optical glass"—

and though at present there are many problems which confront the glass maker, thanks to the researches of Abbe and Schott the knowledge of 1906 is far in advance of that of 1886.

Enough has perhaps been written to show the interesting character of the book. Among the other papers are accounts of some of the various apparatus designed by Abbe, including the now well-known prism binocular, and some reviews and notices, both of books and men. Of these, perhaps the most noticeable is an address delivered in the hall of the Physical Institute at Jena on March 5, 1887, to commemorate the centenary of the birth of Fraunhofer, in which in eloquent words Abbe traces the debt of opticians to that great man.

At some future day a pupil of Abbe's will carry on the story and show how the next great advance in practical optics was the work of Abbe himself. His friends have done well to collect with loving care these writings of their master, and we who know him chiefly through his works are grateful to them for the manner in which they have discharged their task.

OUR BOOK SHELF.

Magnetische Kraftfelder. By H. Ebert. Second edition. Pp. xii+415. (Leipzig: J. A. Barth, 1905.) Price 7 marks.

THIS is a second edition of Prof. Ebert's well known treatise on magnetic fields of force, which first appeared in 1902. The author handles his subject as before with a wealth of illustration, and with a theoretical grasp, which make the book valuable alike to student and teacher. Indeed, the teacher will find in its pages many useful suggestions. Of these is the magnetic vane of Jaumann, depicted on p. 23, which recalls the appliance of Petruscheffsky, in which a small bar magnet was suspended through one pole, with a counterpoise to make it lie horizontally, and act as a one-pole magnet. Again, the little frame depicted on p. 29 for holding bar magnets during the operation of manufacturing their filing figures on a sheet of glass above them is worthy of notice. The author adopts as a brief synonym for "a point in a magnetic field to which we direct our attention" Boltzmann's term "Aufpunkt," for which we have no English equivalent. On p. 206 he uses the term "Billiontel" for 10^{-9}, which is surely a slip, since in German, as in English, a billion is 10^{12}, not 10^{9}. On p. 54 his definition of unit pole is that it is such as to repel with a force of 1 dyne a similar pole when at a distance of 1 centimetre apart *in vacuo,* whereas hitherto the accepted definition has been when *in air.* The difference may be unimportant, but it should not pass without challenge. In this edition the author has cut out most of the section upon cyclical systems, and certain deductions of the Maxwell-Hertz equations which were formerly included. On the other hand, he has introduced new matter relating to the electronic view of electricity in its relation to magnetism and to the Zeeman phenomenon. While this part of the book has been shortened, there have been added at the end fresh sections on induction, on the magnetic circuit—a distinctly valuable chapter—and another of lesser merit on dynamo-machines. The author erroneously attributes to Pixii, on p. 359, the invention of the split-tube commutator. What Pixii used in 1832, on the suggestion of Ampère, was the divided mercury-cup familiar to electricians in the primitive motors of Ritchie.

It is distinctly interesting to find a summary of recent work on kathode rays, Becquerel rays, and the rays emitted by radium, appearing as an integral part of a chapter which opens with the action of the magnetic field upon a movable conductor carrying a current. The doctrine of the electron appears to be thoroughly accepted as an essential part of electromagnetism. But the definitions which the author gives on pp. 157 and 158 of an electron apparently exclude anything and everything that is not actually moving with a high velocity:—"Unter Elektron hat man die sich mit grosser Geschwindigkeit bewegende negative Elementarladung zu verstehen." Is an electron not an electron when it is at rest?

S. P. T.

Inheritance in Poultry. By C. B. Davenport. Pp. v+134. (Washington, D.C.: The Carnegie Institution, 1906.)

THIS is a valuable addition to the rapidly-increasing literature dealing with the subject of inheritance. It affords a good example of the growing complexity of the theories which have been founded on the famous discovery of Mendel. The simplicity of the original Mendelian system has now to be supplemented by such conceptions as those of "imperfect dominance," "incomplete segregation," "compound allelomorphs," and the like. The author of the present treatise, well known as the director of the station for experimental evolution at Cold Spring Harbour, New York, deserves much credit for the care with which his experiments have been devised and their results recorded. Each experiment is methodically described under the heads of "Statement of Problem," "Material," "Results," "Conclusions," and the general bearing of the whole series on evolutionary theory receives full and candid discussion in a final section. The author's standpoint, as was to be expected, is in the main Mendelian, but he recognises the facts that both dominance and recessiveness are frequently incomplete, and that "an adequate theory of gametic purity has not only to explain the simple Mendelian formula, but also the facts of imperfect dominance, impurity of extracted forms, latency and atavism, and occasional particulate inheritance." Prepotency (in Bateson's sense) he holds to be as truly important in inheritance as dominance. It is worth noting that de Vries's dictum as to the sharp separation of the constituent units which make up the characteristics of organisms, between which units transitions exist "as little as between the molecules of chemistry," is, in the author's opinion, not borne out by the present experiments; nor does he find confirmation of the same biologist's assertion as to the different modes of inheritance of "specific" and "varietal" characteristics.

There are a few marks of carelessness in the text, as where the birds represented by Figs. 1 and 2 are spoken of as "black-crested white Polish." The plates are generally admirable, but in the absence of colour it is difficult to distinguish between true white and reflected high lights—a point which in some cases is of great importance.

F. A. D.

German Scientific and Technological Reader. Book i., pp. ix+105; Book ii., pp. viii+115. By E. Classen and J. Lustgarten. (London and New York: Harper and Brothers, 1906.) Price 2*s.* net each.

THESE two books should serve a useful purpose in familiarising students of science who are anxious to read scientific works in the German language with expressions and terms common in such works, but not to be found in school-books. Both volumes consist of descriptive accounts of principles and properties relating to various departments of science, and of technological processes, plainly printed in Roman characters, and suitable for reading by students who know the rudiments of German grammar.

The descriptions in the first volume deal with the propædeutics of physical and chemical science, dyeing, metallurgy, electrotechnics, and engineering; and those in the second volume are concerned, in addition, with some special points in physics, chemistry and chemical technology, spinning and weaving, and brewing. There is a vocabulary in the first volume, but not in the second, which is somewhat more advanced, and requires the use of a dictionary.

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.]*

Biometry and Biology: A Reply to Prof. Pearson.

IN reply to Prof. Pearson's letter in NATURE of September 6 (p. 465), I desire, in the first place, to express my extreme regret if the criticism which I ventured to offer on biometrical work in my address at York has caused pain in a quarter where I should least desire to give offence. Had I foreseen that this was likely to happen I certainly should have refrained from making any criticism on that occasion.

Prof. Pearson wishes me to explain how Dr. Pearl's paper, "A Biometrical Study of Conjugation in Paramæcium," an abstract of which appeared in the Proceedings of the Royal Society (B, 518, p. 377), lays him open to the advice that he should make sure that the problem he seeks to elucidate is sound from the standpoint of biology. I think that there is no course open to me but to comply.

Dr. Pearl states that his work on *Paramecium caudatum* was undertaken for the purpose of obtaining answers to the questions:—

"(*a*) Is the portion of the Paramæcium population which is in a state of conjugation at a given time differentiated in respect of type or variability, or both, from the non-conjugating portion of the population living in the same culture at the same time?

"(*b*) Is there any tendency for like to pair with like ("homogamy") in the conjugation of Paramæcium, and if so, how strong is this tendency?"

In making the first inquiry, and in dealing with it, Dr. Pearl appears to ignore the fact that the differentiation of the conjugants of this species is already well established. Maupas (*Arch. de Zool. exp.*, ser. 2, T. vii., p. 184), writing in 1889, says:—"Tous les observateurs qui se sont occupés de la conjugaison du *Paramecium caudatum* ont signalé la petitesse de taille des individus accouplés." He goes on to say that he has never found them to exceed 225 μ in length, usually 180 μ to 210 μ, while it is not rare to find non-conjugants attaining 300 μ or even 320 μ; so that when Dr. Pearson states that "Dr. Pearl *demonstrates* for the first time that conjugant Paramæcia are differentiated from the non-conjugant population," he appears to be in error.

It may, however, be claimed that by the application of the biometrical method of dealing with the series of measurements he has given a more precise measure of their differentiation.

I would submit that Dr. Pearl's material and modes of procedure are singularly unfitted for yielding such a result.

In the first place, the specimens have been preserved and fixed, a process which every practical biologist knows to be attended with distortion.

They were prepared by different hands, partly by Dr. Pearl himself in Leipzig, partly by Prof. Worcester in America.

Dr. Pearl tells us (p. 377) that "in the measuring conjugant pairs were taken quite at random, and then in each case the two undistorted non-conjugant individuals which were lying nearest in the field of view of the microscope to the conjugant pair were measured."

Now let us consider what would happen with this mode of procedure. Paramecium, as is well known, is not a symmetrical animal. It has been described as "slipper-shaped"—not a very good comparison, but it will serve to bring out the fact that the proportion of length and breadth presented to the observer will vary according to the aspect from which the individual is viewed. At whatever stage of the proceedings the Paramecia took up the position on the slide in which they were measured, they must have sunk through a layer of fluid the depth of which was small, no doubt, but considerable in relation to their size. The conjugant pairs being attached mouth to mouth would tend to settle on the broad base presented by the sides of the attached pair, so that one side of each rested on the slide while the other side would be directed to the observer. The non-conjugants might settle on any lateral aspect. Hence a larger proportion of conjugants would be measured in side view than of non-conjugants. This would be another source of error.

To illustrate the next point I shall refer to another ciliate infusorian, allied to Paramecium, *Leucophrys patula*, to which I shall have to return later. It also was investigated by Maupas (*ibid.*, ser. 2, T. vi., p. 237, and T. vii., p. 250). The ordinary individuals of this species were found to vary in length from 80 μ to 150 μ. They have a wide œsophageal recess bordered by vibratile lips (*cp.* ser. 2, T. vi., Plate xii., Figs. 1–8). The formation of the conjugants occurs by a series of divisions, with progressive reduction in size, of an ordinary individual and of the resulting fission products, giving rise to from eight to thirty-two little conjugants 50 μ to 60 μ in length, and so unlike the non-conjugant form that unless their mode of origin had been ascertained, Maupas says, they might be referred to a distinct genus. There are neither vibratile lips nor œsophageal recess, the mouth is closed, and their movements are much more active. Here, then, is a still more marked case of differentiation of gametes than that presented by *Paramecium caudatum*.

Now the non-conjugant population of the latter species measured by Dr. Pearl to ascertain the range of their variability would include, not only ordinary individuals, but all stages of individuals in process of differentiation as gametes. The non-conjugants are a heterogeneous population; the conjugants are, on the other hand, approximately homogeneous. This appears to me another and grave source of error in his results on the degree of differentiation and variability of the conjugants.

Hence, though I am far from denying that it may be true, it appears to me that Dr. Pearl's conclusion is beset with several sources of error when he attempts to give a measure of the degree to which (p. 379) "conjugant individuals when compared with non-conjugants are found to be . . . less variable in both length and breadth."

I desire to do Dr. Pearl all the justice I can, and his case for homogamy in the conjugation of the gametes appears to me to rest on a sounder basis and to be of interest, though I am doubtful as to the validity of the explanation which he offers for this phenomenon; but that there is any analogy between it and assortative mating in man, as Dr. Pearl and Prof. Pearson conclude, seems to me problematical in the extreme. The phenomenon in man which is comparable with the conjugation of the differentiated gametes of Paramecium is the union of the differentiated gametes of man, and I am not aware that it has been shown that there is any correlation between their external characters and the external characters of the human adult.

Similarly, the conclusion contained in Dr. Pearl's ninth and last heading appears to me altogether unsound. He says (p. 383), speaking of the differentiation of conjugants, "if the individual Paramæcia of a given race must conform to a definite and relatively fixed morphological type every time they conjugate, what they may acquire during fission generations is clearly of no particular account to the evolutionary history of the race in the long run." This is to ignore the conclusion to which Dr. Pearl's results point (though it had already been established by Maupas and others), that the conjugants are differentiated gametes. It is the nature of a gamete that it is able to transmit the characters of the organism from which it springs, although itself of a size and bodily shape wholly different from that organism. Are the gametes of *Leucophrys patula*, though unlike the ordinary individuals in size and other characters noted above, unable to give rise to like forms? As a matter of fact, if proof were needed, Maupas watched them in process of differentiation into ordinary individuals.

In my address at York I urged biometricians to make sure that the problems they seek to elucidate are sound from the biological point of view. When asked by Prof. Pearson for an instance of failure in this respect I gave him, while away on my holiday, and in a private letter, Dr. Pearl's paper. He has now seen fit, although I twice asked him to wait for a full answer until my return to Cambridge, to challenge me to show in the pages of NATURE how my advice was applicable to that paper. I must leave your readers to judge how far I have succeeded in so doing.

The task has been far from an agreeable one. I should never have thought of singling Dr. Pearl's paper out for public criticism in this manner had I not been challenged to do so. I can only say that if he feels himself aggrieved at the result, he can be in no doubt whom he has to thank.

J. J. LISTER.

St. John's College, Cambridge, October 1.

Radium and Geology.

IN the Proceedings of the Royal Society for May and August there appeared important papers by the Hon. R. J. Strutt upon radium in the earth's crust and the earth's internal heat. Taking known values of the heat production of radium, per gram per second, assuming Lord Kelvin's estimate of the conductivity of rocks *in situ* and Prestwich's estimate of the temperature gradient at the surface, Mr. Strutt shows that, if the gradient expresses the outflow of heat due to radium in the earth, the radium must be confined to a comparatively thin crust, because his laboratory experiments prove that the smallest radium content existing in the rocks examined would give a much higher gradient than the one observed if the radium were distributed throughout the entire earth.

In the present connection the crust must be defined by the depth beyond which no heat is caused by radium. In these circumstances, if we adopt a certain temperature gradient at the surface, there is only one value of the radium content which will correspond to any assumed thickness of the crust, and there will also be one corresponding temperature at the bottom of the crust and throughout the interior. I have calculated these at intervals of five miles, both for Prestwich's estimate of the gradient, viz. 1° F. for 42·2 feet descent, and also for the more commonly accepted one of 1° F. for 60 feet.

Gradient 1° F. *in* 42·2 *Feet.*

Thickness of the crust in miles	Radium content per cubic centimetre	Temperature at bottom of crust, Cent.	Temperature at bottom of crust, Fah.
		°	°
15	$15·39 \times 10^{-12}$	519	966
20	$11·55 \times 10^{-12}$	692	1277
25	$9·13 \times 10^{-12}$	865	1589
30	$7·70 \times 10^{-12}$	1038	1900
35	$6·60 \times 10^{-12}$	1211	2211
40	$5·77 \times 10^{-12}$	1384	2464
45	$5·13 \times 10^{-12}$	1557	2834

Gradient 1° F. *in* 60 *Feet.*

Thickness of the crust in miles	Radium content per cubic centimetre	Temperature at bottom of crust, Cent.	Temperature at bottom of crust, Fah.
		°	°
15	$10·27 \times 10^{-12}$	363	676
20	$8·08 \times 10^{-12}$	484	894
25	$6·39 \times 10^{-12}$	606	1112
30	$5·09 \times 10^{-12}$	727	1330
35	$4·62 \times 10^{-12}$	848	1547
40	$3·84 \times 10^{-12}$	969	1725
45	$3·59 \times 10^{-12}$	1090	1984

From the above tables it appears that the radium contents corresponding to such values as are usually assigned to the thickness of the earth's crust by geologists and seismologists are well within the amounts contained in the rocks examined by Mr. Strutt, and that consequently the surface gradient can be fairly accounted for by the theory. But we have also some indication of internal temperature from volcanic products. Prof. Bartoli found the temperature of lava issuing from Etna to be 1060° C. If this came up from beneath the crust it would correspond to a thickness of from thirty to forty miles, according to the rate of increase which we attribute to the gradient. So far all seems favourable to the theory.

Since any reasonable assumption for the mean radium content of the crust would supply sufficient heat to maintain the observed gradient, it follows that no heat can pass up from the interior, because, if it did, the gradient would be higher than it is. The conclusion would be that the earth is not a cooling body, and it is consequently reduced to a state of thermal stability.

Thus a fundamental belief of geologists is shattered at a blow. Sir A. Geikie writes in his chapter on dynamical geology that "it is useful to carry in mind the conception of a globe still intensely hot within, radiating heat into space, and consequently contracting in bulk." . . ."Wide geographical areas are upraised or depressed." These changes of level are constantly going on, such as have been described by Prof. Hull and Dr. Spencer, and the recency of these movements shows that, if they are due to a cooling globe, that process is still in progress, and the primeval heat not yet exhausted. Although there may be differences of view as to the exact mode of its operation, yet it is not too much to assert that there is a consensus of opinion among geologists that the movements of the crust are chiefly attributable to the ultimate cause so concisely expressed by Sir A. Geikie.

It seems clear that one or other of these views concerning the internal heat of the earth must yield. They cannot both be correct; and if the radium theory is to hold the field, how are the movements of the earth's crust to be accounted for?

O. FISHER.

Graveley, Huntingdon, September 28.

IF the internal heat of the earth is mainly due to the radium present therein, must we not assume that the same is the case with the moon? If such were the case, then the internal heat of the latter would be far greater than we have hitherto supposed, and it would be difficult to explain the lack of volcanic activity there.

The age of our satellite is not sufficient for us to assume that all the radium is dead or that none is being produced.

B. J. PALMER.

Technical Schools, Southend, October 4.

Vectors, &c., at the British Association.

IN the report (August 30) of the discussion on the use and notation of vector analysis at the British Association it is stated that I "deplored the substitution of vectors for quaternions." The statement is misleading, for was it not Hamilton more than any other single man who taught us how to use vectors in product and quotient combinations? What I did and do deplore is the substitution of non-quaternionic vector algebras in all their variety of notation for the Hamiltonian or quaternionic vector algebra —a very different thing.

I should like to add that (notation excepted) I was thoroughly in sympathy with all that Prof. Henrici said in opening the discussion. He showed admirably the conciseness of vector methods in attacking both geometrical and physical problems, and so far as he went in the limited time at his disposal there was absolutely nothing to choose between his mode of presentation and that which Hamilton himself might have adopted in the same situation. In his reply at the end of the discussion he pointed out that the quaternion, *as a quantity*, could be got quite easily from his system by taking the difference of his vector and scalar products. That, of course, is self-evident, but it does not seem to me to touch the real issue. It leaves his system still non-associative in vector products, and in higher applications, especially with the differential operator ∇, this introduces difficulties which are unknown to the quaternionist. It is a suggestive fact that both Gibbs and Jahncke, in order to develop their respective systems, found it necessary to introduce quite other kinds of products of vectors—products which are as different from one another as each is from the quaternion product, and yet have not the geometrical significance of Hamilton's creation.

There is an idea in some minds that there is a rivalry between vector analysis and quaternions. There is nothing of the kind. There is a quaternion vector analysis and a crowd of other vector analyses known best by the names of their authors, such as Grassmann, O'Brien, Gibbs, Heaviside, Bücherer, Jahncke, Henrici, Peano, Macfarlane, &c., no two of whom, curiously enough, agree with one another. Of all these, Hamilton's is the only vector analysis associative in its vector products. The importance of this associative law does not, of course, appear so long as we restrict ourselves to products of two vectors only, and, as a matter of fact, many vector analysts never really get to higher products. When, however, three or more vectors are to be combined, the associative law must be fulfilled if simplicity and flexibility of operation are to be retained. The vector analysis which admits the associative law in product combinations *is* the quaternion vector analysis, however it may be disguised by arbitrary symbolism and notation.

C. G. KNOTT.

Edinburgh University, September 21.

I ALSO deplore the use of the current but misleading phraseology which Prof. Knott points out. Quite certainly Prof Knott's more detailed statement should be substituted in the interests of "terminological exactitude."

THE WRITER OF THE REPORT.

Remarkable Rainbow Phenomena.

WHEN I read Mr. Spence's interesting letter (p. 516), it occurred to me that the appearance of the second primary rainbow was due to the reflection of the sun from the sea. The apex of this second bow would be above that of the first bow, the angular distance between the apices being about equal to double the sun's altitude at the time of the observation.

Taking approximate figures, I make Deerness to be in longitude eleven minutes of time west of Greenwich, and in latitude 59° north. Assuming Mr. Spence's times to be Greenwich times, the sun's altitude at 6h. 30m. p.m. was about 4°, so that the angular distance between the apices of the bows would be about 8°, a result differing but little from Mr. Spence's estimate of 5° or 6°. As the sun sank this distance would diminish.

I should be glad to know if Mr. Spence observed any difference in the intensity of the light. One would expect the higher bow to be the fainter of the two, as it was due to a reflected sun, though the loss of light by reflection would be diminished by the very low altitude of the sun. By Fresnel's formula, the reflected sunlight would be to the direct sunlight in the ratio of 13 to 20. If we neglect the slight polarisation of this reflected light, these numbers will also express the relative brightness of the higher and lower bows, other conditions being alike.

Probably the most remarkable case on record is that of the octuple rainbow, seen in 1841, by the late Mr. Percival Frost, from the top of Dunstaffnage Castle, near Oban. The sea, both behind and before the observer, was perfectly smooth. Four bows were seen in the sky, viz. ordinary primary and secondary bows due to direct sunlight, and, above these, primary and secondary bows due to sunlight reflected from the water behind the observer.

Seen in the water in front were also four bows, inverted by reflection. These bows were not images of the first four, but images of four bows that could have been seen in the sky had the water been removed and the observer brought down vertically to a position as far below the sea-level as the actual observer was above it. The eight bows formed four intersecting circles. For further details and an illustration reference should be made to NATURE, vol. xli. (p. 316).

C. T. WHITMELL.

Invermay, Hyde Park, Leeds, September 29.

Suspended Germination of Seeds.

THE letter of "H. B. P." in NATURE of September 27 (p. 540), while giving an interesting instance of the sudden appearance of the foxglove on a bare hill in the north country, does not appear to be conclusive as to the seedlings having developed from long-buried seeds. They might have originated equally well, it appears to me, from wind-blown seeds being conveyed to a recently disturbed soil, where they had an opportunity of germinating, and where they were not subject to the competition of other and stronger species. On the extensive shingle deposit near Dungeness, in Kent, one of the earliest species to appear on the newly deposited shingle is the foxglove. The first is usually the oat-grass *Arrhenatherum avenaceum*, and the third is often the wood-sage *Teucrium Scorodonia*; the seeds of all these must have come from some considerable distance, and it is not suggested that the plants arose from long-buried seeds.

I am by no means asserting that seeds may not under suitable conditions remain dormant for considerable periods, but we want instances to prove this in which other factors have been carefully and completely eliminated. This does not appear to be the case in the above instance, where it is also possible that the seeds produced in the summer may have been blown into the interstices of the wall, the disturbance of which led to their dispersal over the site, and this might account for the absence of the seedlings from the neighbouring turf-surface which had also been disturbed, and which should have yielded them had the seeds been blown from the dry capsules of the plant after the destruction of the wall in the spring.

Yardley Lodge, Oxford. G. CLARIDGE DRUCE.

The Rusting of Iron.

HAS anyone inquired whether the rusting of iron may not be associated with some micro-organisms? The facts that oxygen, water, and carbon dioxide are necessary; that iron does not rust when immersed in boiling water and then sealed up; that certain solutions are said to inhibit rusting (*e.g.* potassium ferrocyanide, a poison), and that certain other solutions encourage rusting (*e.g.* ammonium chloride and perhaps sea-water, compare the composition of plant-culture solutions); that iron is a constituent of chlorophyll, and that rusty nails sometimes cause blood-poisoning, all these facts suggest a case for inquiry. There is, I think, an iron bacterium noted in some of the bacteriological books. The precipitation of iron carbonate might conceivably hold a place in the life of some organism corresponding to the precipitation of calcium carbonate by foraminifera.

HUGH RICHARDSON.

12 St. Mary's, York, October 1.

Colour Illusions.

WITH reference to Mr. T. Terada's letter in your issue of September 27 (p. 540), I noticed some similar effects while making experiments with a form of colour top last year. An old gramophone motor forms a very convenient way to observe this, and by using various discs painted in different rings and segments many curious optical effects may be seen.

I was, in fact, trying to see whether the effect of the persistence of vision could not be used to indicate the speed, and, to a certain extent, it can no doubt, but the effect is not sufficiently definite, and there is too much of the personal equation present to make it of practical use. If a disc is painted in two or more rings, and each ring is divided into a different number of segments, in colours or black and white, it is well known that each ring will become a uniform colour above a certain speed, according to the number of segments; the effect takes place at about forty alternations per second. Very interesting stroboscopic and complementary colour effects may be obtained in this way, some of which I have not seen mentioned yet; the complementary colours only appear at a certain speed, and show best in sunlight; the effect is peculiar—almost iridescent sometimes.

B. J. P. R.

October 3.

LOWELL'S OBSERVATIONS OF THE PLANET MARS.[1]

IN the year 1893 the important volume on Mars, entitled "La Planète Mars et ses Conditions d'Habilabilité," was noticed in these columns (vol. xlvii., p. 553). This work, the outcome of an immense amount of labour on the part of M. Camille Flammarion, brought together every available observation and piece of information that could be gathered from published and unpublished works. In fact, the history of the observations made on this interesting planet was traced from the time of the earliest record (1636) down to the opposition of 1892.

Fourteen years have now elapsed, numerous workers have been busy studying his surface markings, and steady progress has been made in corroborating old and discovering new features. The time seems, therefore, ripe for a work supplementary to that above named which should bring together the mass of valuable material which is now scattered through many different pamphlets and journals.

Such an undertaking would undoubtedly consume much time and labour on the part of the compiler, but would prove a valuable addition to the literature of planetary astronomy.

Failing such a work at the present time, we have, however, a volume which will not only fill up the gap temporarily, but will reduce to a very considerable extent the labour of the future compiler to whom reference is made above.

This very handsome and valuable publication gives a detailed account of the observations made by Mr. Percival Lowell himself during the oppositions of 1894, 1896, and 1903; the supplement to the volume contains the observations of Mr. Douglass, assisted by Mr. Drew, at the opposition of 1898, owing to Mr. Lowell's absence through illness, and of Mr. Lowell and Mr. Douglass at the 1900 opposition.

In the arrangement of the subject-matter Mr. Lowell follows the classic memoirs of Schiaparelli, considering each opposition by itself, and adopting a chronological and topographical order for the observations themselves. In this way, during an opposition, the story runs "on in time while making meanwhile the circuit of the planet."

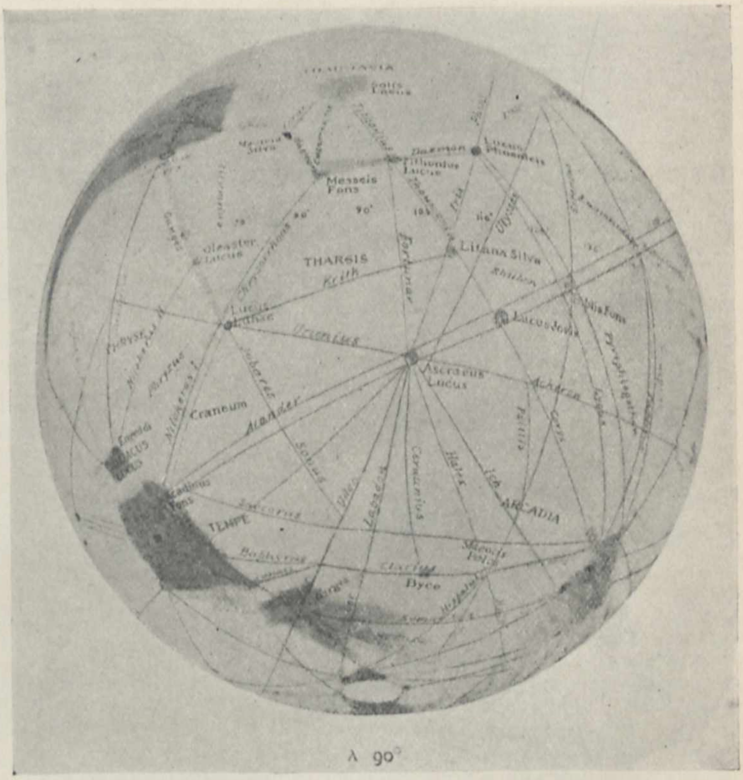

FIG. 1.—Lowell's drawing of Mars at longitude 90° at the opposition of 1903, showing Solis Lacus near the top.

As is well known, Mr. Lowell preserves Schiaparelli's nomenclature, which he refers to as an "at once appropriate and beautiful scheme." He makes, however, one important change, which is necessitated in the light of advance of our knowledge of the interpretation of the planet's markings. In the place of "Lacus" he adopts the word "Lucus," an alteration of a single letter, for markings which were previously considered to represent water are now looked upon as probably oases of land. It was Mr. W. H. Pickering's observations and deductions which first suggested this inversion of the then general idea of the dark and light shadings, and this knowledge was considerably extended by Mr. Lowell's observations.

In the observation of details on a planet's surface it is well to bear in mind that the power of the telescope is of less importance than steadiness and clearness of the air and keenness of the observer's vision. In fact, Schiaparelli's observations of the canals made with his 6-inch telescope were not corroborated at once by observers who were armed with very much more powerful instruments.

That keen-eyed observer Dawes was accustomed to cut down the aperture of his telescope according to the kind of night experienced. Thus he termed his observing nights 6-inch night, 4-inch night, &c., according to the "seeing."

In considering Mr. Lowell's observations of Mars, the reader must bear in mind that, unlike most astronomers who make their observations from where the observatory is permanently situated, Mr. Lowell investigated the "seeing" conditions of a great number of regions in order to choose the most efficient spot for the observation of planetary details, and hence the position for his observatory. The steadiness of the air at Arizona thus allowed him to use larger apertures efficiently, and, coupled with his keen sight and expertness in this kind of observation, his observations are of the first importance. He, like Dawes, found that the aperture of the telescope had to be suited to the night. Thus of the opposition of 1900–1, using a 24-inch refractor, he writes (p. 101):—

"Observations were made with the 24-inch objective of the observatory and usually with the full aperture of the objective. On occasions, however, this was capped down to an aperture of 12 inches; an optical device which usually improved the seeing; . . . but because by so doing the harmful effects of the air currents were reduced. For the same reason at times even the 6-inch could be serviceably used."

[1] "Observations of the Planet Mars, during the Oppositions of 1894, 1896, 1898, 1901 and 1903, made at Flagstaff, Arizona." By Percival Lowell. ("Annals of the Lowell Observatory," vol. iii., 1905.)

At the opposition of 1894 an 18-inch glass made by Brashear was employed, but for the oppositions of 1896 and later the 24-inch objective mentioned above was made and mounted for the observatory by Alvan Clark and Sons, "the last glass, as it chanced, of that famous firm."

Even at Flagstaff Mr. Lowell was not content with the astronomical conditions of seeing all the year round. For this reason, at the opposition of 1896–7, he determined to try the conditions in Mexico for the winter months; observations were therefore terminated in November, 1896, and not resumed until December 30. In the meantime the dome and telescope were transported and set up at Tacubaya, near the city of Mexico, in latitude 19° 26′ N. This temporary change resulted in a long series of post-opposition observations.

With regard to the method of recording the observations, drawings, notes, and micrometer measures formed the usual routine. The drawings were made on circles about 40 mm. in diameter, a convenient size for combining "most satisfactorily sufficient space with possibility of keeping proportions." As a rule, we are told, the drawings were of the complete disc, and were made as nearly instantaneously as possible.

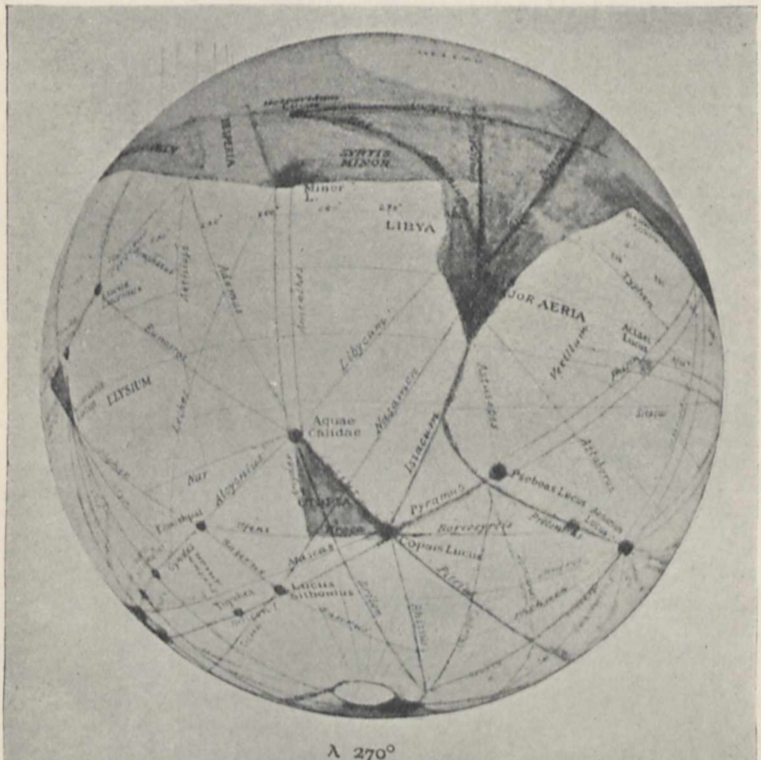

FIG. 2.—Longitude 270° at the opposition of 1901 with Syrtis Major near the centre of the disc (Lowell).

Coming now to the observations themselves, and the numerous clear drawings which accompany them, it seems extremely difficult to refer to any particular set of them, as they are all so full of interest. The observations bring out, however, very clearly the apparent discrepancies which have arisen between observations taken of the same region, but at different times, by well-known Martian observers. Thus, to take a case in point, in the opposition of 1894 Mr. Lowell relates how, in observing the region about Syrtis Major, which was central on the disc, the most prominent features were tongues of shade which lay between Hellas and Naochis, and nearly joined the Syrtis to the blue band bordering the cap. "For the rest no detail could be made out upon the disc, except for two dark spots where the coast-line dipped to enter the Great and Little Syrtes respectively; the only salient points these of an otherwise featureless face. Not only was there no sign of a canal, but even the main markings showed dishearteningly indefinite."

Such an apparent lack of markings was, as Mr. Lowell points out, a matter of the Martian date. It was, as he says, "the very nick of time to see nothing. For the part of the planet most presented to the earth was then at the height of its dead season." Mr. Lowell states, further, "when we consider that such is always the face the planet shows when at its nearest to the earth, and that till lately such time was commonly chosen for examining its disc, it is small wonder that previous to Schiaparelli the strange canal-system should have escaped detection."

The above extracts will, we think, convey to the reader the pitfalls into which the Martian observer can stumble in consequence of the seasonal changes on the planet.

Again, Mr. Lowell gives instances of markings which undergo a secular variation covering many years. Thus a conspicuous single canal, called by Lowell Sitacus, connecting the eastern fork of the Sabaeus Sinus with the north-east corner of Aeria, was not seen by Schiaparelli. It was such a salient feature in 1894 that he could not have missed it had it been there. Cerulli noticed it in 1896, and it has been seen at all subsequent oppositions as a fairly conspicuous canal. This canal exemplifies, as Mr. Lowell says, "the truth of a deduction of Schiaparelli that the canals were curiously subject to secular wax and wane."

Another canal, Ulysses, unrecorded by Schiaparelli, which in 1894 was comparable in strength with the Gigas or the Titan, is a further instance of secular change.

It is interesting to note that Mr. Lowell gracefully explains the great difference between the number, 183, of canals seen at Flagstaff at the opposition of 1894 and that recorded by Schiaparelli, 79, as "due solely in consequence of better observational conditions of one sort and another."

Among other results of this opposition was the clear detection of the seasonal change; an increase in the number of the oases which lie at the intersection of the canals; an extension of the canals in the dark regions which conclusively showed that the dark areas were not "seas"; observations on the changes of shades of the dark areas showing that they were not bodies of water; and, finally, peculiar markings, termed "nicks," were observed where the canals entered the light regions.

Space does not permit one to enter into anything like detail with reference to the observations made at the succeeding oppositions. In that of 1896 there was sufficient evidence to show that, as Schiaparelli had pointed out, the doubling of the canals was not wholly a seasonal effect. Another observation of importance was the identification of a rift in the snow-cap with the subsequent canal called Jaxartes.

In the opposition of 1900 the Phosin and Euphrates were always seen double, as in 1896. Mr. Lowell suggests that probably the two epochs of gemination of the canals on Mars as laid down by Schiaparelli may not be epochs of gemination, but epochs of greater conspicuousness of the gemination at one time than at another; this would bring apparently discordant facts into line.

During this opposition Solis Lacus was not seen with its usual distinctness, and it is inferred that as it was at its dead season it had turned sear and yellow. White equatorial spots of long duration were an important feature at this time.

The observations of 1903 were very fruitful with results, and special reference should be made to the relationship between the oases and the double canals.

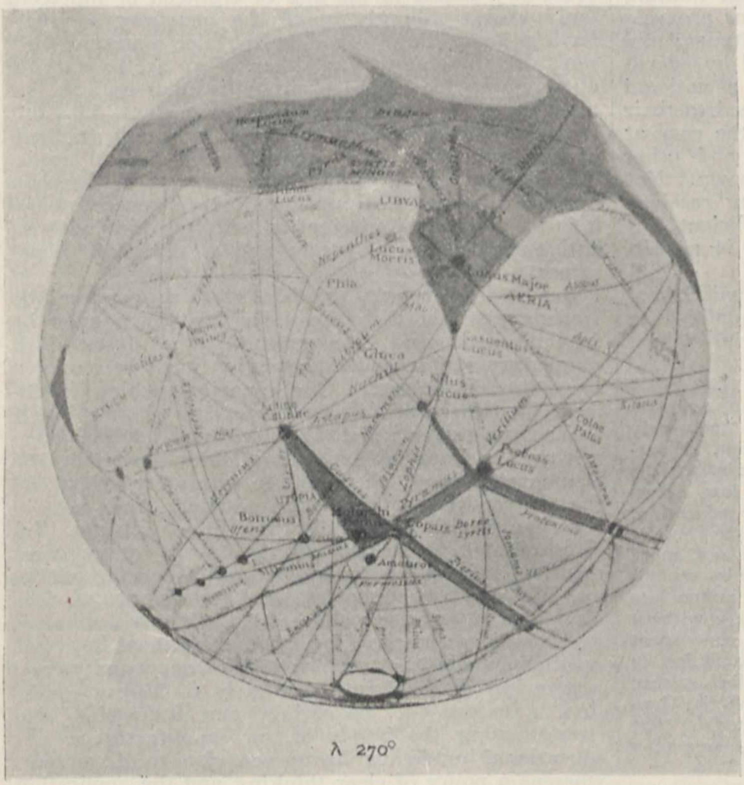

FIG. 3.—The same longitude (270°) as in Fig. 2 from observations made at the opposition of 1903 (Lowell).

The reader should also direct his attention to the semi-annual flux in the development of the canals which was revealed, showing that two waves of development sweep alternately over the planet's surface in the course of one of its years, this being clearly illustrated in Lowell's cartouches.

Regarding the appearance of cloud on the planet's surface, Mr. Lowell is inclined to think that the large, whitish marking named Hellas to the north of Syrtis Major represents either mist or cloud. In the opposition of 1901 it was never seen as white as the polar cap, although it approximated to it more than to all the regions outside of it. He was thus led to believe that it was not formed of snow, but of "something which would thus hold an intermediate position between snow and ground, namely, cloud or mist."

Another, among other references to cloud, is mentioned at the opposition of 1903, in relation to the region about the Mare Acidalium and the pole, this region being obscurely semi-white. On January 23 Mr. Lowell wrote:—"No sharp limit to polar cap. Think it surrounded by spring cloud."

Many other points of interest in connection with these and similar observations might be dwelt on at some length, but the reader must be referred to the volume itself for a more intimate study.

In addition to a good index to the volume, there is a special index of the names on the maps and globes. In the latter there are fifty-four regions, 392 canals, and 172 oases mentioned, which will give the reader some idea of the number of Martian markings seen at Flagstaff.

In addition to the frontispiece, which is a reproduction from a photograph of the 24-inch equatorial, there are thirteen plates and seventy-six illustrations in the text, all of which are of first-class quality.

Printed in large, clear type on smooth, stout paper, and occupying about 350 pages, the volume contains a valuable increase to our knowledge of Mars, and forms a handsome addition to the astronomical library.

On the production of this volume Mr. Lowell and his staff are to be sincerely congratulated, the more so that since its publication success has rewarded their endeavours in recording the canals of Mars on a photographic plate (Roy. Soc. Proc., Ser. A, vol. lxxvii., p. 132).

WILLIAM J. S. LOCKYER.

THE PLACE OF THE MODERN UNIVERSITY IN THE STATE.

THE recent quatercentenary celebrations of the University of Aberdeen, and especially the speeches of the venerable Chancellor of the University on that occasion, again direct the attention of thoughtful men to the vital connection between national efficiency and well-being and the provision made by a State for the higher education of its people in modernised universities. The presence of the King and Queen to open the new buildings at Marischal College serves admirably to accentuate the fortunate fact that in their endeavours to provide this country with institutions adequately equipped to supply instruction of the highest grade and with facilities for research in all departments of knowledge, our statesmen, our men of science, and our men of wealth are receiving some of that encouragement of their efforts which it is the power of our Sovereigns to bestow.

The brilliant gathering of learned men eminent in every sphere of human endeavour, and representative alike of science, art, and letters, may be taken as a happy augury of the unanimity that prevails to spare no effort in the pressing work of supplementing and extending the supply of seats of the highest learning in every part of the country, with a view to place Great Britain on terms of equality with other great nations in the keen competition which is the outstanding characteristic of international relations at the beginning of the twentieth century.

With these evidences of educational enthusiasm and endeavour before us, it seems a fitting opportunity to consider briefly what appears to be the current plan of procedure and to inquire how far this is likely to meet the prevailing needs. Enthusiasm, unless well directed, is not enough. British educational endeavour has too often proved unproductive because of its haphazard character, and instances are extant where in neighbouring countries better results have followed a smaller expenditure of money and trouble, because each new development has made an addition to a carefully conceived plan. The policy of muddle is, at all events, fatal in education.

There must, in the first place, be an intimate connection—a close association throughout, indeed—between the systems of elementary and secondary education on one hand, and the colleges and universities on the other. The trinity of grades must form an organic whole dominated by the same ideals, imbued from base to apex with the same spirit of earnest thoroughness, where at every stage the learner must be taught to be content with nothing short of the best. A boy's opportunities for progress should be limited only by his natural aptitudes; and brains, wherever found, must be regarded by educational administrators in every district as a national asset to be trained, developed, and sharpened to their full extent. How far this is from being the case at present many recent articles in NATURE and other contributions to current literature have shown. Not only is the amount of preliminary training received by boys seeking admittance to college insufficient, but the kind of education they have received is unsuitable.

The principal of the Manchester Municipal School of Technology, who is particularly well qualified to speak on this subject, wrote in an article (*School World*, April) published this year:—

"Those who are familiar with the standards of entrance to our advanced schools and colleges of science know only too well how low are the standards of admission. Whatever may be the 'face' requirements of matriculation, the actual marks required for a pass are extremely low, necessarily so in the present state of our secondary education. It is further well established that the average time actually spent in the secondary schools is not much, if any, more than a third of that required in German and Swiss schools of similar rank—in short, either the pupils go in too late or they finish too early. In any event, they leave without an adequate training, alike in respect of both time spent and subjects studied. Moreover, the age of admission to our universities and specialised schools of applied science is two years below that of similar institutions on the Continent. In these circumstances, how is it possible that the output, in respect of the quality of the students, can rival that of foreign institutions?"

Commenting upon the kind of secondary education given in this country, a writer in NATURE of March 23, 1905 (vol. lxxi., p. 487), states:—

"The custodians of English education are still actuated by mediæval ideals. The entrance of the student of science to the older universities is still obstructed by an obsolete and ludicrous test in Greek. There is a tendency even yet among those in charge of our Department of Education to discourage and hamper the instruction in science in our elementary and secondary schools."

Lord Strathcona did well to emphasise in his address at the Aberdeen graduation ceremony the stimulating influence which Scottish universities have had upon the schools of that country, for it is especially to the improvement of the type and standard of English secondary education that attention must be at once seriously directed if full advantage is to be made of English universities and technical colleges. We have arrived at the stage when the pressing need is neither suitable buildings nor qualified teachers—these we have in a more abundant measure than is necessary to meet present needs—but students suitably prepared and thoroughly grounded in the fundamentals of a sound secondary education. The number of day students in our technical schools and colleges is still ridiculously small, and too many of those in attendance are reaping little benefit, because they lack habits of serious study and the acquaintance with fundamental principles they should have acquired at school. It is in this direction that immediate improvement is required. In Germany, to quote an example of what can be done, the secondary schools are turning out youths trained to think and to reason, trained in the methods of acquiring knowledge, and inspired with an earnest desire to study the subjects necessary to enable them to occupy positions of command in their country's industrial army. But the German boy is, as a matter of course, allowed to remain at the secondary school to the age of eighteen or nineteen, and parents willingly make the necessary sacrifice, having learnt how abundant in later years is their reward. In some way or other, if we are to compete on anything like equal terms with other nations, we must import a spirit of greater earnestness into our secondary schools, allow our boys to remain in them longer, and adjust our curriculum to modern needs. The British boy, if rightly directed, has no superior in ability, earnestness, and intelligence generally, and it is little short of criminal to handicap him with an antiquated course of study and a curtailed school career.

But it is not only the bonds which connect the secondary school with the university which must be drawn closer and strengthened; the systems of elementary and secondary education must be rendered more interdependent. Our capacity-catching machinery has improved in recent years, it is true, but it is far from perfect; and the endeavours made to open a way for boys of exceptional brain-power in the elementary school, through the secondary school, to the university, have been spasmodic and not in accordance with a carefully thought-out scheme. Indiscriminate scholarship giving has in many cases resulted only in the manufacture of surplus clerks and ill-trained schoolmasters, and the absence of clear aims and a definite policy as to what education is expected to accomplish for these exceptional boys has resulted in waste of money, loss of opportunity, and a growing disbelief in the efficacy of higher education. Instead of benefiting our industries and strengthening the hands of our manufacturers, our educational muddling has given rise to discontent, whereas a policy of clear thinking and the application of the methods of science to educational problems would have produced a well-balanced and judiciously graded system of national education—capable of providing the country with trained workers for every sphere of activity.

Equally striking would be the effect on the universities themselves if such a coordinated scheme of education could be brought into being. Instead of the glorified boarding-school type which at present functions as a university, where young men continue to play games and practise "good form" to the exclusion of serious work, all our universities would be institutions filled with well-trained youths earnestly intent upon acquainting themselves with the triumphs accomplished by modern research, and upon fitting themselves in their turn to extend the bounds of knowledge.

Lord Strathcona in his address at the graduation ceremony also wisely insisted upon the national character of the Scottish universities, and brought into high relief a feature which should distinguish all modern universities. It is too often forgotten in this country that the provision of universities is primarily a national obligation, and that the State which is content to leave to private initiative and to individual generosity the all-important work of raising and endowing seats of the higher learning is neglecting one of the most potent means for securing its own vitality. The recognition by statesmen of this national duty need not discourage local effort and enthusiasm; indeed, experience tends to show that both are quickened in districts where such State universities are established. The duty has been fully recognised by foreign Governments, and the lavish generosity of the State in Germany and the United States was ably pointed out by Sir Norman Lockyer in 1903. Sir James Crichton Browne has repeated the warning more recently. Speaking at the University of Leeds at the beginning of the month, he said:—

"England has been remiss of late in perceiving and promoting those interests that hinge on scientific and medical research. In this direction Germany has stolen a march upon us, for the various Governments in that Empire have unstintedly provided their universities with fully-equipped research laboratories, organised and conducted by professorial directors."

The importance of securing this exercise of what should be regarded as a State prerogative consists, not only in ensuring an immediate and adequate supply of institutions of university standing, but—in an equal degree—in realising the right atmosphere in the university when it gets itself established. The parochial spirit is fatal to university development. The boy proceeding from the school to the university should pass from an institution dominated by local aspirations to one imbued with Imperial instincts, where thought is unfettered and ambitions are free to soar. Sir James Crichton Browne expressed the same thought very distinctly at Leeds when he remarked:—

"It would be a misfortune to a boy to pass from a secondary school to a university in the next street, where he would meet as his fellow-students only his old schoolfellows, and where, however amply fed with knowledge, he would still be surrounded by the same traditions and associations and shop amongst which he had been brought up. A provincial university is a contradiction in terms. What is wanted is a group of territorial universities, each with distinctive features of its own, specially adapting it to its environment, but all affording the most liberal instruction, the finest culture, the best intellectual discipline of the day, and collectively meeting the higher educational needs of the whole country."

Another point made by Lord Strathcona may be considered profitably in conclusion. Speaking of American universities, the Chancellor said:—

"They found out long ago that law and medicine and theology are not the only legitimate points of academic study; and in their faculties of applied science they are training their young men to do work that is most loudly called for. They have never accepted the view that universities must necessarily be institutions cloistered and apart from the main current of public life and service. On the contrary, they make a training for citizenship and for public usefulness the basis and foundation of much of their educational activity. The reward they have is that—fully as much as we do here—they find their *alumni* in every walk of life, not in the 'learned professions' only; and some of the most notable benefactions which the American universities have lately received come from men whose desire it is to connect them still more closely with practical work."

In other words, a university training is valuable in every department of work. The culture which is the gift of every living university to each of its sons is capable, in addition to equipping for remunerative labour, of affording intellectual guidance in all life's difficulties, of encouraging individuality, and of promoting a symmetrical intellectual development. Besides providing men able to compete worthily in the international struggle for industrial supremacy, the modernised university, which is actually the crown and summit of a sanely planned system of secondary and elementary education, will send out men of wide sympathies, above insular prejudices, and in all things dominated by a sweet reasonableness.

NOTES.

THE seventh annual Huxley memorial lecture of the Anthropological Institute will be given on Thursday, November 1, at 8.30 p.m., in the theatre of the Civil Service Commission, Burlington Gardens, W., when Prof. W. M. Flinders Petrie, F.R.S., will deliver an address on "Migrations." Tickets can be obtained on application to the secretary of the institute, 3 Hanover Square, W.

THE inaugural meeting of the session of Guy's Hospital Pupils' Physical Society will be held on Saturday next, October 13, when Prof. T. Clifford Allbutt, F.R.S., will deliver an address on "Words and Things." The chair will be taken at 8 o'clock by Sir Samuel Wilks, F.R.S.

DR. THOMAS HARRISON, formerly Chancellor of the University of New Brunswick, died on September 18 in Fredericton, at the age of sixty-eight. He was professor of mathematics in the University from 1885 to 1892, and Chancellor from 1892 until last August, when he retired on a Carnegie pension.

A REUTER message from Wellington, New Zealand, reports that a monument to Captain Cook was unveiled on October 8 in the presence of a large gathering of both races at Poverty Bay, on the east coast of the North Island, at the spot where the explorer first landed.

WE learn from the New York correspondent of the *Times* that Sir William Perkin was the guest of honour at Delmonico's on October 6 at a dinner given by four hundred American chemists and manufacturers of chemical products. Prof. Chandler presided, and many well-known Americans were among the guests. Dr. Nichols presented to Sir William Perkin the first cast of a gold medal to be known as the Perkin medal, and to be awarded each year to some American chemist who has distinguished himself in the field of research. Another gift to Sir W. Perkin was a silver service as a personal tribute from the chemists and manufacturers who were present.

IT was mentioned last week (p. 545) that the Governor of Hong Kong had appointed a committee to inquire into the alleged failure of the observatory to give warning of the violent storm that burst over the colony on September 18. According to a Laffan message from Hong Kong on October 8, the report of Zi-ka-wei Observatory at Shanghai shows that a published warning was issued against the passage of a typhoon two days before it struck Hong Kong. The latter place was not warned because for years the Hong Kong Observatory has refused to exchange warnings with the Jesuit observatories at Shanghai and Manila.

IT is announced in the *Lancet* that the first International Congress on Alimentary Hygiene and a Rational Diet for Man, to be held at the Paris Faculty of Medicine on

October 22–27, will include the following sections:—(1) biological physics; (2) biological and physiological chemistry; (3) rational food systems and dietetics; (4) analytical chemistry, adulteration, and legislation; (5) bacteriology, toxicology, and parasitology; (6) statistics, instruction, and ways and means; (7) application of hygienic principles in the manufacture and preparation of food, and conveyance of food from place to place; (8) the hygiene of food and rational food systems in the home and elsewhere; (9) cooperation and competition; (10) distribution of food gratis or at reduced prices; (11) food in relation to the prevention of alcoholism and tuberculosis; and (12) the diffusion of knowledge in schools and elsewhere with respect to rational food systems and the hygiene of food. The first seven of these twelve sections constitute Division 1 of the congress, dealing with scientific methods, and Prof. Bouchard and Prof. Armand Gautier will preside. The five last sections constitute Division 2 of the congress, dealing with social questions relating to food; the president will be M. Jules Siegfried.

THE annual Huxley lecture was delivered at Charing Cross Hospital on October 1 by Prof. Ivan Pawlow, of St. Petersburg, the subject being the scientific investigation of the psychical faculties or processes in the higher animals. All the experiments were made on dogs, and the excretion of saliva was made the test of the response of the animals to external impressions. As is well known, the salivary glands secrete, not only when the stimulus of appropriate substances is impressed on the mouth, but also when other receptive surfaces, including the eye and the ear, are stimulated; the latter actions have received the name of psychical stimuli, but have unquestionably much in common with ordinary reflex action, and are termed by Prof. Pawlow "conditioned reflexes," to distinguish them from the ordinary or unconditioned reflexes. The greater part of the lecture was devoted to the development of this conception of the nature of the conditioned reflexes, which would thus be removed from psychical phenomena and be relegated to the domain of physiology.

THE winter session of the London School of Tropical Medicine was opened on Monday last with an address by Colonel Kenneth Macleod. In the unavoidable absence of the Duke of Marlborough the chair was taken by Sir Francis Lovell, the dean of the school, who, in introducing the lecturer, briefly described the aims and objects of the school. Colonel Macleod, after paying a tribute to the work of Sir Patrick Manson, briefly detailed the inception of the school, and pointed out that, while the debt has been paid off, a sum of at least 60,000*l.* is needed for endowment. Prominent among the needs of the school at present is the appointment of an entomologist. The trend of modern investigation and thought has forced into the forefront the fascinating subject of comparative pathology. In the tropics all life, and particularly parasitic life, is exuberant; the lower life is rampant, and the higher heavily handicapped. The salutary effect of drainage, cultivation, and cleansing is well illustrated by the banishment of malaria from England. To develop and strengthen the resistive and curative elements of the animal organism is one of the chief objects of medical science, and the principle which underlies the great discovery of Jenner is, after the lapse of a century, obtaining new and remarkable applications. Examples were also given by the lecturer of problems still awaiting solution. In the evening the staffs and past and present students of the London Schools of Tropical and of Clinical Medicine held their annual dinner at the Hotel Cecil, Sir W. Hood Treacher in the chair. Among the guests were Prof. Blanchard, of Paris, the medical director-general of the Navy, Sir John McFadyean, and others.

WITH regard to the series of demonstrations in practical microscopy mentioned in NATURE of September 13 (p. 496), the committee of the Quekett Microscopical Club has made the following arrangements:—November 16, Mr. H. F. Angus, on "Axial Substage Illumination with Artificial Illuminant"; December 21, Mr. Angus, on "Dark-ground Illumination"; January 18, 1907, Mr. C. L. Curties, on "Polarised and Multicolour Illumination" and "Various Methods of Recording Observations"; March 15, Mr. Conrad Beck, on "The Illumination of Opaque and Unmounted Objects"; April 19, Mr. Beck, on "The Comparison of Objectives"; May 17, Mr. F. W. Watson Baker. The next ordinary meeting of the club will be held at 20 Hanover Square, W., on Friday, October 19, at 8 p.m., when the following papers will be read:—On *Tetramastix opoliensis*, a rare rotifer, C. F. Rousselet; and on the reproduction of mosses and ferns, J. Burton. Cards of admission to the demonstrations or the ordinary meetings may be obtained from the hon. sec., Mr. A. Earland, 31 Denmark Street, Watford, Herts.

"UEBER DIE ZELLE" (Leipzig: W. Engelmann, price 60 pf.) is the title of a fragment (45 pp.) of a work on the cell begun by the late Prof. Alfred Schaper. It contains a short historical introduction wherein the chief stages in the development of the cell theory are given, and also a discussion of the more modern views as to the structure of the cell constituents. Its chief interest will probably be for those who knew its author.

SOME phases of the gastrulation of the horned toad (*Phrynosoma cornutum*) form the subject of a paper by Messrs. C. L. Edwards and C. W. Hahn published in the *American Journal of Anatomy* (vol. v., No. 3). The egg in the genus Phrynosoma comes nearer to those of lower vertebrates than does that of any other of the Amniota in that its protoplasmic pole seems less encumbered with yolk, while the elevation of the blastoderm renders the processes taking place therein as independent as in amphibians. Phrynosoma is, in fact, a connecting link in this respect between other reptiles and the axolotl, and thus with the mollusc Bithynia.

To the *Zeitschrift für wissenschaftliche Zoologie* (vol. lxxxiv., part iii.) Mr. H. Schlichter communicates a paper on the electrical organs of the proboscis-fish (*Mormyrus oxyrhynchus*) of the Nile, dealing specially with their histology, which has hitherto received little or no attention, although the organs themselves have been long known. Although situated in the tail, as in Torpedo and Raia, the electric organs of Mormyrus (which have but little power) have each plate composed of a whole bundle of modified muscular fibres instead of a single fibre, so that they must be regarded as representing the union of numerous electro-blasts. Special attention is devoted by the author to the manner in which the nerves supplying these organs terminate, and to the nature of such terminations. Another and longer article in the same issue, by E. Rossbach, is devoted to the anatomy and developmental history of the "redia"-stages of the trematode worms infesting (in the above-mentioned stage) the pond-snails *Paludina vivipara, Limnaea stagnalis*, and certain other species of the same genus as the latter. The budding, degeneration, and regeneration phenomena of certain marine ectoproctous Bryozoa form the subject of the third article, by Mr. O. Römer.

IN the *Revue Scientifique* (September 1) Dr. A. Calmette discusses the channels of entrance of the tubercle bacillus into the organism. The chief conclusion is that both in man and animals the tubercle virus usually gains access by the digestive tract, particularly the intestine.

THE *Bio-Chemical Journal* for September (vol. i., Nos. 8 and 9) has a number of important papers, including a study of the digestive gland in mollusca and crustacea, by Mr. H. E. Roaf; variations in the gastric hydrochloric acid in carcinoma, by Mr. F. W. Morton Palmer; an investigation of the staining act with eosin-methylene blue, by Dr. Wakelin Barratt; secretin in relation to diabetes mellitus, by Messrs. F. A. Bainbridge and A. P. Beddard; and further observations on the treatment of diabetes by acid extract of duodenal mucous membrane, by Prof. B. Moore, Mr. E. S. Edie, and Dr. J. H. Abram.

IN the opening article of the sixth number (July) of the *Philippine Journal of Science*, published at Manila, Mr. P. G. Woolley discusses the disabilities against which the serum-laboratory has had to contend in its crusade against rinderpest in the islands, one of these being the difficulty of procuring cattle sufficiently susceptible to the disease. As the investigations connected with the nature of the virus are only in their infancy, it will suffice to state that the results at present obtained are not in all ways in accord with previous theories. As the result of a preliminary survey of the Lobu Mountains, in the Batangas province, Mr. W. D. Smith is enabled to report the occurrence of post-Eocene strata containing the gastropod genus Vicarya, so widely distributed in the Indo-Malay countries. The remaining articles are devoted to the vegetation of the Lamao forest, a catalogue of Philippine Hymenoptera, with descriptions of new species, and notes on Mindoro birds.

AN extension of cotton cultivation is again recorded in the annual report for 1905–6 on the botanic station in Antigua, the crop being estimated at forty tons. A new variety, Centreville, received from the Department of Agriculture in the United States, and said to be immune to wilt, was grown experimentally; the yield was good, but the staple proved to be irregular. An experiment is being fostered by the curator, Mr. T. Jackson, to grow broom corn with the object of manufacturing brooms to supply local requirements.

IN an article on Antarctic botany, printed in the *Scottish Geographical Magazine* (September), Mr. R. N. R. Brown discusses our present knowledge and future problems. Only two flowering plants have been collected in the Antarctic regions as compared with about 400 species from Arctic countries, but the lichens and algæ are better represented, and fifty mosses have been recorded. Seeing that the mean summer temperature never rises to 32° F., the vegetation is richer than would be expected. Much still remains to be done in collecting, especially from the Pacific and Indian sides, to obtain data that may throw light on the former configuration of land and water.

IN the annual report for 1905–6 on the botanic station and experimental plots in St. Kitts, the curator, Mr. F. R. Shepherd, notes that a number of cacao and rubber plants have been distributed, the latter being principally specimens of *Castilloa elastica*; a first consignment of Hevea plants was received during the year. The crops grown on the experimental plots included sweet potatoes, cassava, yams, onions, and cotton. The cotton exports from St. Kitts, Nevis, and Anguilla, amounting to 120 tons of lint, showed a very large increase over the preceding year. A trial was made in St. Kitts of growing wrapper tobacco under shade and Sumatra tobacco in the open; as this was a first attempt, the curing presented difficulties that might be avoided in the future.

WE have received a short pamphlet referring to the preservation of a portion of the primeval forest, known as Riccarton Bush, that still exists on the Canterbury Plains in New Zealand, about two miles from Christchurch. The pamphlet gives some details as to the indigenous and rare plants growing there, and contains a list of the flowering plants and ferns. The dominant tree is the *kahikatea, Podocarpus dacryoides*, but there are large specimens of two other species of Podocarpus and two species of Elæocarpus. There are also found the urticaceous milk-tree *Paratrophis heterophylla*, a Pseudopanax with protean foliage, the pepper tree, *Drimys colorata*, and other specialities. The acquisition of forest land containing so many unique specimens merits the consideration, not only of the citizens of Christchurch, but of the inhabitants of New Zealand generally. An influential committee has been formed to raise the necessary funds, and the Government of New Zealand has promised a vote of about one-fifth of the sum required.

A MEMOIR of the Geological Survey on the water supply of the East Riding of Yorkshire, by Mr. C. Fox-Strangways and Dr. H. R. Mill, has just been published by the Board of Agriculture and Fisheries. The memoir contains an outline of the geology of the East Riding and of portions of the vales of York and Pickering, with especial reference to the water-bearing strata. It includes records of all known sinkings and borings in the area, together with analyses of waters and a bibliography. There is also a section on the rainfall, with a colour-printed map. Copies may be obtained from any agents for the sale of Ordnance Survey maps, or directly, or through any bookseller, from the Ordnance Survey Office, Southampton, price 3*s*.

THE latest addition to the series of reports designed by the Geological Survey to describe the mining centres of Western Australia is a report (Bulletin No. 22, Perth, 1906) by Mr. H. P. Woodward on the auriferous deposits and mines of Menzies, North Coolgardie goldfield. It covers ninety-two pages, and is accompanied by two maps and six plates of sections. The area embraced covers about fifty square miles, and consists of a complex series of basic rocks through which have been intruded a series of acidic dykes. The quartz veins, which are confined to the greenstones, are of various types, most of the gold having been obtained from segregation veins of lenticular form. From the area described there have been produced 403,787 ounces of gold, derived from the treatment of 348,967 tons of quartz. The deepest mine in Menzies, the Menzies Consolidated Gold Mine, has yielded 65,875 ounces from 99,371 tons of quartz. The vein in this case is clearly of the true fissure type.

THE standardisation of error is a difficult problem to which the attention of the Engineering Standards Committee has been directed. Much has been written on the limits of error, but no attempt has hitherto been made to deal with the subject in the exhaustive manner that it is treated in reports No. 25 (London: Crosby Lockwood and Son, price 10*s*. 6*d*. net) and No. 27 (price 2*s*. 6*d*. net), issued by sectional committees of the Engineering Standards Committee. Report No. 25 deals with errors in workmanship, based on measurements carried out for the committee by the National Physical Laboratory. In order to assist them in the formulation of a system for limit gauges, the committee, in addition to collecting evidence from both manufacturers and users, carried out a comprehensive series of measurements on actual work, and a record of these measurements is contained in report No. 25, but no system of limits is laid down therein, the recommendations being contained in report No. 27, which deals with British standard systems for limit gauges (running fits). The measurements were carried out on a number of plain cylindrical shafts and holes from 2 inches to 12 inches in diameter. The recommendations based on these measurements deal with running fits, and cover diameters of ¼ inch up to 12 inches. It is proposed that the allowance for a running fit shall be made in the hole, and not on the shaft. The standard tolerances and allowances are clearly shown graphically and in tabular form. Four grades of work are provided for, the highest being intended for special cases in which extreme accuracy is necessary. The reports should be carefully studied by all mechanical engineers, and it is to be hoped that the committee will carry its investigations still further, and ascertain whether it is possible to draw up recommendations for standardising driving fits.

A PAPER by Mr. Wilkinson in the current number of the Journal of the Institution of Electrical Engineers, on waste in incandescent lighting, is of particular interest in view of the recent recommendations of the standardising committee in connection with incandescent lamps. Mr. Wilkinson deals very fully with the question, and gives examples of waste due to various causes, and suggests remedies to counteract them. The need for local laboratories and standardising of the pressure of supply is very strongly insisted upon, and several pressure charts are given which show how irregular the pressure regulation is at various supply stations. Automatic regulators in the generating stations are the author's solution of the latter difficulty, the benefit of which has already been proved at Harrogate, where they are installed. Mr. Wilkinson also finds that "local control" of lamps to be used on the supply mains is effective in ensuring that the lamps supplied by the manufacturers are up to specification, and at the same time leaves the contractors the benefit of the trade in lamps.

MR. F. HOWARD COLLINS has sent us a specimen of the "360° Mariners' Compass Card," designed and registered by him. There is nothing new in the idea of marking by degrees, it having been suggested for use in ships of H.M. Navy so far back as about 1896. But though the plan is a good one, the great difficulty is to get it made universal. Ships nowadays generally do steer by degrees, but the card is marked from N. and S. 90° each way to E. and W. Thus a ship would steer N. 80° W. present style, new style 280°, which would convey very little to a poorly-educated sailor man. As regards compasses in use ashore for surveying and similar purposes, they have been marked to 360° for a very long time; and the only other markings on the card are the cardinal points, the method of recording being similar to that suggested. The system has much to commend it, and if it could only get generally known there is no doubt its advantages would in time lead to its adoption throughout the fleets of the world.

THE development of certain species of moulds, such as Penicillium and Aspergillus, is shown by B. Gosio in the *Atti dei Lincei* (vol. xxv., ii., p. 59) to be accompanied by the transformation of carbohydrate into phenolic derivatives containing a closed carbon chain. In certain cases coumarin and its derivatives seem to be formed, which show characteristic colour reactions with alkalis and with ferric chloride. The production of such substances, it is suggested, may prove a valuable means of detecting changes in maize caused by parasitic agency, and a method of diagnosis in cases of pellagra, which is generally regarded as due to the toxic action of substances elaborated in maize owing to the development on it of certain fungi.

WE have received a copy of vol. xix. of the annual reports on the advancements of pharmaceutical chemistry and therapeutics, issued by Messrs. E. Merck, of Darmstadt. The work comprises 260 pages of information of a character sufficiently defined by the title, and supplies a really valuable summary of recent pharmacological research. Each substance is dealt with under the heading of its name, the names of the drugs being arranged alphabetically. A useful index of diseases and symptoms is appended as a guide to the appropriate drugs for their treatment. The fact that particulars are given of the chemical nature and properties of new drugs which have been put on the market with fancy names makes the report valuable, not only to the medical man, but to the chemist. The work is sent free to medical men and others interested in pharmacology or therapeutics on application at Messrs. Merck's London office, 16 Jewry Street, E.C.

IN No. 85 of the Communications from the Physical Laboratory of the Leyden University Prof. H. Kamerlingh Onnes and Dr. W. Heuse describe some experiments made on the coefficient of expansion at low temperatures of Jena and of Thüringen glass. An ordinary dilatometer method was employed, the temperature of the rods of glass, which were about 1 metre long, being measured by an appropriate platinum-resistance method, accepting for this platinum the relation between resistance and temperature obtained in experiments described in Communication No. 77, $R_t = R_0(1 + 0{\cdot}003864t - 0{\cdot}000000103t^2)$. The steady, low temperatures were obtained by means of liquid gases contained in an ingeniously constructed vacuum vessel open at both ends, into the outer wall of which was sealed about the middle point a kind of "aneroid box," to take up the strains due to the very different expansion of the outer and inner glass tubes. The results of the experiments gave for the range −182° C. to +16° C. the following values of the coefficients in the ordinary formula for linear dilatation, $L_t = L_0(1 + \alpha t + \beta t^2)$:—

For Jena glass 16‴, $\alpha = 7{\cdot}74 \times 10^{-6}$, and $\beta = 0{\cdot}00882 \times 10^{-6}$
For Thüringen glass, $\alpha = 9{\cdot}15 \times 10^{-6}$, and $\beta = 0{\cdot}0119 \times 10^{-6}$

The authors seem unaware of the experiments by Dr. Travers on the same subject, and their result gives for mean expansion of ordinary glass a value considerably greater than that found by him.

AMONG the articles in the current number of the *Monthly Review* are two dealing with scientific subjects. M. Henryk Arctowski deals with polar problems and the international organisation for their solution. He first directs attention to the conference held on September 7 in Brussels, when the three questions it is suggested might be solved by international cooperation were discussed, viz. the problem of the North Pole, the geographical problems of the Antarctic regions, and the scientific problems necessitating simultaneous expeditions and universal cooperation. M. Arctowski gives a brief historical sketch of polar research up to the present time, considers critically the difficulties yet to be surmounted, and suggests several new plans which would possibly prove successful in clearing up outstanding questions. Mr. S. Leonard Bastin discusses the possibility of an intelligence in the plant. The purpose of the paper is to bring together a few instances which seem to point to a limited intelligence in the vegetable kingdom. The cases selected are those not easy to explain as direct response to any special stimuli. The Droseraceæ provide Mr. Bastin with several instances. The study of roots and the opening and shutting of floral envelopes add other interesting examples to a readable article. The same number of the magazine contains some reflections upon English and German education, by Mr. R. B. Lattimer.

THE Proceedings of the Royal Physical Society, Edinburgh, for September (vol. xvi., No. 6), contains an interesting account of certain blood-inhabiting protozoa by Miss Muriel Robertson, including the description of a new trypanosome from a python. Other papers are a note on a rare sponge from the *Scotia* collection, by Prof. Arthur Thomson and Mr. J. D. Fiddes; notes on fossils from the Falkland Islands, by Mr. E. T. Newton; note on the geology of Gough Island, by Mr. J. H. Harvey Pirie; and notes on the petrology of Gough Island, by Mr. R. Campbell.

A SECOND revised edition of Prof. E. Mach's "Erkenntnis und Irrtum" has been published by the firm of J. A. Barth, Leipzig. The original work was reviewed in NATURE of November 30, 1905 (Supplement, p. vii).

THE practical treatise on "Nitro-Explosives," by Mr. P. Gerald Sanford, published by Messrs. Crosby Lockwood and Son ten years ago, was reviewed in NATURE of September 3, 1896 (vol. liv., p. 410). The second edition, revised and enlarged, which has just appeared, embodies accounts of important advances since the publication of the original work, and the chapter on smokeless powders has been considerably enlarged.

OUR ASTRONOMICAL COLUMN.

THE RELATION BETWEEN THE SPECTRA OF SUN-SPOTS AND STARS.—The conclusion arrived at by Sir Norman Lockyer regarding the similarity of the spectra of sun-spots and Arcturian stars (Proc. Roy. Soc., vol. lxxiv., 1904) receives confirmation from a research carried out at the Mount Wilson Observatory. The results of this research are published by Mr. W. S. Adams in No. 2, vol. xxiv., of the *Astrophysical Journal*. During the latter part of June some spectrograms of sun-spots were obtained, including the blue end of the spectrum, and these were compared with a spectrogram of Arcturus secured with the Snow telescope and a grating spectroscope, with a total exposure of twenty-three hours. The comparison showed that a striking resemblance exists between the sun-spot and the star spectra. Not only are the lines intensified in the spot found to be intense in the star, but the absolute intensities are very similar.

From this evidence Mr. Adams concludes, as did Sir Norman Lockyer, that the physical conditions prevailing in the atmosphere of Arcturus are nearly identical with those existing in sun-spot vapours. Hence, on the probable supposition that sun-spots are cooler than the general solar photosphere, Arcturus and similar stars must be placed on a lower temperature level than the sun.

THE MOUNT WILSON SPECTROSCOPIC LABORATORY.—An interesting illustrated account of the spectroscopic laboratory attached to the solar observatory on Mount Wilson is given by Prof. Hale in No. 2, vol. xxiv., of the *Astrophysical Journal*. As Prof. Hale points out, it is now necessary, if research in solar physics is to produce the most fruitful results, to be able to imitate, as nearly as is possible in the laboratory, the conditions of temperature, pressure, &c., obtaining in the sun. To this end the laboratory at Mount Wilson has been equipped, and the means are always at hand to obtain, immediately, spectrograms for which the light-source has been subjected to enormous pressure or temperature, or has been placed in a strong magnetic field, is in an attenuated atmosphere, or, in fact, is under any special conditions which may possibly account for peculiarities observed in the solar phenomena.

THE UTILITY OF SHORT-FOCUS REFLECTORS.—In No. 39 of the *Naturwissenschaftliche Rundschau* Dr. A. Berberich discusses the advantages of short-focus reflectors in nebula photography, and describes the results obtained at Potsdam with an astrographically mounted reflector of 41 cm. diameter and 92·7 cm. focal length. The mirror is an exceptionally good one, made by Schmidt, of Mittweida, Saxony, and giving well-defined small images, over a large field, with the full aperture. When the full aperture is used in photographing the Pleiades, the resulting photograph, with thirty minutes' exposure, shows all the details of the nebula secured by Prof. Keeler, with the Crossley reflector, in four hours.

Similarly, forty minutes' exposure on γ Cassiopeiæ shows as much detail in the nebula as was obtained by Dr. Roberts, with his reflector of 51 cm. aperture and 250 cm. focal length, in ninety minutes. With the aperture reduced to 24 cm., the Potsdam instrument will photograph the Orion nebula in one hour, and show all the details and all the stars shown on Dr. Roberts's photograph after an exposure of three hours twenty-five minutes.

PROF. BARNARD'S "UNEXPLAINED OBSERVATION."—In a letter to the *Observatory* (No. 375) Mr. Charles L. Brook suggests that the object seen by Prof. Barnard in 1892, for which he was unable to account by any known object, and therefore published a note on the subject only quite recently, may have been a new star. The reason for suggesting this possibility is that, with but one exception, all the known Novæ have appeared in the Milky Way; and Venus, which Prof. Barnard was examining when he made the unexplained observation, was on that date either on the border of or in the galaxy.

JUPITER'S SIXTH SATELLITE.—As Jupiter is now approaching opposition, the search for the smaller satellites has been commenced at Greenwich. Owing to unfavourable meteorological conditions no photographs were obtained until August 28, but on that date, and on August 31, the sixth satellite was successfully photographed with the 30-inch reflector, giving exposures of twenty-eight and forty-five minutes respectively. Several other successful photographs have been obtained since (the *Observatory*, No. 375).

OBSERVATIONS OF LONG-PERIOD VARIABLES.—In No. 4116 of the *Astronomische Nachrichten* Prof. A. A. Nijland publishes the results of a series of observations of a number of long-period variable stars. The list includes thirteen Algol variables, four short-period and forty-one long-period variables, and the observations were made with the 10-inch telescope and 3-inch finder of the Utrecht Observatory, the "step" method being employed.

THE CONGRESS OF AMERICANISTS AT QUEBEC.

THE fifteenth International Congress of Americanists was held at Quebec on September 10–15 under the presidency of Dr. Robert Bell, of the Geological Survey of Canada. There were about 133 members and associates, most of whom were Canadians; a noticeable and pleasing feature of the congress was the large number of French-

Canadian clergy and missionaries who attended the conferences; the missionaries were hearty, bronzed, bearded men, mainly in the brown or white robes of their several orders; many of them contributed papers, and several joined in the discussions. An exceptionally large number of papers was promised, but owing to the non-appearance of many authors, most of whom were Americans, the actual number read was not excessive, and there was generally time for a short discussion; it is a common fault of congresses that too much time is occupied by the reading of papers, many of which are of limited interest, and too little time is provided for discussion of problems of general interest; it is scarcely an exaggeration to state that the most valuable discussions were the informal ones that took place on the precipice-poised Dufferin Terrace.

The papers that were read fell into two or three groups, of which the more important were Canadian ethnology and Central American archæology. The former were mainly provided by missionaries, who, from their long residence among the tribes of whom they treated and their knowledge of the languages, were able to give faithful and detailed accounts of the customs and mode of life of the people; but the scientific hearers could not always feel a perfect reliance upon the interpretation of customs and ideas by certain observers, their point of view being so different.

The genial Father Morice was much in evidence, and he read a long paper on the position of women among the Dénés, or Athapascans, as they are generally termed. He described the five different ways in which marriage may be contracted, and related the deplorable part of the women during the funeral ceremonies which accompany cremation, and during widowhood in general. He repeatedly referred to the slight consideration paid to women, the men treating them no better than dogs; one would like to hear what the women themselves really think of the matter, but this information could only be obtained by sympathetic white women from native women. This side of similar questions has hardly ever been obtained, and it promises most important results. Father Pacifique, a missionary among the Micmacs, considers the *manitus*, or guardian spirits, of that tribe as of "truly diabolical nature," and states that these Indians have now conceived a profound aversion against them, and gained such an attachment to the true God and to the Church that religion has become a second nature to them. The good man apparently has not realised that the Indians were previously saturated with spiritual ideas, and that their religious sense is by no means the result of the foreign doctrine.

The Rev. J. Jetté, S.J., stated that the Ten'a, an Alaskan tribe living on the Yukon River, not only have no chiefs or rulers, but lack a word that signifies chief, or authority, or even family. Individual authority in any form is unbearable to the tribe. They are controlled solely by public opinion, and no individual thinks for himself; as they do act spontaneously they are most untrustworthy, and the stupidity of their obedience is appalling. Wealth and influence make the people who own them the natural advisers of the tribe, but they do not confer any real authority. Dr. F. Boas gave a valuable paper on the most important unsolved ethnological problems in Canada; of particular importance is archæological investigation of the extreme north-western Arctic region, in order to determine the influence of the Indian and of the Asiatic cultures upon the western Eskimo. The prehistoric distribution of types, as well as the present types, of the interior of Labrador and of the Mackenzie Basin require investigation. The linguistic subdivisions of the Algonquin and the Athapascan are not sufficiently known, and extended collections of linguistic material from the Salish tribes, from the Nootka, as well as from the northern branches of the Kwakiutl of British Columbia, are required. The early history of the eastern Algonquin still presents many obscure points. A particularly promising region is the interior of Labrador.

Prof. McCurdy exhibited a large number of lantern-slides to illustrate an extensive collection of pottery in Yale University from Chiriqui which is decorated with representations of the armadillo, the treatment including all stages from realism to extreme conventionalism, and Dr. Gordon, of the Philadelphia Museum, illustrated an analogous series of rattlesnake motives in Central American and Mexican art. Miss Angel de Cora, of the Winebago tribe, described her efforts to revive among the Indian students of the Government school at Carlisle the decorative art of their respective tribes; the experiment has met with great success, and the Indians have begun to recover their national pride and an interest in their legendary lore. Miss Natalie Curtis, who has travelled much in North America and lived among various tribes in order to study their music and songs, sung before the congress a delightful series of various types of Indian songs; these were faithfully rendered with great spirit.

Several papers were given by the veteran Dr. Seler on his recent discoveries in Mexico, and he joined in many discussions; and Senor L. Batres, of Mexico, gave a long, copiously illustrated account of his recent excavations in Teotihuacan. Dr. Tozzer gave an interesting account of his field work in Central America. The Maya of Yucatan are at present all Catholic, but they still retain a considerable number of their old beliefs and customs, although in a modified form. The Lacandones, who are comparatively free from outside influence, retain many of their ancient customs. They make pilgrimages to ruined cities, where they offer incense to the gods, making offerings of copal placed in the bowls of incense burners. Idols are anointed with blood drawn from the ear. The names and attributes of deities recorded by early Spanish writers have also survived; but no knowledge of the hieroglyphic writing survives, a circumstance which appears to be due to the extinction of the noble and priestly castes; the surviving population probably represents the descendants of the ancient common people, who, while having a general superficial knowledge of ceremonial religion, would not be instructed in esoteric religion or in ceremonial lore.

The above are some of the subjects brought before this congress, and are sufficient to show the range of subjects dealt with; from this point of view the congress was very successful, and not less was this the case from the social aspect. Government officials and private citizens did their best to render the congress a success, and especial thanks are due to the staff of Laval University, who by their assiduity, urbanity, and diplomacy helped to make everything go smoothly. The weather, too, was all that could be desired.

Abstracts of nearly all the papers were printed and distributed to members and associates, who were also provided with a local guide-book and various publications, amongst which may be noted a special number of the Transactions of the Department of Archæology of the University of Pennsylvania (vol. ii., part i.). The Provincial Government of Quebec gave two volumes dealing with geographical names in Quebec. The Provincial Government of Ontario presented the archæological report of the Department of Instruction; this contains a number of valuable papers on the archæology, anthropology, and ethnology of Canada by authors of repute; indeed, it forms a very welcome statement of the present state of our knowledge of these subjects. The University of California contributed a report, by Putnam and Merriam, on cave exploration in California, and the American Anthropological Association a report on anthropology in America since the New York meeting, 1902. A series of publications, by L. Batres, was given by the Commission of Inspection and Preservation of Antiquities of Mexico.

It is to be hoped that one result of the congress will be to encourage the central and provincial governments and the learned societies of the Dominion to take a greater interest in their native peoples. Unfortunately there has been great neglect in this respect, and if those in authority do not bestir themselves it will soon be too late, as the opportunities for successful work are rapidly disappearing. The British Association has given a small grant for many years towards ethnological research in British Columbia, and for the last year or two the Government grant committee has continued this work; valuable results have been obtained, but this is but a drop in the bucket, and ethnologists look to the Canadian governments to complete the work in a manner worthy of a great country.

A. C. HADDON.

THE STUDY OF FOSSIL FISHES.[1]

THE discovery of general principles in the study of fossils is much hampered by the imperfection of the geological record. As every geologist is aware, we are dependent for our knowledge of the life of past ages on a few isolated episodes which have been locally preserved. There is no continuous history of the life of long periods in the rocks of any region that has hitherto been well explored. Cessations in the deposit of sediment, the recurrence of unfavourable conditions, and extensive migrations, among other causes, have all contributed to this result. An increasing acquaintance with scattered episodes in the secular development of life, however, tends to reveal its main outlines; and if we are unable to discover the actual facts we can at least arrive at an approximation to them which serves all immediate purposes. If we can determine the "fashion," so to speak, which prevailed during each successive period in the geological history of a race of animals, we are able to distinguish between those changes in anatomical structure which led to stagnation or extinction, and those which were necessary for evolution to a higher plane. An acquaintance with the precise links between one grade and the next is not of supreme importance.

In the case of fossil fishes, some general principles are already discoverable, and they may be treated as an illustration of the results which palæontology is now attaining.

The earliest remains of fish-like animals satisfactory enough for discussion are those from the Upper Silurian rocks, both of Europe and North America. They suggest that long before the latter part of the Silurian period fishes had already become a flourishing and varied race, but could not be preserved among fossils because they had not

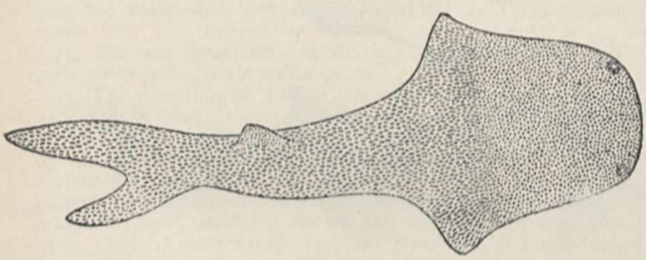

FIG. 1.—*Thelodus scoticus*, Traquair; head seen from above, the tail twisted to show dorsal fin and heterocercal tail mainly in side-view, about one-half nat. size.—Upper Silurian; Lanarkshire. To illustrate the most primitive skeleton of separate skin tubercles. [After Traquair.]

acquired a hard skeleton. The Upper Silurian fossils show how this skeleton first began, and, if we may assume that the order in which the different kinds of hard parts successively predominate is the order in which they evolved, it is easy to perceive how they gradually arose. Fortunately all the phenomena can be traced in one compact group of lowly fish-like animals, the Ostracodermi or Ostracophori, which are so readily distinguished from the fishes proper that there is no risk of confounding with them members of any other line of descent. The hard skeletal parts were confined exclusively to the skin, and in most of the earliest members of the group they were merely scattered tubercles of limy matter like the shagreen of modern sharks (Fig. 1). The tubercles fused together into armour plates in two different ways. Sometimes (as in the Cephalaspidæ) a few regularly spaced tubercles grew larger than the others, and each of these became a centre of attraction round which the immediately surrounding tubercles coalesced to form polygonal plates. These coalesced again in accordance with the shape and motions of the underlying soft parts. More rarely (as in the Asterolepidæ) fusion of the tubercles occurred first along the sensory canals, thus eventually producing overlapping armour plates which were symmetrically arranged like those of Pterichthys.

No link is known between the Ostracoderms and the typical fishes which have a lower jaw and paired fins; and it is evident that the latter had already appeared in Silurian times before they possessed a skeleton hard enough to be preserved among fossils. The Silurian and earliest Devonian Acanthodians (Fig. 2), however, cannot be far from the beginning of these typical fishes, and they seem to show how paired fins began. These very old Acanthodians are known because they are completely covered by small, hard skin-granules like those of the oldest fossilised Ostracoderms. Not only did the armour begin here in the same way as in the Ostracoderms, but there was also an

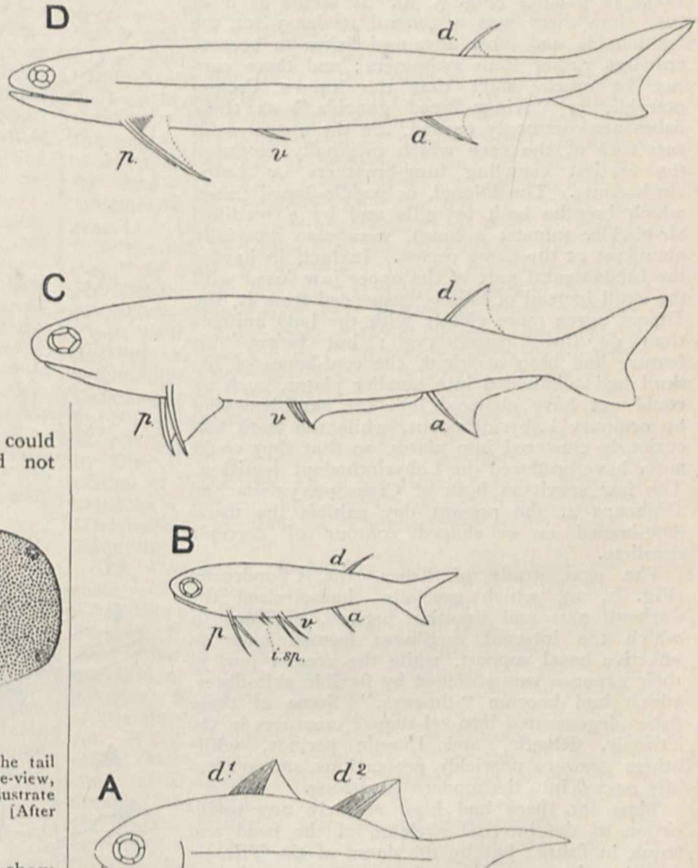

FIG. 2.—Outlines of Acanthodian Fishes, illustrating their gradual elongation in shape and loss of "intermediate spines," as they are traced upwards in geological formations. A, *Climatius scutiger*, Egerton; Lower Old Red Sandstone, Forfarshire. B, *Mesacanthus mitchelli* (Egerton); *ibid.* C, *Acanthodes sulcatus*, Agassiz; Lower Carboniferous, Edinburgh. D, *Acanthodes gracilis*, Roemer; Lower Permian, Bohemia. [Figs. B, C after Traquair, D after Fritsch.] *a.*, anal fin; *d.*, dorsal fin; *i. sp.*, pairs of spines between paired fins ("intermediate spines"); *p.*, pair of pectoral fins; *v.*, pair of pelvic fins.

occasional fusion of the skin-granules into plates where stiffness was possible or necessary. A few rows of the granules fused together at the front edge of the median fins above and below the body, thus forming cut-waters or "spines"; and as a double series of exactly similar "spines" occurs along the lower border of the abdomen where the two pairs of fins are found in later fishes, it is reasonable to infer that these are likewise the stiffened front edges of fins. In other words, paired fins were not originally restricted to two pairs, but formed a double series along the entire length of the abdomen. The later Acanthodians (Fig. 2, C, D) had only the ordinary two pairs

[1] Abridged from the Presidential Address to the Geologists' Association, February 2, 1906. (Proc. Geol. Assoc., vol. xix., pp. 266–282, figs. 1–15.)

of fins; but as these were unsuited for further elaboration, the primitive fishes of this grade did not advance further. They became long-bodied or almost eel-shaped before their final extinction.

Fishes only began to make real progress when their fin-flaps were stiffened by internal rods of cartilage in addition to the hard skin-structures. Such fins were essentially paddles, and could be used for crawling in the mud as well as for ordinary swimming in water. It is therefore interesting to observe that during the Middle and Upper Devonian periods, when four-legged lung-breathers must have been just beginning to appear on the land, nearly all the highest fishes had their fins in the shape of paddles (Fig. 3, A). It seems as if at that time there was a general tendency for the fashionable and most advanced fishes to become crawlers rather than swimmers; and there cannot be much doubt that the known Crossopterygii, or "fringe-finned ganoids," as these fishes are commonly termed, are the unsuccessful survivors of the race which originally produced the earliest crawling lung-breathers or Labyrinthodonts. The Dipnoi, or paddle-finned fishes, which breathe both by gills and by a modified air-bladder (almost a lung), were also especially abundant at the same period. In fact, in having the fundamental part of the upper jaw fused with the skull instead of loosely suspended from it, the Dipnoi agree more closely with the land animals than do the Crossopterygii; but before this feature had been acquired, the roof-bones of the skull had subdivided into smaller plates, such as could not have changed into the skull-bones of an ordinary Labyrinthodont, while the teeth had curiously clustered into plates, so that they could never have produced the Labyrinthodont dentition. The few survivors both of Crossopterygians and Dipnoans at the present day exhibit the usual long-bodied or eel-shaped contour of decrepit derelicts.

The next grade of fishes, the Chondrostei (Fig. 3, B), which specially characterised the Carboniferous and Permian periods, had fins in which the internal cartilages formed only an effective basal support, while the greater part of their expanse was stiffened by flexible skin-fibres, which had become "fin-rays." Some of these fishes degenerated into eel-shaped creatures in the Triassic, Rhætic, and Liassic periods, while others grew to unwieldy proportions and eventually passed into the modern sturgeons.

Thus far there had been scarcely any ossification of the internal skeleton of the head and trunk in fishes; but by the dawn of the Triassic period a large number of the Chondrostei had passed into the Protospondyli, and then the formation of a hard brain-case and vertebral column began. This only happened after the median fins had become absolutely complete, namely, after the upper lobe of the tail had shortened so that the tail-fin formed a flexible fan-shaped expansion at the blunt end of the body, while each separate ray in the other median fins was provided with its own definite support. The Protospondyli (Fig. 3, C) characterised the Triassic, Rhætic, and Jurassic periods, and exhibited endless variety; but their sole survivors at the present day are the long-bodied Lepidosteus and Amia of American fresh waters.

Associated with almost the earliest Protospondyli, there were a few precocious fishes which evidently completed their vertebral column at once. This race, including such genera as Pholidophorus and Leptolepis, seems to have temporarily exhausted itself in the effort, for it always occupied a secondary place in the fish-faunas until the beginning of the Cretaceous period, when it rapidly multiplied, became fashionable, and replaced the Protospondyli. Thus arose the modern fishes of the same grade as the herring and salmon, characterised, not only by a complete vertebral column, but also by a simplified lower jaw, which consists only of two pieces on each side (without the splenial bone which forms so conspicuous a feature of the earlier fishes). The Isospondyli, as they are termed, being thus provided with a completely bony internal skeleton as well as completed fins, admitted of many more variations than any of their forerunners. The typical fish-head now began, for the first time in its history, to exhibit essential changes. The supraoccipital bone often grew upwards to project on the roof, and thrust outwards the now well-ossified and enlarged ear-capsules (Chirocentridæ); while the premaxilla sometimes extended backwards to slip beneath the maxilla and exclude the latter from the margin

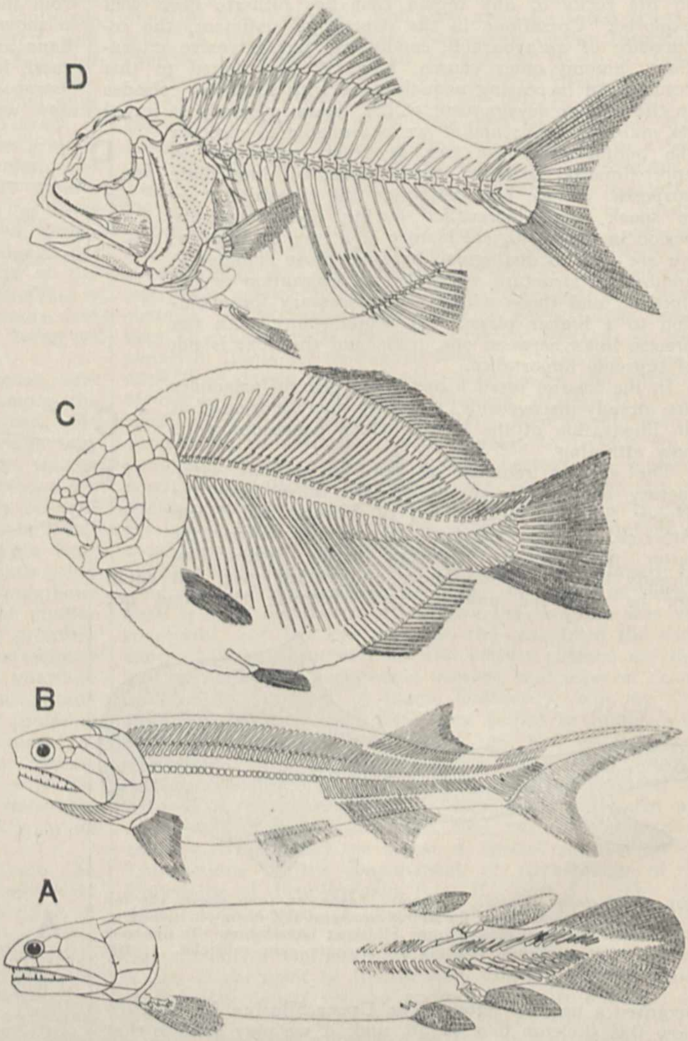

FIG. 3.—Diagram illustrating grades in the evolution of bony fishes.—A, Paddle-finned fish (Rhizodont Crossopterygian) characteristic of the Middle and Upper Old Red Sandstone periods, internal skeleton only partially shown in drawing; *tendency* towards shortening lobes of fins and simplifying their internal supports. B, Ray-finned fish (Palæoniscid) characteristic of the Carboniferous and Permian periods, showing the extended pelvic fin with numerous supports, the dorsal and anal fins with supports fewer than rays, and the caudal fin heterocercal; *tendency* towards shortening upper lobe of tail, and towards equality in number between rays and their supports in the other median fins. C, Ray-finned fish (Dapedius) characteristic of the Triassic and Jurassic periods, showing short-based pelvic fin with one large support, the dorsal and anal fins having a separate support for each ray, and the caudal fin almost homocercal; *tendency* towards acquisition of bony vertebræ and ossification of the cartilaginous skull. D, Modern ray-finned bony fish (Hoplopteryx) characteristic of the Upper Cretaceous and Tertiary periods, showing premaxilla below maxilla, completed internal skeleton, pelvic fins far forwards, and some spinous fin-rays; *tendency* towards extreme development of ear-capsules, supraoccipital bone, and premaxilla, besides a fixed number of spinous fin-rays and the forward position of the pelvic fins.

of the upper jaw (Enchodontidæ). The pelvic fins in a few fishes were now displaced forwards, so that their supports even touched the bones bearing the pectoral fins (Ctenothrissidæ). Still more interesting, the bones of the gill-cover began for the first time to develop spines (Enchodontidæ).

Among fishes, as among other animals, spines characterise only the latest representatives of the class. When the skeleton is well ossified, races which have reached or just passed their prime tend to acquire more skeletal matter than they actually need, and the surplus is then arranged as spines and bosses, usually in a symmetrical manner. In the case of fishes, some of the fin-rays become hardened, and spines arise chiefly on the cheeks and gill-covers. The Acanthopterygii ("spine-finned") are thus the highest and latest fishes of all, though they sometimes eventually descend from their high estate by degeneration. They exhibit all the peculiar changes in the skull, upper jaw, and pelvic fins noticed as first appearing in a variable manner in the Cretaceous Isospondyli. They also differ from all the earlier races of fishes in the common numerical fixity of their vertebræ and fin-rays. There are whole families in which the number of vertebræ never varies, and there are large genera in which all the species have the same definite number of spinous fin-rays.

The spiny-finned fishes began by Berycoids and possibly Scombroids in the Chalk, closely resembling, but not identical with, genera living at the present day. The so-called Beryx of the Chalk (Hoplopteryx, Fig. 3, D) is now proved to be very different from the existing genus bearing that name. By the Eocene period, however, nearly all the modern groups of Acanthopterygii had become completely separated and developed, and their sudden appearance is as mysterious as that of the early Eocene Mammalia.

The study of fossil fishes, as now pursued, is thus an attempt to solve the following fundamental problems:—

(1) The nature and order of the successive advances in anatomical structure which have suddenly infused new life into the class—the "expression points," as Cope termed them.

(2) The new possibilities of development which arose with each successive "expression point."

(3) The direction of the various abortive lines of advance and degeneration in each successively higher grade.

The results of such a study have an important bearing on the most fundamental questions concerning "living" matter as contrasted with "dead" matter; for, in my opinion, we are much more likely to approach some explanation of life by studying the secular development of whole races than by examining the vital processes of individuals or by comparing the members of a single contemporaneous fauna.

A. SMITH WOODWARD.

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Mr. William Heinemann announces :—" The World's History : a Survey of Man's Record," edited by Dr. H. F. Helmolt :—Vol. v., " Eastern Europe," vol. vi., " The Teuton and Latin Races," vol. viii., " Western Europe since 1800—The Atlantic Ocean "; " Motors and Men, a Guide for Non-technical Readers to the Construction, Management, and Use of the Automobile," by H. Norman, M.P., illustrated; " The Desert and the Sown : Tales of Syrian Travel," by G. Lowthian Bell, illustrated; " The Garden Library " :—" Roses, and how to Grow Them, a Manual for Growing Roses in the Garden and under Glass," illustrated, " Ferns, and how to Grow Them," by G. A. Woolson, illustrated; " A Handbook of Metabolism," by Prof. C. von Noorden, 3 vols., translated; " Medical Hygiene " (The Harben Lectures, 1906)," by Prof. E. Metchnikoff; " The Criminal Prosecution and Capital Punishment of Animals," by E. P. Evans; " Hints on the Management of the Commoner Infections," by Dr. R. W. Marsden; " Eclipse, and the Modern Thoroughbred," compiled and edited by T. A. Cook, with the assistance of various experts, illustrated; " The Dog Book," by J. Watson, 2 vols., illustrated; and new editions of " Sex and Character," by O. Weininger; " The Nature of Man : Studies in Optimistic Philosophy," by Prof. E. Metchnikoff, edited by Dr. P. C. Mitchell.

Messrs. Hodder and Stoughton's list includes :—" Panama to Patagonia, the Isthmian Canal and the West Coast Countries of South America," by C. M. Pepper, illustrated; " The Nature and Origin of Life in the Light of Modern Knowledge," by Prof. F. le Dantec; " Physical Diagnosis," by E. Le Ferre; " The Pathology of the Eye," by Dr. J. H. Parsons; " Dental Materia Medica and Prescription Writing," by E. H. Long; and " The Home in Order," by Dr. A. T. Schofield.

Messrs. T. C. and E. C. Jack's list contains :—" Wireless Telegraphy," by W. J. White, illustrated; and " Spiritualism," by E. T. Bennett, with preface by Sir Oliver Lodge, F.R.S., illustrated.

Mr. John Lane promises :—" Rifle and Romance in the Indian Jungle, Record of Thirteen Years of Indian Jungle Life," by Captain A. I. R. Glasfurd, illustrated; (Practitioner's Handbooks) :—" Forms of Paralysis," by J. S. Collier, " Post-mortem Handbook," by C. R. Box, " Minor Operations," by E. M. Corner; (Country Handbooks) :—" Stable Handbook," by T. F. Dale, illustrated, and a new edition of " Tree Book," by M. R. Jarvis; (Handbooks of Practical Gardening) :—" Book of Pruning and Grafting," by R. L. Castle, " Book of the Flower Show," by C. H. Curtis, and " Book of the Chrysanthemum," by P. S. Follwill.

Mr. Werner Laurie announces :—" Lotus Land, being an Account of the Country and the People of Southern Siam," by P. A. Thompson, illustrated.

In Messrs. Crosby Lockwood and Son's list we notice :—" Gold Mining Machinery, its Selection, Arrangement, and Installation, for Use of Mine Managers and Engineers, with a Chapter on the Preparation of Estimates of Cost," by W. H. Tinney, illustrated; " Engineering Standards Committee's Publications "; " First Lessons in Coal Mining for Use in Primary Schools," by W. Glover; " Blast Furnace Calculations and Tables for Furnace Managers and Engineers," by J. L. Stevenson; " Electric Wiring, Diagrams, and Switchboards, Practical Guide for Wiremen and Others," by N. Harrison; " Portfolio of Measured Drawings," issued annually by the School of Architecture of the University of Liverpool under the direction of C. H. Reilly, vol. i.; " Handbook of Reinforced Concrete, for Architects, Engineers, and Contractors," by F. D. Warren; " Practical Farming in relation to Soils, Manures, Crops," by E. T. Shepherd; " Leather Manufacture, Handbook of Tanning, Currying, and Chrome Leather Dressing," by A. Watt; " Practical Patternmaking," by W. F. Barrows, illustrated; " Cultivation and Preparation of Para Rubber," by W. H. Johnson; " Concise Interest Calculator," by A. M. Campbell: and a new edition of " Art and Science of Sail-making," by S. B. Sadler, illustrated.

Messrs. Longmans and Co. give notice of :—" A Memoir of Thomas Hill Green, late Fellow of Balliol College, Oxford, and Whyte's Professor of Moral Philosophy in the University of Oxford," by R. L. Nettleship, reprinted from the third volume of " The Works of Thomas Hill Green," with a short preface specially written for this edition by Mrs. T. H. Green; " The Design of Lathes for High Speed and Heavy Cutting," by J. T. Nicolson and D. Smith; " The Electron Theory : a Popular Introduction to the New Theory of Electricity and Magnetism," by E. E. Fournier D'Albe; " Producer Gas," by J. E. Dowson and A. T. Larter; " Practice and Science of Religion : a Study of Method in Comparative Religion," by J. H. Woods; and " The Mammals of Great Britain and Ireland," by J. G. Millais, vol. iii., illustrated.

Messrs. Macmillan and Co., Ltd., announce :—" Pagan Races of the Malay Peninsula," by W. W. Skeat and C. O. Blagden, 2 vols., illustrated; " The Lower Niger and its Tribes," by Major A. G. Leonard; " At the Back of the Black Man's Mind; or, Notes on the Kingly Office in West Africa," by R. E. Dennett, illustrated; " Berkshire," by J. E. Vincent, illustrated (Highways and Byways Series); " An Outline of the Idealistic Construction of Experience," by Prof. J. B. Baillie; " The Structure and Growth of the Mind," by Prof. W. Mitchell; " Studies in Humanism," by Dr. F. C. S. Schiller; " Alcohol and the Human Body : a Survey of Modern Knowledge on the Subject," by Sir Victor Horsley, F.R.S., and Dr. Mary D. Sturge, with a chapter by Dr. A. Newsholme; " Studies in the Bacteriology and Ætiology of Oriental Plague," by Dr. E. Klein, F.R.S., illustrated; " The Clinical Study of Epilepsy," by Dr. W. A. Turner; " Some Points in the Surgery of the Brain and its Membranes," by C. A. Ballance, illustrated; and new editions of " A System of Medicine," by many writers, a new edition, edited by Prof. T. Clifford Allbutt, F.R.S., and Dr. H. D. Rolleston, vol. ii., in two parts; " Anæsthetics and their Administration," by Dr. F. W. Hewitt; " A Handbook of Metallurgy," by Prof. C. Schnabel, translated and edited by Prof. H. Louis, vol. ii., illustrated; " History of Chemistry from the Earliest Times to the Present Day," by Prof. E. Meyer, translated by Dr. G. McGowan.

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Mr. Murray's list includes :—" The Shores of the Adriatic : an Architectural and Archæological Pilgrimage, the Italian Side," by F. H. Jackson, illustrated; " An Idler in the Wilds," by T. Edwardes, illustrated; " Heredity," by Prof. J. A. Thomson (The Progressive Science Series); " A Philological Study of the English Language," by Prof. H. C. Wyld; " Recent Advances in the Study of Variation, Heredity, and Evolution," by R. H. Lock, illustrated; " Simla Village Tales : or, Folktales from the Himalayas," by A. E. Dracott, illustrated; " The Life of Isabella Bird " (Mrs. Bishop), by Miss A. M. Stoddart, illustrated; " Recent Development in Biological Science," by W. B. Hardy, F.R.S.; " Exercises in Physics, for the Use of Schools," by J. H. Leonard and W. H. Salmon; and " Science Progress in the Twentieth Century, a Quarterly Journal of Scientific Thought," No. 2.

Messrs. George Newnes, Ltd., give notice of :—" A Technological and Scientific Dictionary."

Messrs. J. Nisbet and Co., Ltd., promise :—" Experiments on Animals," by S. Paget; and " Alcoholism," by W. C. Sullivan.

Messrs. George Philip and Son, Ltd., announce :—" Model Duplex Maps," a series of maps for scholars' use, showing a photo-relief model and a political map coloured opposite one another, with summaries of geographical information, sixteen varieties; and a new series of " Geographical Readers," by H. J. Mackinder, illustrated.

In Messrs. G. P. Putnam's Sons' list we notice :—" The Evolution of Religions," by E. Bierer; " Diagnosis of Organic Nervous Diseases," by Dr. C. A. Herter, illustrated; " The Family : an Ethnographical and Historical Outline, with Descriptive Notes, planned as a Text-book for the Use of College Lecturers and Directors of Home-reading Clubs," by Dr. E. C. Parsons; "On the Great American Plateau: Wanderings among Canyons and Buttes in the Land of the Cliff Dweller, and the Indian of To-day," by T. M. Prudden, illustrated; "Scientific Sanction for the Use of Alcohol, Proved and Popularly Expanded by a Physiologist," by Dr. J. Starke; "Hunting Big Game with Gun and with Kodak: how Wild Animals Look and Live in their Haunts, from Personal Experiences in the United States, Dominion of Canada, and Old Mexico," by W. S. Thomas, illustrated; "A Manual of Prescription Writing, with a Full Explanation of the Methods of Correctly Writing Prescriptions, and Rules for Avoiding Incompatibilities and for Combining Medicines," by Dr. M. D. Mann; "Science and a Future Life," by Dr. J. H. Hyslop; "Enigmas of Psychical Research," by Dr. J. H. Hyslop; "The Interpretation of Nature," by Prof. C. Lloyd Morgan, F.R.S.; and "Life in the Open: Sport with Rod, Gun, Horse, and Hound in Southern California," by C. F. Holder, illustrated.

The Religious Tract Society promises:—"Stories of Animals," illustrated; "Stories of the Seasons," illustrated; "Animal Life," illustrated; "Round the Sun," illustrated; "By-paths in Nature," by F. Stevens, illustrated; "Every Boy's Book of British Natural History," by W. P. Westell, with an introduction by Lord Avebury, F.R.S., illustrated; and new editions of "How to Study Wild Flowers," by Rev. G. Henslow, illustrated; and "Walks and Talks in the Zoo," by H. Scherren, illustrated.

Messrs. E. Grant Richards will publish:—"Christopher Columbus and the New World of his Discovery," a narrative by F. Young; and "Voyages of Captain William Dampier," edited by J. Masefield, illustrated.

In Messrs. Alston Rivers's list appears:—"Tibet the Mysterious," by Sir Thomas Holdich, K.C.M.G.

Messrs. Smith, Elder and Co. promise:—"The New Physics and Chemistry: a Series of Essays on Physical and Chemical Subjects," by W. A. Shenstone, F.R.S.; "South Polar Times," reproduced in facsimile, with coloured sketches by Dr. Wilson, and other illustrations, brought out by the officers of the National Antarctic Expedition on board the *Discovery*, during the winters of 1902 and 1903; and "Animal Life," by Dr. F. W. Gamble.

Messrs. Swan Sonnenschein and Co., Ltd., direct attention to:—"Thought and Things: a Study of Logical Process," by Prof. M. Baldwin, vol. ii., "Experimental Logic," vol. iii., "Real Logic"; "The History of Philosophy," by Dr. J. E. Erdmann, revised by W. B. Erdmann, an English abridgment, translated and edited by W. S. Hough; "A Treatise on Psychopathology," by Prof. Storring, translated by Prof. T. Loveday; "Physiological Psychology," by Prof. W. Wundt, translated by Prof. E. B. Titchener, vol. ii., illustrated; "The Student's Text-book of Zoology," by A. Sedgwick, F.R.S., vol. iii., illustrated; "The Natural History of Our Shores," by J. Sinel, with chapters on collecting and preserving marine specimens, methods of microscopic mounting, and the marine aquarium, illustrated; and "How to Study Geology," by E. Evans, illustrated.

The University Tutorial Press will issue:—"Geometry, Theoretical and Practical," by W. P. Workman and A. G. Cracknell, parts ii. and iii.; Clive's "New Shilling Arithmetic"; "The Junior Chemistry," by R. H. Adie; "Technical Electricity," by Prof. H. T. Davidge and R. W. Hutchinson; "Elementary Science of Common Life (Chemistry), Subject xxvi. of the Board of Education Science Examinations," by W. T. Boone; "New Matriculation Physics, Heat, Light, and Sound," by Dr. R. W. Stewart and J. Don; and "Certificate Hygiene," by R. A. Lyster.

In Mr. T. Fisher Unwin's list we observe:—"The Principles and Practice of X-Ray Diagnosis and Therapy," by Dr. J. Rudis-Jicinsky, illustrated; "The Horse: a Guide to its Anatomy for Artists," 110 drawings (reproduced by photolithography) by H. Dittrich, with explanatory notes by Profs. Ellenberger and Baum; "Methods in Plant Histology," by Dr. C. J. Chamberlain, illustrated; "The Psychology and Training of the Horse," by Count E. M. Cesaresco; "The Sanitary Evolution of London," by H. Jephson; "The Psychology of Child Development," by I. King; and a new edition of "Australian Sheep and Wool: a Practical and Theoretical Treatise," by A. Hawkesworth, illustrated.

Messrs. F. Vieweg and Son (Brunswick) direct attention to:—"Prüfungen in elektrischen Zentralen," by Dr. E. W. Lehmann-Richter, II. Teil, illustrated; "Die chemische Düngerindustrie," by L. Schucht, illustrated; "Die Anilinfarben und ihre Fabrikation," by Dr. K. Heumann, vierter Teil, edited by Prof. G. Schultz, Zweite Hälfte, erste und zweite Abteilung; "Sechs Vorträge über das thermodynamische Potential und seine Anwendungen auf chemische und physikalische Gleichgewichtsprobleme," by J. J. van Laar; "Die Nichtzuckerstoffe der Rüben in ihren Beziehungen zur Zuckerfabrikation," by Dr. A. Rümpler; "Technisch-Chemisches Jahrbuch, 1904," edited by Dr. R. Biedermann; "Die Untersuchung des Erdöles und seiner Produkte," by M. A. Rakusin, illustrated; and "Handbuch der chemischen Technologie," edited by Profs. Bollen and Birnbaum, sections 13 and 14.

Messrs. Watts and Co. announce:—"A Picture Book of Evolution," by D. Hird, illustrated; "The New Scientific System of Morality," by Dr. G. Gore, F.R.S.; and "The Cultivation of Man, according to the Teachings of Common Sense," by C. A. Witcheil.

Messrs. Whittaker and Co. promise:—"Modern Practice in Coal Mining," by D. Burns and G. L. Kerr; "A Pocket-book of Aëronautics: a Practical Treatise for Balloonists," by H. W. Moedebeck; "Electricity in Mining," by P. R. Allen; "Electric Lamps and Photometry," by L. Gaster; "Concrete Steel Buildings: a Treatise giving the Examples of Reinforced Concrete Construction," by W. N. Twelvetrees; "A Guide to Electric Lighting," by S. R. Bottone; "Motor Construction," by T. Gray; "The Care of Motor-cars," by T. Gray; "An Advanced Text-book on Steam, Gas, and Oil Engines," by J. W. Hayward; "A Treatise on Fuels," by T. Gray; "Motor-car Ignition Methods," by W. Hibbert; and "Sound, Light, and Heat," by J. R. Ashworth.

Messrs. Williams and Norgate direct attention to:—"The Surgical Anatomy of the Horse," by J. T. Share Jones, in four parts.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. W. L. H. Duckworth, Jesus College, has been appointed demonstrator in anatomy for one year.

Mr. J. F. Cameron, Caius College, and Mr. G. T. Bennett, Emmanuel College, have been nominated moderators, and Mr. A. Munro, Queens' College, and Mr. R. H. D. Mayall, Sidney Sussex College, examiners in part i. of the mathematical tripos for the year beginning May 1, 1907.

The proposed alterations in the regulations for the mathematical tripos will be voted upon at a Congregation fixed for 2 o'clock on Thursday, October 25.

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DR. G. C. SIMPSON has resigned his post as lecturer in meteorology at the University of Manchester on his appointment as assistant to the director of observatories under the Indian Government.

ON Tuesday evening, October 9, Prof. H. G. Seeley, F.R.S., began a course of lectures at King's College, London, on some of the larger questions of geology, including (1) atmospheric denudation; (2) jointing in rocks; (3) internal heat of the earth; (4) the relations of rock masses; (5) minerals which form rocks. The lectures will be delivered on alternate Tuesday evenings, at 6 p.m., during the Michaelmas term.

THE Merchant Venturers' Technical College at Bristol was totally destroyed by fire early on Tuesday morning. The fire appears to have broken out in the chemical laboratory on the top floor, and in a short time the whole building was in flames. The college, which was attended by more than two thousand students in the day and evening classes, was erected in 1885 by the Society of Merchant

Venturers at an outlay of about 50,000*l*., which is covered by insurance, but not the least heavy loss sustained is that of books and manuscripts in the library of the principal, Prof. Wertheimer.

AT the distribution of prizes awarded to successful students of the Royal College of Science, for the session 1905–6, on October 4, Prof. W. A. Tilden, who presided, remarked that two public events of great importance to the college have occurred since the prize distribution last year. The first is the publication of the final report of the departmental committee appointed to study the condition, appliances, purposes, and work of the Royal College of Science and the Royal School of Mines, and to consider what could best be done with them. The committee well described the main object of the institution to be the teaching of science, especially in its application to industry. The other event is the practical completion of the great museum buildings, which have been in progress for seven or eight years. Dr. T. E. Thorpe, who presented the prizes, in an address to the students said those whose business it is to examine students recognised that the system of examinations, like all human institutions, is liable to fall into error. Nevertheless, it is the conviction of those who have given dispassionate consideration to the matter that, faulty and fallible as the system may be, it affords the best method of arriving at the relative positions of schools and students. As a rule, in England a university takes only its name from the place in which it is situated. What has made the Aberdeen University an integral part of the life of the people is that the people make special efforts to create and maintain it, and their self-sacrifice on its behalf gives them an abiding interest in it. It is an unfortunate thing for education in London that London is so vast it is impossible to get collective effort and collective influence enlisted for any of its educational institutions.

A SERIES of articles on public-school education was commenced in the *Times* of September 10, and among the subjects which have been dealt with in the eight contributions which have been published already are mathematics, science, and engineering. Mr. T. J. Garstang, in his article on the teaching of mathematics (September 13), traces the course of development which has led to the adoption of reformed courses of geometry, arithmetic, and algebra in our schools. Much, however, remains still to be accomplished. As Mr. Garstang points out, the commercial arithmetic still exacted through examinations is largely either a survival of past commercial method or a collection of artificial fictions. Mr. W. D. Eggar, writing on science in public schools (September 20), considers what school science is now compared with what it was thirty years ago. Thanks largely to Prof. Armstrong's efforts, science teaching by lectures or talks illustrated by curious experiments has given place to practical work, by which pupils measure and weigh and accumulate experience by and for themselves. If nature-study forms part of the English teaching in schools, and practical measurement part of the mathematical work, Mr. Eggar thinks it is possible in one stage of every boy's career to give him a real chance of learning scientific method. In some middle portion of the school through which all boys must pass, a year's course with four hours a week should be mapped out. To this work the main energies of the laboratory staff must be directed, and the classes must be small. The most suitable subjects Mr. Eggar believes to be heat or chemistry or magnetism and current electricity. The subject should be one in which mathematical theory may be kept in the background until a thorough practical acquaintance with facts has been gained; also one which gives ample scope for cultivating the scientific virtues of accuracy and honesty. The Rev. F. Stephenson describes (October 9) what is done by a public school to train boys who intend to become engineers. In his concluding paragraph he remarks:—"The public school caters mostly for those whose means and brains alike are limited, and attempts to combine the teaching of the science of engineering in the class-room with practice in the workshops in such a way that at eighteen a boy may be ready to take full advantage of the opportunities offered him in large commercial works, and may neither waste six months in picking up as best he may from mechanics the purport of nuts, valves, and cylinders, nor allow himself to sink in manners and morals to lower standards that may not unnaturally be prevalent among associates of a humbler class."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 28.—"An Investigation of the Influence of Electric Fields on Spectral Lines." Preliminary Note. By Prof. G. F. **Hull**. Communicated by Prof. J. Larmor, Sec.R.S.

In general the electrical fields used were those concomitant with the luminous electric discharge. An interferometer of the Michelson form and an echelon spectroscope of eighteen plates were used to analyse the radiations. The results may be summarised as follows:—

(1) End-on discharge tubes of special design in which the light-source was a uniform column of luminous mercury vapour, viewed in the direction of discharge, showed no change of wave-length so great as 1 part in 4,000,000 when the direction of the discharge was reversed. The pressure in the tube was varied from a few millimetres to a vacuum so high that there was but little luminosity.

(2) The passage of Röntgen rays through the tube did not alter the wave-length nor the width of the mercury lines to an extent sufficient to affect the visibility of interference fringes formed with a difference of path of 400,000 waves. When the luminous column was viewed at right angles to the direction of the discharge no polarisation effects in the radiation from it, due to the passage of the Röntgen rays, could be detected by a sensitive Savart plate and Nicol prism.

(3) When the discharge passed in air between electrodes formed of an amalgam of cadmium and mercury, no variation of the wave-lengths of the strong Cd, Hg, lines greater than 0·002 tenth-metre was obtained by changing the line of sight from a direction along the discharge to one at right angles to that direction. Approximately the same result held good when a small capacity was inserted in the circuit, but in this case the discrepancies in the readings were larger.

This result shows that the luminous particles do not acquire a velocity in the direction of the discharge greater than 150 metres per second. Hence the curving of the image of the discharge produced by a rotating mirror, as in the Feddersen experiment, and as recently studied by Schuster and Hemsalech for individual spectral lines, appears to be due, not so much to motion of luminous particles as to the propagation along those particles of a condition of luminosity.

(4) Doppler effects in the canal rays, as announced by Stark during the course of the present investigations, were found for the strong hydrogen lines. In some cases they appeared also in mercury lines. The velocities represented by the displacements of the lines were of the order of 4×10^5 metres per second for the hydrogen particles and $2{\cdot}5 \times 10^4$ metres per second for those of mercury. But it was found that, in general, the luminous mercury particles in the canal rays did not move (with a velocity greater than 100 metres per second). In these cases the canal rays appear to be due to non-luminous particles streaming through the mercury vapour and producing luminescence in the latter, probably by bombardment.

(5) A glass tube was sealed on to a canal-ray tube at right angles to the direction of the rays. This tube was covered by a piece of optical glass as free as possible from strain. A very sensitive combination of Savart plate and Nicol prism was used to detect, if possible, any polarisation that might exist in the light from the rays in hydrogen. After eliminating reflections from the walls of the tube no polarisation could be recognised.

(6) The light produced by electrical discharge, in uniform tubes 3 cm. or 4 cm. in diameter, was examined at right angles to the direction of discharge, at various points between the electrodes, and also behind the perforated kathode. It was found that the principal hydrogen lines were greatly broadened in those parts where the electric

field is known to be of great intensity. For example, the luminous layer covering the kathode (the dark space being 0·5 cm. to 4 cm.) gave hydrogen lines 0·4 Ångström unit in width, but the lines of the second hydrogen spectrum and certain air lines were not appreciably broadened. This broadening seems to be due mainly to motion of the particles rather than change of free periods, for it is found to the same extent behind the kathode in the canal rays. The broadening is so great that it is not possible with the instruments at the author's disposal to determine the shift of these lines except to fix a superior limit of 0·1 Ångström unit to its possible magnitude. The amount is probably considerably less than this. On the other hand, the shift of the lines of the second spectrum of hydrogen is so small as to approach the limits of error, viz. 0·005 Ångström unit. The mercury lines show no shift but a slight broadening.

The experiments thus show that any electrical analogue of the Zeeman effect is, under the above conditions, largely masked by a widening of the lines.

"The Alcoholic Ferment of Yeast-juice. Part II.—The Coferment of Yeast-juice." By Dr. A. **Harden** and W. J. **Young**.

Summary.—I.—(1) Photolytic decomposition of aqueous carbon dioxide can take place in the presence of chlorophyll, independently of vital or enzymic activity, provided that the necessary physical and chemical conditions are strictly adhered to.

(2) The products of the decomposition are formaldehyde and hydrogen peroxide, formic acid being an intermediate product.

(3) It is possible to reconstruct the process of photosynthesis outside the green plant, (*a*) as far as the production of formaldehyde and oxygen, by introducing a suitable catalysing enzyme into the system, and (*b*) as far as the production of oxygen and starch, by introducing, in addition to the enzyme, certain kinds of non-chlorophyllous living protoplasm.

II.—(1) There is direct experimental proof that formic acid is a product of the photolytic decomposition of carbon dioxide in the presence of an inorganic uranium salt.

(2) Formaldehyde has not been isolated and identified, in the case of an inorganic uranium salt, but a study of the reactions involved favours the view that it is formed as a transitory intermediate product.

MANCHESTER.

Literary and Philosophical Society, October 2.—Dr. W. E. Hoyle in the chair.—An account of *Eucommia ulmoides*, a Chinese tree yielding gutta-percha: Prof. F. E. **Weiss.** The author exhibited a young specimen of the tree, and mentioned that he had two larger ones growing in the open in his garden at Withington. The special interest in this tree lies in the fact that it is the only known plant yielding gutta-percha which can be grown outside the tropics.—A preliminary account of the life-history of the common house-fly (*Musca domestica*, L.): C. Gordon **Hewitt.** The female fly lays her eggs in the crevices of horse excrement, which for this purpose must be fresh. Despite the difficulty met with in getting the flies to lay their eggs in confinement, five lots of larvæ were reared, each batch experiencing different conditions of temperature. A rise in temperature produced an acceleration of the rate of development at any stage. In the larval state three stages are recognisable. The shortest period for the egg state was twenty-four hours, and remained constant. Those for the larval stages were two, two, and four days respectively, whilst that of the pupal state was six days. If these times be taken, the whole period from the deposition of the egg to the exclusion of the imago would last about fifteen days. In the actual experiments the total period varied from twenty to thirty days.

DIARY OF SOCIETIES.

WEDNESDAY, OCTOBER 17.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Some Rotifera of the Sikkim Himalaya: J. Murray.—*Cornuvia serpula;* a Species of Mycetozoa new to Britain: J. M. Coon.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, OCTOBER 18.

CHEMICAL SOCIETY, at 8.30.—Presentation of the Longstaff Medal to Prof. W. Noel Hartley.—The Amino-dicarboxylic Acid derived from Pinene: W. A. Tilden and D. F. Blyther—The Preparation and Properties of Dihydropinylamine (Pinocamphylamine): W. A. Tilden and F. G. Shepheard.—Determination of Nitrates: F. S. Sinnatt—The Nature of Ammoniacal Copper Solutions: H. N. Dawson.—Malacone, a Silicate of Zirconium containing Argon and Helium: S. Kitchen and W. G. Winterson.—The Relationship of Colour and Fluorescence to Constitution, Part i., The Condensation Products of Mellitic and Pyromellitic Acids with Resorcinol: O. Silberrad.—The Colouring Matters of the Stilbene Group, Part. iii.: A. G. Green and P. F. Crosland.—(1) Separation of *aa*- and *ββ'*-Dimethyladipic Acids; (2) Action of Alcoholic Potassium Hydroxide on 3-Bromo-1 : 1-Dimethyl-hexahydrobenzene: A. W. Crossley and N. Renouf.—(1) The Compounds of Pyridine with Dichromates; (2) The Normal Chromates and the Unsaturated Character of the Chromate Radical: S. H. C. Briggs.—(1) Interaction of Succinic Acid and Potassium Dichromate, Note on a Black Modification of Chromium Sesquioxide; (2) Derivatives of Polyvalent Iodine; the Action of Chlorine on Organic Iodo-derivatives, including the Sulphonium and Tetra-substituted Ammonium Iodides: E. A. Werner.—(1) New Derivatives of Diphenol (4·4'-Dihydroxydiphenyl); (2) The so-called "Benzidine Chromate" and Allied Substances: J. Moir.—The Interaction of the Alkyl Sulphates with the Nitrites of the Alkali Metals and Metals of the Alkaline Earths: P. C. Rây and P. Neogi

INSTITUTION OF MINING AND METALLURGY, at 8.—The Auriferous Rocks of India, Western Australia, and South Africa: M. Maclaren.—Sand Sampling in Cyanide Works: D. Simpson.—Treatment of the Precipitate and Manipulation of the Tilting Furnaces at the Redjang-Lebong Mine, Sumatra: S. J. Truscott.—A Combined Air and Water Spray: T. White.

FRIDAY, OCTOBER 19.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—*Discussion:* Railway-motor-car Traffic: T. H. Riches and S. B. Haslam.—*Paper:* Some Notes on the Mechanical Equipment of Collieries: E. M. Hann.

CONTENTS.

SUPPLEMENT TO "NATURE."

THE ENTROPY OF RADIATION.

Vorlesungen über die Theorie der Wärmestrahlung. By Dr. Max Planck. Pp. viii+222. (Leipzig: Johann Ambrosius Barth, 1906.) Price 7 marks.

A QUANTITY of heat Q is transferred by radiation from a body the surface of which is at temperature T_1 to a body the surface of which is at a lower temperature T_2. From this cause alone the former body loses a quantity of entropy Q/T_1, while the latter gains a quantity of entropy Q/T_2. The net gain of entropy of the bodies arising from the transaction is $Q(1/T_2-1/T_1)$. Where and how does this gain take place?

Some people have expressed the view that the notion of entropy has no place in radiation phenomena, and that it is only a convenient symbol introduced for the purpose of representing a certain class of heat phenomena occurring in material bodies. But the entropy gained or lost by a body measures the gain or loss of unavailable energy on the supposition that energy can be converted into work by means of ideal reversible engines working between the body and an indefinite medium at unit absolute temperature. It will thus be seen that the change of entropy above considered represents a definite amount of what Mr. Swinburne calls "incurred waste," a change which cannot be undone, which leaves an indelible imprint on the state of the universe, which represents a loss of availability, or, from an engineering point of view, a loss of value. We might say that, though the energy Q has not been altered in amount, it has become a less marketable commodity by the change. It thus becomes important to examine exactly where and how the change of entropy has taken place, that is, to extend the notion of entropy to the ether.

If we begin by attempting to apply reversible thermodynamics to the ether, we arrive at a single result only, namely, Boltzmann's differential equation connecting Maxwell's formula for the radiation pressure with Stefan's law for the intensity of radiation inside a black cavity. For this particular kind of radiation entropy is fully defined, and the energy per unit volume being proportional to the fourth power of the absolute temperature, the entropy is proportional to the cube, being 4/3 of the energy divided by the temperature.

In this case there is no violation of the relation between unavailable energy and entropy which forms the basis of the thermodynamics of a material body. At the temperature of the cavity the unavailable energy represented by the entropy is 4/3 of the total energy, but the discrepancy is accounted for by the work of expansion against the radiation pressure. Further, as the author shows, the gain of entropy when communication is established between two black cavities at unequal temperatures is calculable by ordinary thermodynamic methods, just as is the gain of entropy produced by diffusion of two portions of gas at unequal pressure or temperature or both.

Irreversible changes will necessarily occur at the surface of a body unless either the surface is perfectly reflecting or the incident radiation in the ether is of the character of black-cavity radiation; for the radiation emitted by a body is necessarily distributed in all directions, while it can absorb radiation falling on it in particular directions.

If, on the other hand, a uniformly heated black body is radiating heat into space, the radiation received at an external point will be limited in direction by the solid angle which the body subtends at that point, and this will decrease as the distance from the body increases, but no passage of heat from a hotter to a colder body is necessarily associated with the outward propagation of the radiation. We may imagine an ideal perfectly reversible burning glass capable of concentrating the radiation on a receiving body in such a way that it converges from all directions on the body, the solid angle formed by the directions being thus increased to 2π. If the radiating and receiving bodies are perfectly black, the latter will be in a state of thermal equilibrium with the ether if its temperature is equal to that of the radiating body, and the radiation may thus be absorbed at the temperature of emission by perfectly reversible methods.

This does not mean that the outward propagation of radiation from a finite body is reversible, for if a body, say a sphere, commences to radiate into infinite space previously devoid of radiation, available energy is lost in consequence of the radiation pressure set up. If, now, we imagine the sphere surrounded by a concentric perfectly reflecting sphere, and suppose that at the surface of this latter the energy of radiation per unit volume is ψ and radiation pressure f, then, if the volume of the sphere is decreased by dV, the sphere will have to absorb heat-energy ψdV which is unavailable at the temperature T of the sphere, and, moreover, available energy $f dV$ will have to be supplied in order to overcome the radiation pressure. Hence it appears that even in this case the entropy per unit volume at any point of the ether assumes the form $(\psi+f)/T$, where T is the black-body temperature corresponding to the same intensity of radiation per unit solid angle. And as the radiation proceeds outwards the quantity $f dV/T$ represents the gain of entropy over and above the quantity of entropy taken from the radiating sphere which is given by the dQ/T formula.

These introductory statements will give some idea of the difficult task which Dr. Planck has undertaken in his endeavour to trace the connection between radiation phenomena and the assumed principles of irreversible thermodynamics. So many physicists have given up this task as hopeless that Dr. Planck has had to rely, to a large extent, on his own investigations; and the list of original papers, published between 1896 and 1902, affords an insight into the amount of time and thought the author has given to the subject in its many and varied aspects. The present book, based as it is on the courses of lectures delivered by Dr. Planck at Berlin during the session 1905–6, is intended to place the whole subject before the reader in a connected form. Briefly stated, the following is the order of treatment:—

The book opens with an introductory sketch of definitions and first principles, the proof of Kirchhoff's law, and the definition of a black body. In the second section we have an investigation of Maxwell's formula for the radiation-pressure, Boltzmann's proof of Stefan's law, and Wien's law of distribution of the energy over the different parts of the spectrum, based on the well-known application of a modified form of Doppler's principle. In the last chapter of this section Dr. Planck gives a general discussion of the entropy and temperature of monochromatic radiation. Although the method of treatment is different from that adopted in the introductory part of this review, the conclusions appear to be identical. In particular, it is pointed out that emission without absorption is irreversible, absorption without emission impossible.

In the third part emission and absorption are considered from the point of view of the electromagnetic theory. A resonator is under the influence of periodical or stationary waves. In these circumstances Dr. Planck investigates the oscillations induced in the resonator, and assigns meanings to the entropy and temperature of the resonator which account satisfactorily for reversible phenomena; but the equations of the electromagnetic field being deducible from those of rational dynamics cannot of themselves account for irreversibility, for, corresponding to the solution representing any given process, another solution representing the reverse process can be obtained by changing the sign of the time-differential *dt*. Whether the case is stated in this or in some other form, there is no *a priori* reason for asserting that waves cannot converge to a point as readily as they diverge from it. The convergent wave motion simply represents a second solution of the differential equation of propagation, which is commonly omitted merely on the grounds that the corresponding phenomenon does not exist.

The subsequent sections represent an exposition of the valuable work done by Dr. Planck in applying to radiation phenomena the same probability considerations which have led to such fruitful results at the hands of Boltzmann in connection with the kinetic theory of gases. Dr. Planck starts with the assumption that the entropy of a system in a given state depends in some way on the probability of that state, whence it follows that if the system consists of two parts which are independent of each other, and we assume that the entropy of the whole is the sum of the entropies of the parts, the entropy must be a logarithmic function of the probability. A short account of Boltzmann's work for the case of monatomic gases follows, and Dr. Planck then shows how to determine expressions for the entropy of radiation from analogous considerations.

Now Boltzmann's work was not independent of an assumed *a priori* law of probability. He first supposed that for an individual molecule all values of the energy were *a priori* equally probable, and, considering the case of a large assemblage of molecules the total energy of which was constant, he found that the most probable distribution only agreed with the Boltzmann-Maxwell law in the case in which the molecules were moving *in two-dimensional space*. To obtain the Boltzmann-Maxwell law in other cases it was necessary to start with the assumption that for an individual molecule all values of the *coordinates and momenta* were *a priori* equally probable. If we mistake not, Dr. Planck in § 148 starts with Boltzmann's first assumption. He supposes he has to deal with a large number N of resonators, that the total energy is divided into a large number P of equal elements, and that these elements are distributed at random among the resonators perfectly independently of each other. This is, of course, an assumption, but it is shown in § 150 to be equivalent to assuming that all values of the electric and magnetic coordinates of the resonator (f and df/dt) are equally probable. There appears, however, to be an alternative assumption in the case of oscillators distributed in space, namely, that all values of the rectangular components of f and df/dt are equally probable, and this might lead to a different result. Would it? and if so, which is right?

In any case, the important fact remains that Dr. Planck obtains results consistent with Stefan's law, notwithstanding that this law cannot possibly represent equipartition of energy at all temperatures between ether and matter. Perhaps the other assumption here suggested would result in equipartition, or the writer of this review has omitted to take account of something in the book. The fifth section is mainly taken up with applications to irreversible processes. In it the consequences of imagining a direct reversal of radiation processes are carefully discussed; the behaviour of an oscillator in a field of radiation is then investigated; the next chapter deals with the conservation of energy and increase of entropy, and, finally, we have a detailed discussion of the particular case of an oscillator exposed to black-body radiation.

It will be thus seen that Dr. Planck's work belongs to a class of investigation which has played an all-important part in building up our knowledge of physical phenomena. It deals with the logical consequences of certain well-defined hypotheses, and as such brings us measurably nearer obtaining a clear and definite idea regarding the irreversible processes associated with radiation. Moreover, the author is careful to define the limitations of his method. As he points out, an unfilled gap still exists in the theory, as he does not fully discuss the tendency to an equilibrium state between oscillations of different periods. The fact that the oscillators are really in motion shows, in connection with Wien's method, that there is a tendency to an equilibrium distribution, and this process may be capable of association with increase of entropy. All readers must express the hope that Dr. Planck may have an opportunity of pursuing this investigation further.

Dr. Planck's book has the great merit of being very readable and intelligible. It is quite easy to see everywhere what the author is driving at; many points of discussion that a reader would naturally suggest are considered by him exactly where the discussion is wanted, and it will be very easy to criticise the work in the light of any further developments which may arise at the hands of future investigators.

In extending the notion of entropy to radiation, he is working on the lines best calculated to advance our knowledge of thermodynamic phenomena. When a system is in the course of undergoing an irreversible transformation, the entropy at any instant is a definite quantity, provided that at that instant it is possible to conceive a reversible compensating transformation which would bring the system back to its initial state, and also that a definite line can be drawn between the forms of energy that are to be regarded as available and unavailable. In the case of radiation, it is important to push the notion of entropy as far as it will go. Only when this has been done, and the results compared with those of experiment, will it be possible to say whether any limitations exist in the statement that perpetual motion of the second kind is impossible; but the vague and indefinite statements that have hitherto been made regarding the possibility of such motion have mostly been based on the consideration of processes which, when performed cyclically, involve considerable absorption of available energy, and the prospects of obtaining perpetual availability from the ether in *ordinary* cases of radiation are anything but hopeful.

G. H. BRYAN.

ELEMENTARY BOTANY.

(1) *A Text-book of Botany.* By John M. Coulter. Pp. vii+365. (London: S. Appleton, 1906.) Price 5*s*. net.

(2) *A First Course in Practical Botany.* By G. F. Scott Elliot. Pp. viii+344. (London: Blackie and Son, 1906.) Price 3*s*. 6*d*.

(3) *First Studies of Plant Life.* By G. F. Atkinson. Edited for use in English Schools by Miss E. M. Wood. Pp. xiv+266. (Boston and London: Ginn and Co., 1905.) Price 2*s*. 6*d*.

(4) *A Text-book of Botany.* Part i. The Anatomy of Flowering Plants. By M. Yates. Pp. v+147. (London: Whittaker and Co., 1906.) Price 2*s*. 6*d*. net.

(1) INFLUENCED, it may be, by one's early training, it has always seemed most reasonable to begin an elementary course of botany with morphology, working in so soon as convenient the explanation of form and structure in the light of purpose served, an arrangement that is adopted by Prof. Coulter in his text-book.

The nature and modifications of leaf, stem, and root are first considered, after which the student is directed to the study of unicellular organisms, then to the examination of types of increasing complexity selected from the main taxonomic groups. The summaries of these groups have been carefully prepared, the account of the fungi being specially comprehensive yet brief. Following on the Bryophyta and ferns, a brief sketch of the two generations of the horsetails and lycopods leads up to the phanerogams. The lessons on flowers and fruits are introduced with the angiosperms, and ecology receives due recognition in the last few chapters.

As the book is liberally supplied with illustrations, chosen with much forethought, it is observable that Prof. Coulter has brought his extensive survey within a remarkably small compass. The merit of the book lies in the judicious selection of essential facts and principles. The numerous references to economic plants constitute a novel feature that is most noticeable in the chapters on the classification of phanerogams. There would be little or no objection to offer if the author made the most of their botanical characters, but these are omitted, and only commercial facts are given, occupying space that would be better filled with botanical information.

Apart from this adverse criticism the book deserves high commendation, and is admirably suited to its purpose for use in secondary schools.

(2) The practical course drawn up by Mr. Scott Elliot presents a somewhat unusual arrangement, inasmuch as the experiments are grouped on a morphological basis; this has, it is true, some advantages, but not sufficient to prefer it to the more usual physiological disposition.

A considerable amount of space is devoted to the flower, as, in addition to one or two chapters, full descriptions of two or more flowers are appended to each day's work. The practice of giving students, when time is available, a few flowers each day is excellent, but it seems unnecessary to provide detailed descriptions of all of them; further, the sequence—if there is a sequence—is not suitable to beginners. The theoretical discussions preceding, but not always relevant to, the practical work are also long, and curtail the space that is allotted to the actual experiments. The experiments, numbering nearly a hundred, are fairly representative, although the fundamental experiments of transpiration, respiration, and osmosis are not so satisfactory or complete as one could have wished. A sufficient amount of anatomical work is included, and a useful bibliography is appended referring the student to accounts of original investigations.

(3) Among the many elementary books dealing with plant life, the studies by Prof. G. F. Atkinson, published about four years ago, have a freshness and vitality of their own. The numerous references to American plants that are not known in this country robbed the book of much of its value for use in schools in the United Kingdom. This defect has been remedied by the introduction of British types, also, we note, of British expressions. Excellent as were the original drawings and photographs, the substitutes prepared by Miss Wood and Dr. J. W. Ellis are quite up to the same standard.

(4) The small volume prepared by Miss Yates is on the lines of the German "Repetitorium," and presents a collection of morphological definitions and terms with illustrations. In the course of thirteen chapters the author collates the different organs of flowering plants, their modifications, and the scientific terms

used to denote special features. The list of terms is very complete, and includes a few, *e.g.* "marcescent," "fovilla," and "sobole," that would not have been missed. A few of the definitions, notably those of the seed and leaf, might be more accurately expressed, and among misprints one of the most noticeable is "aetoeris" for "etaerio"; but on the whole the author has done her work well, and the book should prove useful.

THE PHOTOGRAPHY OF COLOUR.

Natural-colour Photography. By Dr. E. König. Translated from the German, with additions, by E. J. Wall. Pp. 94. (London: Dawbarn and Ward, Ltd., n.d.)

Colour-correct Photography. By T. Thorne Baker. Pp. 95. (London: Dawbarn and Ward, Ltd., 1906.) Price 1*s.* net.

THE first of these volumes deals with the reproduction of colour and the second with the representation of coloured objects in black and white or monochrome.

Towards the end of the first volume we read that "colour photography is not a purely mechanical copying of nature, carried out with mathematical precision, and that, indeed, it will never be. He who works quite automatically will never advance." The statement as to the present is certainly true, and the prophecy, though bold, is, literally, justifiable so far as experience goes. The reproduction of colour is thus essentially different from the representation of form, for this latter depends only on the perfection of one's instruments and a commonly intelligent use of them. Colour photography, as at present practicable, may be described as a kind of simplified chromolithography, inasmuch as the choice of colours rests with the worker or those who provide him with materials, and the depth of tint depends on the worker's judgment. Its distribution is mechanical, but, again, this depends on the colour-screens or filters used in the photography, which are never more than approximately what they are desired to be. And when it is remarked that the colours used are none of them permanent in the sense in which carbon or platinum is permanent, it is obvious that, so far as the colour goes, colour photography does not furnish more trustworthy records than painting or any other colour-production method, except, perhaps, that the possible errors of the unskilful may be a little more limited.

At the same time, there are certain principles which, if they could be perfectly applied, would give perfect colour reproduction. Remarkably fine work has been done by those who have adhered as closely as possible to these principles, as well as by those who have trusted chiefly to empirical methods. The volume before us is a small one; it merely mentions the underlying principles, being devoted almost entirely to the practical details of the "subtractive method" of three-colour photography, that is, where the three coloured prints are superposed so that their absorptions are added, and to the "additive method," in which the three colours themselves are added to each other, as when they are separately projected by optical means on to the same screen, or united in the eye itself by means of mirrors. That the two methods are not so radically different as they might at first appear to be is obvious from the fact that, to a certain extent, the colour-screens used are interchangeable. We think that a little more of the theoretical basis would have made the practical details more understandable. Spectrum diagrams of the effects of the various colour-filters might have been given, and, in dealing with three-colour work, some confusion might have been avoided by omitting the reference to yellow as a fundamental colour, thus giving four colours instead of three to deal with. We are astonished to read at p. 47 that "it is a recognised fact that photography always reproduces shadows much too dark." It would have been better to blame the photographer for this rather common error than apparently to justify him by suggesting that he is helpless.

As to the scope of the volume, photo-mechanical methods are altogether and designedly excluded, as the book professes to appeal to amateurs and others who are photographers, but not to commercial printers. The direct processes such as Lippmann's, and those in which the colour work is practically done by the maker of the materials, are only shortly referred to in the introduction. As a practical guide to the working of those methods that are now generally available for amateurs the volume will be found very useful, as it gives formulæ for the various colour-filters and dyes for staining, quite practical instructions for making the filters and other apparatus, and deals systematically with the subject.

Mr. Thorne Baker's volume is more than the title indicates, for he gives a chapter on the representation of colours incorrectly, as may be sometimes desirable for distinguishing emphatically between two or more colours. To get a coloured flashlight that will shorten the exposure by increasing the brilliancy of the colours to which the plate is less sensitive, he recommends to mix magnesium powder with a twentieth to a fortieth part of a mixture of equal weights of calcium and lithium carbonates. The author gives much other useful information in the ten chapters that deal with the various branches of the subject. We do not see, however, why the exposure should be shortened when the studio blinds are coloured instead of using a coloured screen as usual, nor why metol should be "*not* recommended" as a developer. Such advice would be more acceptable if the reasons for it were given. The explanation given at p. 85 of the fact that "the exposure required with cells of different thickness does not vary directly as their width" is incorrect; it is not a matter of absorption by the glass sides of the cell, but of the selective absorption by the coloured liquid. But the book as a whole forms a useful introduction to the subject, and contains some formulæ and suggestions rarely met with.

C. J.

ESSAYS AND ADDRESSES ON CHEMISTRY AND PHYSICS.

Abhandlungen und Vorträge zur Geschichte der Naturwissenschaften. By Prof. E. O. von Lippmann. Pp. xii+590. (Leipzig: Veit and Co., 1906.) Price 9 marks.

THE author of these collected essays and addresses, the director of the sugar refinery at Halle, is perhaps best known to English chemists by his contributions to the chemistry of the sugars and his comprehensive treatise on the same subject. Dr. Lippmann is clearly, not only a sugar technologist and chemist, but a classical scholar and litterateur.

The essays before us deal mainly with the history of various branches of physical and chemical science, and have been written, as a rule, to commemorate some special occasion. From the chemistry of Pliny and Dioscorides we pass to the history of freezing mixtures, of gunpowder, of the thermometer, and of bismuth. The history of sugar and the discoveries connected with its development have naturally claimed a share of the author's attention.

In the final section are included such divers subjects as the scientific work of Lionardo da Vinci, the philosophy of Francis Bacon, the natural science of Shakespeare, a tercentenary address on Descartes, and the law of the conservation of energy of Robert Mayer. The essays are short, the style simple and easy, and the matter excellent.

The ordinary chemist with little leisure for historical research and unequipped with the requisite classical erudition will find these pages full of things which he is glad to know. He discovers, for example, that Geber, whom he has probably been taught to venerate as the greatest of the Arabian alchemists, must take his place beside Basil Valentine as a mythical creation. In the abstract from Pliny's "Natural History" he will find that purified wool-fat (our modern lanoline) was a valued cosmetic among the Romans, and that they were familiar with both a hard and a soft soap. Whether these corresponded to their modern equivalents we are not informed, nor is it anywhere stated that the caustic alkalis were known, yet the saponification of tallow would doubtless necessitate the use of these substances.

One of the most interesting essays is that on the history of gunpowder. The author takes some pains to establish the fact that saltpetre, and consequently gunpowder, were unknown to the Greeks and Romans, and that the so-called Greek fire was a mixture of which the principal ingredients were mineral oil and quicklime. In contact with water, the heat generated by the hydration of the lime would ignite the mineral oil. The author brings evidence to prove that the Chinese were not the discoverers of gunpowder, and consequently that the Arabians did not introduce it into Europe from China during the eighth and ninth centuries as commonly supposed. The first Arabian writer to mention saltpetre lived apparently early in the thirteenth century, and the author considers that the knowledge of the manufacture of fireworks and gunpowder is derived from the "Fire-book" of Marcus Græcus, which appeared about the middle of the thirteenth century in Constantinople, and was the source from which Roger Bacon, Albertus Magnus, and Thomas Aquinas drew their information. Finally, the use of gunpowder for discharging projectiles is ascribed to the monk Berthold Schwarz, or Bertholdus of the Black Art, who accidentally discovered its power when preparing the mixture for medicinal purposes. The last statement agrees substantially with Boerhaave's account, who says that Berthold made his secret known to the Venetians. "The effect is," says Boerhaave, "that the art of war has since that time turned entirely on this one chemical invention; so that the feeblest boy may now kill the stoutest hero," and he concludes with the pious wish, "God grant that mortal men may not be so ingenious at their own cost as to pervert a profitable science any longer to such horrible uses."

There is one curious point in this interesting story which seems to require explanation. Whilst the author considers that the *nitrum* mentioned by Pliny represents native soda, it seems unlikely that the efflorescence which Pliny also mentioned under nitrum as being collected from walls and used as a manure should in all cases have been this substance. The white efflorescence in cattle stalls and places where animal matter was undergoing putrefaction must have been a common observation, and must date back to a very early time. It is therefore difficult to believe that nitre was unknown until the thirteenth century, as the author states.

Further on in the volume we come across an interesting little contribution to the history of the thermometer in the form of a poem of the early part of the seventeenth century. The name of the first inventor of the thermometer seems to be wrapped in some obscurity. Although Boerhaave in his treatise ascribes the invention to Cornelius Drebbel, of Alcmaer, in W. Friesland, who lived in the sixteenth century, yet in the appendix to his "Elements of Chemistry," published in 1753, of which the writer possesses a copy, he states that Robert Fludd, an Oxford physician who lived at the beginning of the seventeenth century, found in an ancient manuscript a statement to the effect that it was an old invention which had been revived and improved.

One of the essays which is sure to attract the reader is the history of the sugar industry. The various steps are described by which the sugar-cane was transplanted from India to Persia in 500 A.D., introduced by the Arabs into Egypt about 640 A.D., thence along the shores of the Mediterranean to the Canaries, Madeira, and St. Thomas by the Portuguese in 1420, and so to the West Indies, where it flourished so luxuriantly that it killed the European industry. An interesting table of prices, which range from about 40*l.* the cwt. in 1260 to 7*l.* 13*s.* in 1800, is included at the end of the essay.

The two following essays are devoted to the rise and development of the beet-sugar industry, which, like that of the coal-tar dyes, is a history of successful scientific effort. It has taken less than a century for half the sugar of the world to be supplied from the beet.

Space will not permit a more extended review of this interesting volume, but enough has perhaps been said to indicate its character and scope.

J. B. C.

SCIENCE AND ART OF MEDICINE.

A System of Medicine. By many Writers. Edited by Prof. T. Clifford Allbutt, F.R.S., and Dr. H. D. Rolleston. Vol. i. Pp. xvi+1209. (London: Macmillan and Co., Ltd., 1905.) Price 25*s.* net.

A PARAGRAPH in the preface to this new edition of Prof. Clifford Allbutt's great "System of Medicine" sufficiently explains the necessity for a revision. The editors (for Dr. H. D. Rolleston is now associated with Prof. Allbutt in this capacity) point out that "the life of a text-book of medicine is comparatively short, and that it is desirable that a new edition should appear before the first has ceased to represent accurately the present positions of medical knowledge." With this object it is intended to revise and bring out every year a new volume corresponding to one of the first edition.

The volume under review is the first to be issued under this scheme, and interesting and instructive articles by Prof. Allbutt and Dr. Payne on the history of medicine serve as a fitting introduction to the more technical portion. The first half of the latter comprises a number of articles, which are really concise monographs, on subjects ancillary to the practice of medicine, the names of the contributing authors being a sufficient guarantee of their general excellence. In this way the practitioner is furnished with brief but sufficient guides to such subjects as nursing (Miss Amy Hughes), dietetics (Sir Dyce Duckworth and Dr. Hutchison), climatic treatment of disease (Sir Hermann Weber and Dr. Foster), hydrotherapy (Sir Hermann Weber and Dr. Parkes Weber), physical exercises (Mr. Corner), massage (Dr. Mitchell), electrical treatment (Dr. Lewis Jones), X-rays (Dr. Williams), &c. The important subject of the hygiene of youth is dealt with by Dr. Clement Dukes, and a natural complement to this, old age, is discussed by Sir Hermann Weber and Dr. Parkes Weber. Medical statistics are in the able hands of Dr. Tatham, and a readable account of the national records of mortality is thus presented. It is a question whether some details of statistical methods and of the mathematical pitfalls of statistic making might not with advantage have been included.

Five articles have been devoted to the science of medicine; these comprise the general pathology of nutrition, by Dr. Mott; the general pathology of new growths, by Dr. Andrews, which includes all the recent work on cancer genesis; the clinical examination of the blood, by Dr. Drysdale, giving a good account of this important subject; inflammation, by Prof. Adami, probably the best account of this subject in the English language; and fever, by the late Sir J. Burdon-Sanderson, with additional chapters by Dr. Hale White and Dr. Pembrey.

The last 300 pages include some of the acute infections. Septicæmia, pyæmia, and erysipelas are dealt with by Mr. Watson Cheyne; infective endocarditis, by Prof. Dreschfeld; cerebro-spinal fever, by Dr. Ormerod (in which, by the way, no mention is made of the small outbreaks of this disease which have occurred in the British Isles since 1900); influenza, by Dr. Goodhart; and relapsing fever, by Dr. Rabagliati and Dr. Bulloch, the latter giving a very complete and up-to-date account of the bacteriology of the disease and of spirochætes in general.

Enteric fever and the so-called paratyphoid infections are treated in a very complete manner, Prof. Lorrain Smith dealing with the bacteriology and Prof. Dreschfeld with the clinical subjects; no point seems to have been overlooked.

Diphtheria is similarly dealt with in a very complete fashion; epidemiology, by the late Sir R. Thorne, revised by Dr. Hamer; bacteriology, by the late Prof. Kanthack, and revised by Dr. Andrewes; clinical features, by Dr. Gee; and serum treatment, by Dr. Herringham; in the latter section, while eight pages are devoted to statistics showing the efficacy of the treatment, a mere paragraph describes the dosage, &c., and no reference is made to the use of an anti-microbic serum in cases in which the bacilli persist during convalescence.

Tetanus is described by the late Sir George Humphry, the article being revised by Prof. Woodhead. An excellent account of the pathology of the disease is here presented, but the passage of the toxin along the nerve trunks is not emphasised so much as it might be, and no reference is made to the injection of anti-toxin into the course of the great nerves in cases of traumatic tetanus.

Altogether this volume commands admiration, and if its high standard be maintained, as it doubtless will be, in the succeeding volumes, this "System of Medicine" will form a lasting monument of the high place which British medicine holds at the present time.

PRACTICAL ZOOLOGY.

A Course in Vertebrate Zoology. By Dr. H. S. Pratt. Pp. x+299. (London and Boston: Ginn and Co., n.d.) Price 7*s.*

THIS work, a companion volume to one on invertebrates published four years ago, is a laboratory manual, and gives directions for the dissection of the dog-fish, the perch, Necturus, the frog, a turtle, a pigeon, and a cat. It is on the whole a trustworthy guide, and may usefully serve as a handbook for a short course on vertebrate anatomy. The animals chosen are, with two exceptions, already described in text-books available in every laboratory, and we are at a loss to discover what particular office the present volume serves to fill, as in fulness, accuracy, or mode of treatment it does not surpass its predecessors. We presume that it represents the author's course of teaching, and owes its existence rather to the desire to emphasise that experience than to the supposed existence of a gap in anatomical literature which it may be held to fill.

As the writer desires attention to be directed to misstatements or improvements, we may limit our remarks to matters of detail, since of such accurately known types as those he has chosen the bulk of the descriptions can hardly be other than correct. In serial order, then, we note the following points on which revision is required.

The mucous canals of the dog-fish are termed sense-organs (p. 2), instead of the tubes containing the sense-organs; water is said to enter the spiracle as well as the mouth; the anus is described as the outlet of the cloaca (p. 3); and an ear-opening is affirmed and denied in the same paragraph (p. 15). But it is in connection with the nervous system that we encounter the least satisfactory description. No mention is made of the pre-olfactory nerve which has been demonstrated in elasmobranchs, nor of the buccalis branch of the lateral line system; whilst the old and incorrect statement that the lateralis nerve is a branch of the vagus is again repeated. The spinal nerves and limb-plexuses, to which so much attention has lately been directed, are omitted.

In the description of the perch the account of the nervous system is equally unsatisfactory, and there is the same absence of any attempt to delimit the nerves of the lateralis group or to point out their function and distribution. In this respect the work is very much behind the times. A serious slip occurs on p. 45, where, in connection with the ear of the perch, it is stated:—

"At the anterior end of the sacculus is a small pocket containing a minute otolith called the lagena; this is the structure which in mammals becomes the cochlea."

As it stands the sentence is nonsense, since, of course, the pocket, and not the otolith, is the lagena. A similar slovenliness of composition is responsible for such sentences as (p. 67) "Note the position of the limbs in reference to the trunk, which in Necturus is of a primitive character," in which it is hard to say whether the position or the trunk is referred to; or this, "If the human arm be extended straight out from the body with the thumb up . . . the back of the hand will be dorsal . . . ." We should have thought in the position referred to the hand would be vertical.

The description of the frog and of the turtle call for no special remark, but in his prefatory account of the pigeon the author states:—

"Another effect which has been correlated with the loss of teeth in the bird is the development of a greater intelligence. Inasmuch as the weight of the head is strictly limited by the conditions of the animal's existence, a larger brain could develop than would have been possible if the teeth which characterised primitive birds had not disappeared."

A larger brain and greater intelligence are certainly not convertible terms, and it is as misleading to speak of "primitive" birds in this connection as it is to assume that birds' brains have enlarged since Cretaceous times. Such a statement, however, is pardonable in comparison with the explanation of the air sacs on p. 169:—"Their function is somewhat obscure but they probably help supply (*sic*) the lungs during rapid flight." The need for revising the physiological statements made in this book may be shown by this further quotation:—"it is largely because of the development of feathers that birds have become warm blooded"! (p. 166).

The use of the book would have been aided by putting practical directions into special type, and by giving fuller instructions for the injection of blood-vessels. But, notwithstanding these drawbacks, the work remains as a useful guide to those teachers who wish to arrange a course in comparative anatomy.

F. W. G.

TARIFF REFORM AND THE EMPIRE.

Compatriots' Club Lectures. First Series. Edited by the Committee of the Compatriots' Club. Pp. vi+327. (London: Macmillan and Co., Ltd., 1905.) Price 8*s.* 6*d.* net.

THIS volume consists of a series of papers and lectures given at meetings of the Compatriots' Club, a non-partisan body, "constituted" (as the prefatory note states) "in March, 1904, with the object of advancing the ideal of a united British Empire, and of advocating these principles of constructive policy on all constitutional, economic, defensive, and educational questions which help towards the fulfilment of that ideal."

Although the club is non-partisan, the same cannot be said of the papers in this volume. They are mostly controversial in tone, and too frequently adopt the vocabulary of the political platform. The object throughout is to advocate Mr. Chamberlain's Tariff Reform proposals. The two most prominent writers on economic subjects among the contributors are engaged in almost purely personal conflicts with their opponents on the fiscal question. Prof. Ashley, in "Political Economy and the Tariff Problem," gives an interesting, and indeed masterly, sketch of the progress of economic science from Adam Smith and Friedrich List to the present time, with the main object, however, of providing a counterblast to the manifesto on the fiscal question by fourteen English economic experts, which appeared some two years ago. Dr. Cunningham, in "Tariff Reform and Political Morality," attacks the same manifesto on the curious ground that it was an attempt to "provide the public with excuses for apathy"—"to undertake to do their thinking for them." He makes a similar complaint, with perhaps more point, about another manifesto, signed by some eminent ecclesiastics, which appeared in the *Guardian*, and, incidentally, comes into conflict with Mr. Harold Cox and the editor of the *Echo*.

Mr. J. L. Garvin's paper, read at the inaugural meeting of the club, and since published as a supplement in the *National Review*, on "The Principles of Constructive Economics as Applied to the Maintenance of Empire," which appears first in the volume, describes the club's *raison d'être*. Conscious purpose and effective action of the State itself are to take the place of *laisser faire*. What follows is a re-statement of Mr. Chamberlain's proposals and an estimate of their effects upon national development and Imperial unity. So far he is clear enough, but his argumentative methods are not convincing. He discards the use of statistics, since they do not rouse enthusiasm, and since "no cause was ever carried by figures." Enthusiasm without knowledge is dangerous, and the cause which Mr. Garvin advocates can hardly be carried without figures. Consequently, his recapitulation of the familiar assertions concerning the decline of British industries carry little weight. Mr. Garvin, indeed, admits the general prosperity of this country, but considers it the result of our exceptional natural resources. Elsewhere he attributes the prosperity of Germany and America to their tariffs, not (so far as can be gathered from this paper) to their natural resources. He also makes a bold attack upon the "fallacy" that exports balance imports, but argues from the point of view of *supply*, leaving *demand* out of consideration.

Mr. H. W. Wilson, in "Tariff Reform and National Defence," makes a strong plea for efficiency in the services, and especially for the increased superiority of our naval power. He regards Tariff Reform as the only possible means of raising the required revenue. He adds two valuable tables illustrating the naval expenditure and strength of the chief Powers.

In "Imperial Preference and the Cost of Food," Sir Vincent Caillard maintains that preference will not raise prices, apparently because the foreign producer can defeat the preference given. Sir John A. Cockburn deals with "The Evolution of Empire"; Mr. H. A. Gwynne with "The Proper Distribution of the Population of the Empire," in the course of which he makes some startling suggestions for encouraging emigration to the colonies by State action; and Mr. John W. Hills, in "Colonial Preference in the Past," summarises the history of the "old colonial system," without, however, noticing its effect upon the loss of the American colonies.

J. H. S.

IMPERIAL FOREST POLICY.

Manual of Forestry. Vol. i. Forest Policy in the British Empire. By Dr. W. Schlich, F.R.S. Third edition, revised and enlarged. Pp. ix+246. (London: Bradbury, Agnew and Co., Ltd.) Price 6*s*. net.

In the present edition Prof. Schlich has made some important additions which add considerably to the value of the volume. The volume is divided into three parts, viz. part i., the utility of forests; part ii., the State in relation to forestry; and part iii., forestry in the British Empire.

In part i. the direct and indirect utility of forests are considered, and the author has stated in a very clear and concise manner the great importance of forests to man. Sometimes people are too apt to estimate the utility of forests according to the money value of the timber grown, and to forget the important and beneficial influence which proper afforestation confers on the soil, the climate, and the whole sister industry of agriculture. The indirect utility of forests is of importance, not only to the proprietor and agriculturist, but to the entire State, and is one of those questions of general interest which has been almost wholly neglected in the past. The author deserves great credit for bringing this matter so prominently into notice.

The duty of the State in relation to forestry forms the subject-matter of part ii., and here the author is entirely at home with a subject to which he has given much time and thought, and on which he is a recognised authority. The extent to which the State should go in maintaining, or assisting in the maintenance of, forests is carefully considered from a thoroughly practical point of view.

In part iii. the wider question of forestry in the British Empire is dealt with in a very masterly fashion. As a result of his long experience and wide knowledge, the author is well able to deal with this subject. Space forbids our entering into details, but we are quite certain that but few people realise the enormous amount of revenue which is at present lying dormant or actually lost to the Empire through the deplorable inattention that is given to many of our colonial forests. India is, of course, a notable exception, and the success which has attended proper forest policy in that part of the Empire should stimulate other colonies to follow the good example. This, however, they seem slow to do. Nevertheless, there are signs of awakening interest, for example, in Canada. Many of our colonial forests have suffered severely at the hands of settlers through pure lack of knowledge. It is quite possible to use the forest without abusing it, and to cut timber in such a way that the forest will continue to give a sustained, if not increasing, yield; but this implies a proper knowledge of forestry, and here the author makes out a strong case for improved educational facilities, the end results of which would be increased revenue and benefits from our forests at home and in all parts of the British Empire.

As an example of what may be done in this direction, Prof. Schlich shows (p. 106) how, principally through the exertions of one man, namely, Dr. Brandis, "the greater portion of the Lower Burmah teak forests was saved, forests which now yield an average annual net revenue of 2½ million rupees."

The volume contains many well-chosen photographs to illustrate the different points mentioned in the text, as well as a rainfall map of India. A useful appendix dealing with forestry in the United States is also included in the book. The author is to be congratulated on the production of a work which is of true importance from a national point of view.